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

Data Acquisition & Processing Report

Type of Survey *Multibeam and Side Scan Sonar*

Project No. *OPR-E350-TJ-10*

Time Frame: *16 Mar, 2010 –8 Apr, 2010*

LOCALITY

State *Virginia*

General Locality *Southern Chesapeake Bay*

2010

CHIEF OF PARTY

CDR Shepard M. Smith
National Oceanic and Atmospheric Administration

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A. EQUIPMENT

The methods and systems described in this report are used to meet Complete and Object detection coverage requirements and are in accordance with the Hydrographic Surveys Specifications and Deliverables Manual (April 2009), Hydrographic Survey Directives, and the Field Procedures Manual for Hydrographic Surveying (April 2009).

The Survey Vessels

The platforms used for data collection were the *NOAA Ship Thomas Jefferson,* (Figure A-1) and *Hydrographic Survey Launches 3101 and 3102* (Figure A-12). *THOMAS JEFFERSON* acquired multibeam echosounder (MBES) data, Side Scan Sonar (SSS) imagery and sound velocity profile (SVP) data. The vessel is equipped with a DT Marine Products tow winch (Model 307EHLWR) for side scan deployment, and a DT Marine Oceanographic winch with approximately 1500m of galvanized steel cable for CTD and bottom sample deployment, and a Brooke Ocean Technology MVP 100 Moving Vessel Profiler (MVP). Launches *3101* and *3102* acquired multibeam echosounder (MBES) data, vertical beam echosounder (VBES) data, Side Scan Sonar (SSS) imagery and sound velocity profile (SVP) data. Table A-1 presents the vessel characteristics for all platforms.

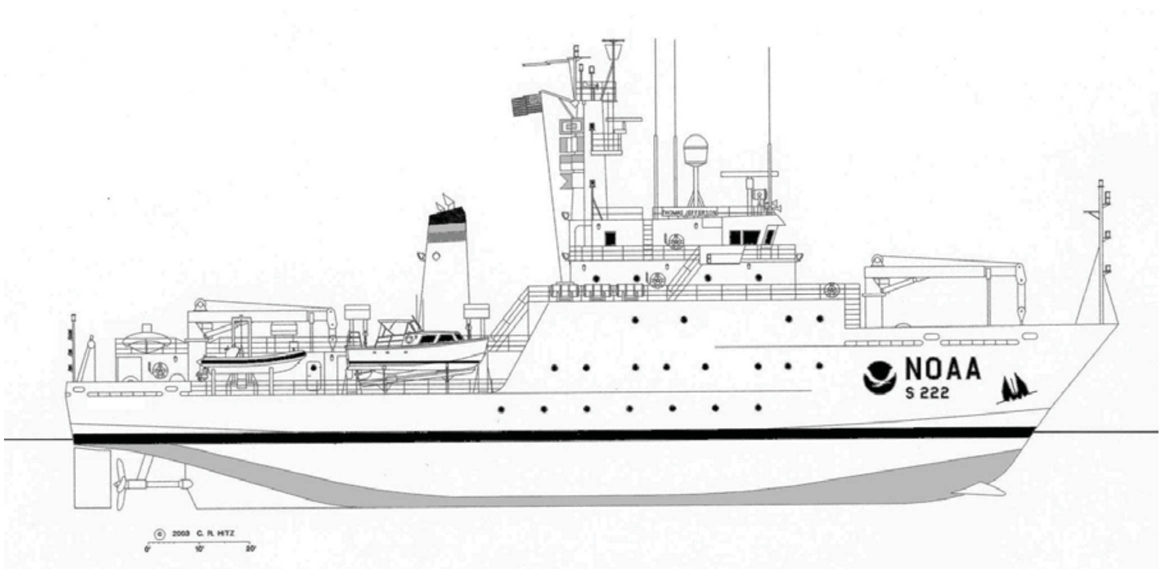


Figure A-1. The NOAA Ship *Thomas Jefferson*

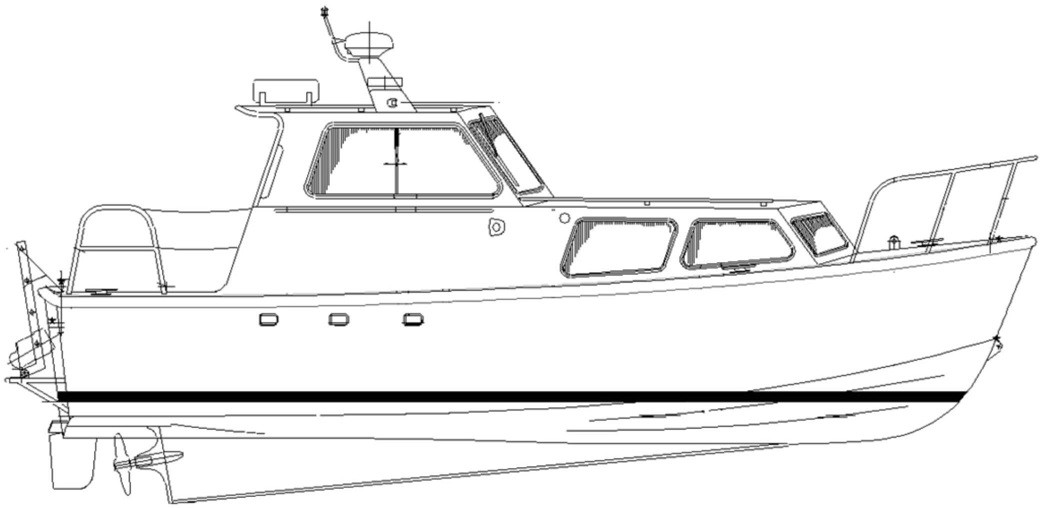


Figure A-2. Hydrographic Survey Launch *3101/3102*

Vessel Name	LOA (Ft)	Beam (Ft)	Draft (Ft)*	Survey Speed	Date of last Vessel Survey	Date of last Dynamic Draft Measurement
NOAA Ship Thomas Jefferson	208’	45’	14.0’	5-10 kts	3/10/2005	3/11/2010
HSL 3101	31’	10’8”	5’2”	4-12 kts	1/20/2010	3/12/2010
HSL 3102	31’	10’8”	5’2”	4-12 kts	1/20/2010	3/13/2010

Table A-1. Survey Vessel Characteristics

* The draft listed is a nominal draft, actual draft of the vessels depends on loading

Data Acquisition Systems

A complete listing of the data acquisition systems used for Project OPR-E350-TJ-10 is listed in Appendix A of this report.

A.1 ODOM Echotrac CV-200

The Echotrac CV-200 is a dual-frequency digital recording echosounder system with a digital recorder. The systems high frequency setting is 200 kHz, low frequency is 24 kHz. It is hull-mounted on HSL *3101*and *3102*.

On Launches *3101* and *3102*, the transducer is mounted on the port side forward of the retractable arm that accommodates the RESON 7125-SV (Figure A-3). The installation of the Odom on Launch *3101, 3102* allows simultaneous acquisition of KLEIN 5000 side scan with general survey-grade bathymetry when the ODOM is operated in either low or high frequency mode.

Figure A-3. Odom Vertical Beam on *3101 / 3102*

For the purposes of calculating total propagated error (TPU), the ODOM Echotrac CV-200 is assumed to be a single-frequency multibeam transducer with one beam. The maximum across-track and along-track beam angles are assumed to be identical at a value of 7.5°. The sonar is assumed to have a pulse length of 0.1 ms at 100 kHz and a ping rate of 20 Hz.

The ODOM Echotrac is used with side scan sonar to meet NOAA requirements for object detection.

Owing to its wide beamwidth, vessel pitch and roll calculations are not applied to ODOM Echotrac data. During typical acquisition conditions, the high-frequency beamwidth is sufficiently wide to receive a primary-lobe hit at nadir regardless of vessel attitude. This breaks down, however, when the vessel pitches more than 3° or rolls more than 5°. Care is taken to avoid using the ODOM as the primary source of bathymetry in situations where the pitch or roll would cause attitude artifacts or side-lobe hits.

Notable Odom Echotrac equipment changes:

None, new equipment installation for 2010 field season, new .hvf files created.

A.2 RESON SeaBat 7125 Multibeam Echosounder

The RESON SeaBat 7125 system is a single-frequency, digital recording multibeam echosounder with a central frequency of 400 kHz. The RESON 7125 system aboard *THOMAS JEFFERSON* is installed in a steel housing assembly with hydrodynamic shape mounted to a pylon extending from the starboard hull of the ship (Figure A-4).

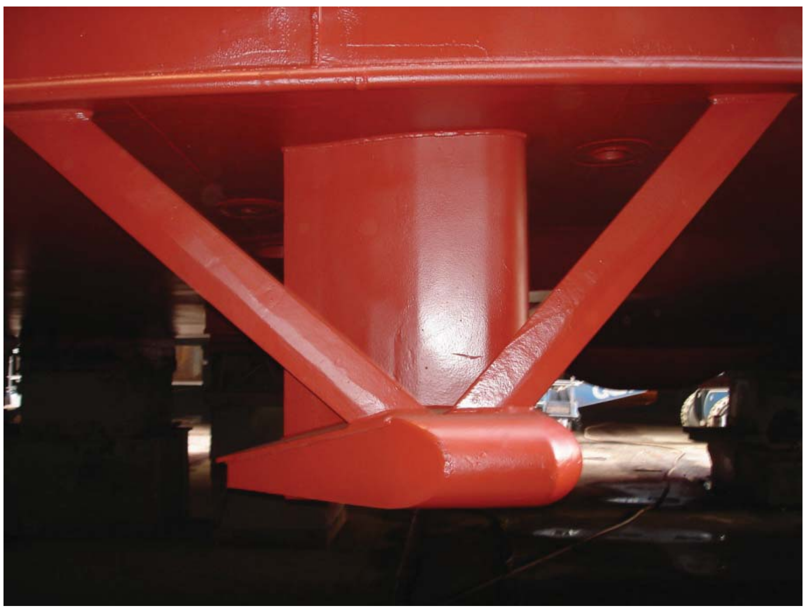


Figure A-4. 7125 Housing on *Thomas Jefferson*

The RESON 7125 forms 256 beams and can be set to interpolate to 512 beams. The RESON 7125 and can be set to acquire equi-distant or equi-angular beam spacing. Each beam in the receive array has a 0.5° across-track resolution and 1° along-track resolution. The RESON 7125 has a maximum ping rate of 48 Hz and can achieve a full swath width to a depth of 75m. Standard operating procedure on *Thomas Jefferson* is to acquire 512 beam equi-distant bathymetry.

The sonar contribution to the total propagated error is computed using parameters provided by the manufacturer and distributed with Caris HIPS.

The RESON 7125 performs active beam steering to correct for sound velocity at the transducer head using an Applied Microsystems LTD Sound Velocity and Temperature Smart Sensor. This sensor will be discussed in more detail in the Sound Velocity Equipment Section.

The user selectable range scale on the RESON 7125 was adjusted using the "autopilot" settings, or by hand. In some cases during skunk striped surveys or complete coverage surveys, the range scale was set one setting higher than optimal to reduce noise in the data.

A.3 RESON SeaBat 7125_SV Multibeam Echosounder

The RESON 7125-SV system aboard Launches *3101, 3102* are installed on a RESON Seabat 7125 mounting bracket deployed on a retractable arm from the hull. (Figure A-5).

Figure A-5. 7125-SV Housing on Launch *3101/3102*

The RESON 7125-SV forms 256 beams and can be set to interpolate to 512 beams in the receive array and can be set to acquire equi-distant or equi-angular beam spacing. Standard operating procedure on *Thomas Jefferson* is to acquire 512 equi-distant bathymetry. The 400 kHz frequency has a 0.54° across-track resolution and 1° along-track resolution. The 200 kHz frequency has a 1.1° across-track resolution and 2.2° along-track resolution. The RESON 7125-SV has a maximum ping rate of 50 pings/s and can maintain a full swath width in depths of 1-75 m for the 400 kHz, and 1-150 m for the 200 kHz systems.

The sonar contribution to the total propagated error is computed using parameters provided by the manufacturer and distributed with Caris HIPS.

The RESON 7125-SV performs active beam steering to correct for sound velocity at the transducer head using a RESON Sound Velocity Probe (SVP) 70. This sensor will be discussed in more detail in the Sound Velocity Equipment Section.

The user selectable range scale on the RESON 7125 was adjusted using the "autopilot" settings, or by hand.

Notable RESON7125-SV equipment changes:

New equipment installation for 2010 field season, new .hvf files created.
During our pre-season HSRR, HSL 310X experienced a failure of the receiver cable to the Reson 7125SV. As a result of this, HSL 310X was not available for multibeam surveying on H12181 and H12182.

A.4 Kongsberg EM 1002 Multibeam Echosounder

The Kongsberg EM1002 system is a single-frequency, digital recording multibeam echosounder with an operating frequency of about 95 kHz. The EM1002 aboard *THOMAS JEFFERSON* was installed in August 2001 in Jacksonville, FL, while the ship was still under the purview of the U.S. Navy.

The Kongsberg EM1002 transducer consists of a curved transmitter array and flat receiver array encased in an acoustically transparent fiberglass blister that is rigidly fixed to the hull of *THOMAS JEFFERSON* at the keel near frame 20. The KONGSBERG EM1002 forms 111 beams each of which has a 2° across-track beam footprint for a maximum total swath width of 150°. Each beam has an along-track beam resolution of 1.5°. The ping rate is nominally 10 Hz, but may vary depending on water depth, swath width, or user specification. For any given survey area optimal line spacing is determined for the system. A maximum width is set in the acquisition software (using the equidistant setting). The resulting swath is usually less than the maximum of 75 degrees. This compressed swath increases the ping frequency and therefore the data density. The KONGSBERG EM1002 is capable of bottom detection in depths from 5-1000m. Aboard the *THOMAS JEFFERSON* the KONGSBERG EM1002 is used in depths from 15m-1000m. The Windows-based Kongsberg Seafloor Information System (SIS) software package is used to acquire EM1002 data.

Active beam steering is performed to correct for sound velocity at the transducer head using an Applied Microsystems Smart SV&T sea surface sound velocity sensor. This sensor will be discussed in more detail in the Sound Velocity Equipment section. In addition, the curved face of the transducer array is designed to mechanically steer acoustic energy. An outer beam roll calibration coefficient is determined before starting acquisition for a project. This value is entered into the acquisition software and cannot be post processed.

The Kongsberg EM1002 does not meet NOAA specifications for object detection in shallow water (<20m). Data must be acquired with side-scan sonar.

For the purposes of calculating total propagated error, the KONGSBERG EM1002 is assumed to have an operational frequency of 95 kHz, pulse length of 0.2ms and a typical ping rate of between 1-8 Hz.

The best expected performance of the KONGSBERG EM1002, as installed on *THOMAS JEFFERSON* in 15m of water with an isopycnal water column and sound velocity of 1500 ms-1, is to the IHO Order 1 standard. Actual performance will vary according to sea state, water depth, swell, tide zoning error, and sound velocity spatial and temporal distribution.

The Kongsberg EM1002 was not used during OPR-E350-TJ-10.

A.5 KLEIN 5000 High-speed Side Scan Sonar

The KLEIN 5000 high-resolution side-scan sonar (SSS) system is a beam-forming acoustic imagery device with an operating frequency of 455 kHz and vertical beam angle of 40°. The KLEIN 5000 system consists of a KLEIN 5500 towfish, a Transceiver/Processing Unit (TPU), and a computer for user interface. Stern-towed units also include a tow cable telemetry assembly. There are two configurations for data acquisition using the KLEIN 5000 system: stern-towed and hull-mounted. S-222 uses exclusively towed SSS, HSL 3101 is hull mount configuration, HSL 3102 can be converted from hull-mounted to towed as required.

The KLEIN 5000 system is distinct from other commercially-available side scan sonars in that it forms 5 simultaneous, dynamically-focused receiver beams per transducer face. This improves along-track resolution to approximately 20cm at the 100m range scale, even when acquiring data at up to 10 knots. Across-track resolution is typically 7.5cm at the 100m range scale. The achievable 20cm resolution meets the NOAA Hydrographic Surveys Specifications and Deliverables Manual (HSSDM) for object detection. Digital data from the KLEIN 5000 TPU were sent directly to the KLEIN 5000 computer for display and logging by KLEIN SonarPro software. Raw digital side scan data from the KLEIN 5000 were collected in (SDF) and maintained full resolution, with no conversion or down sampling techniques applied. These files were archived to the raw data storage drives at the end of each line for initial processing and quality control review.

Towfish positioning was provided by CARIS HIPS using cable out values recorded in the Sonar Pro SDF files. This program uses Payout and Towfish Depth, Figure A-6, to compute towfish positions. The Payout and Depth method computed the position of the tow point using the offsets of the tow point from the POS/MV IMU and the vessel heading. The tow fish position was calculated from the position of the tow point using the cable out value received by SonarPro from the cable payout meter, the towfish pressure depth (sent via a serial interface from the KLEIN 5000 computer to SonarPro), and the Course Made Good (CMG) of the vessel. This method assumes that the cable is in a straight line therefore no catenary algorithm is applied at the time of acquisition, but in processing, CARIS SIPS applies a 0.9 coefficient to account for the catenary.

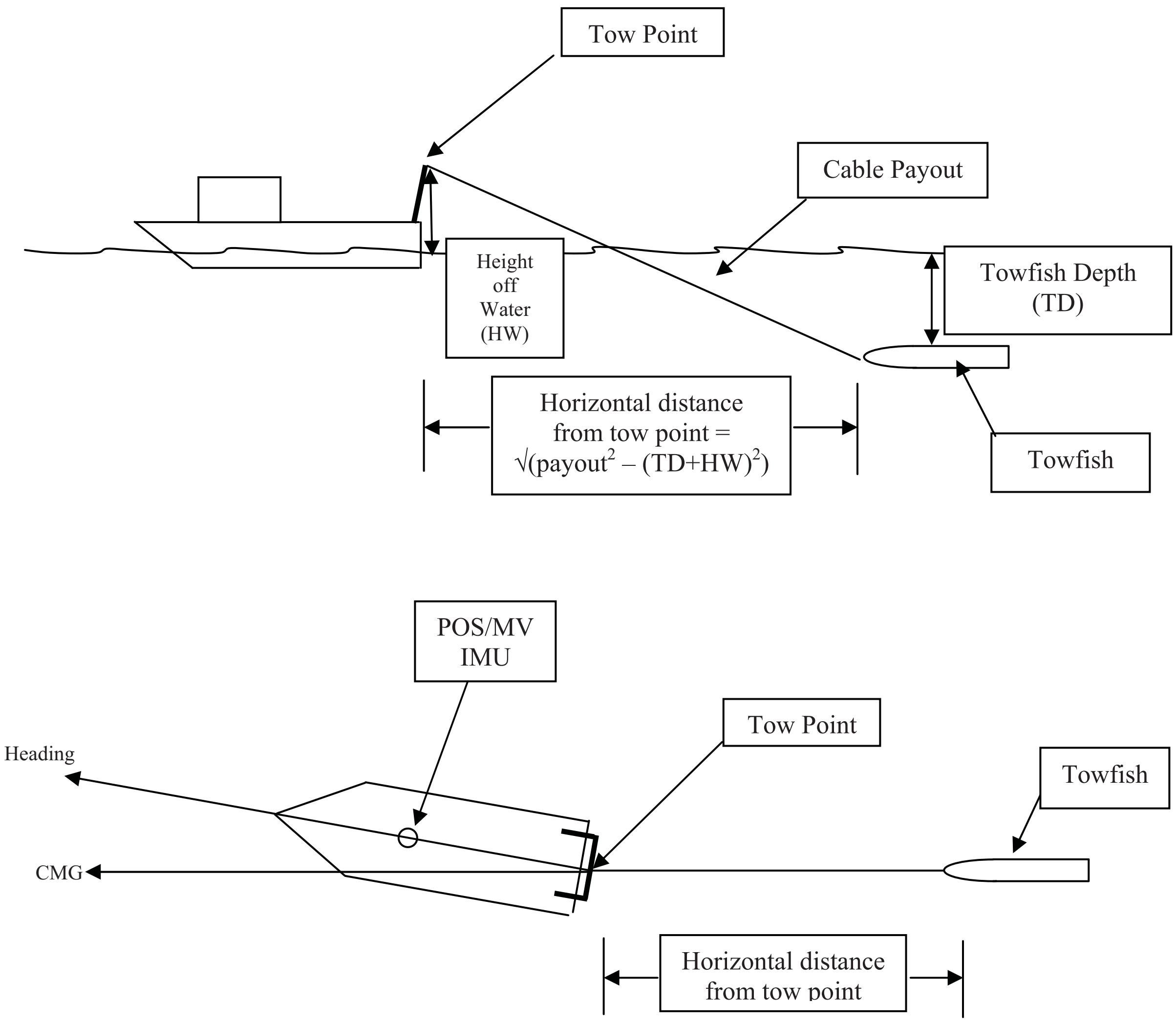


Figure A-6. Side Scan Towfish Position Calculations

The ship's north and east velocity vectors are filtered to calculate the ship's CMG. The CMG is used to determine the azimuth from the tow block to the side scan towfish. The position for the side scan towfish is computed based on the vessel's heading, the reference position (POS/MV IMU), the measured offsets (X, Y, and Z) to the tow point, height of the tow point above the water, Course Made Good and the amount of cable out. This calculated towfish position was sent to the sonar data collection system in the form of a GGA (NMEA-183, National Marine Electronics Association, Global Positioning System Fix Data String) message where it was merged with the sonar data file. Cable adjustments were made using a remote winch controller in acquisition in order to maintain acceptable towfish altitudes and sonar record quality. Changes to the amount of cable out were automatically saved to the SonarPro SDF.

Towfish altitude was maintained between 8% and 20% of the range scale in use (e.g. 4m-10m @ 50m range scale), when conditions permit. For equipment and personnel safety as well as safe vessel maneuverability, data may have been collected at towfish altitudes outside the 8% to 20% of the range over shoal areas and in the vicinity of charted obstructions or wrecks. In some regions of the survey area, the presence of a significant density layer required that the altitude of the towfish be maintained outside the 8% to 20 % of the range to avoid refraction in the sonar data that would mask small targets in the outer sonar swath range. When the towfish altitude was either greater than 20% or less than 8%, periodic confidence checks on linear features (e.g. trawl scars) or geological features (e.g. sand waves or sediment boundaries) were made to verify the quality of the sonar data. Confidence checks ensured the ability to detect one-meter high objects across the full sonar record range.

Another feature that affected the towfish altitude was the use of a K-wing depressor. The K-wing depressor was attached directly to the towfish and served to keep it below the vessel wake, even in shallower near shore waters at slower survey speeds. The use of the K-wing reduced the amount of cable payout, which in turn reduced the positioning error of the towfish. Another benefit to less cable out was the increased maneuverability of the ship in shallow water. Less cable out reduced the need to recover cable prior to turning for the next survey line, permitted tighter turns and increased survey efficiency.

Side scan data file names were changed automatically every 15 minutes and manually at the completion of a survey line.

Notable SSS equipment changes:

Hull-Mounted Configuration
Aboard both survey launches, the lightweight or heavyweight Klein 5500 towfish can be mounted to an aluminum sled using omega brackets.

Figure A-7. Side Scan Hull Mounted on *3101 / 3102*

The hull-mounted configuration is normally used in depths of twenty meters or less, per the HSSDM. Aboard Launch *3101* and *3102*, sidescan may be collected concurrently with ODOM Echotrac CV-200 vertical beam bathymetry.

A.6 Manual Sounding Equipment

No manual sounding equipment was used for this project.

A.7 Positioning and Orientation Equipment

Positioning for data acquired by the launches and the ship are achieved by writing differentially corrected GPS positions output from the POS/MV to the raw sonar data in real time. Upon conversion in CARIS, the positional information in the raw sonar data is used to create vessel track lines for the processed data. During normal survey operations, no further processing of positional information is required. However, beginning in 2010, OCS has begun adding additional positioning requirements to certain projects in an effort to build the internal capabilities necessary to conduct Ellipsoid Referenced Surveys (ERS).

When assigned, the additional positioning requirements involve logging full POSPac data from the POS/MV and utilizing POSPac MMS 5.3 to derive Smoothed Best Estimate Trajectory (SBET) files. POSPac MMS requires ephemeris and clock data for the GPS constellation and data downloaded from Continually Operating Reference Stations (CORS) or other base stations to correct for atmospheric effects in the GPS data. SBET files are extremely accurate measurements of the position, speed, and motion of a vessel and can be used to apply higher quality navigation information to the processed data. Post Processed Kinematic (PPK) navigation is applied in CARIS during the SVP step in the processing workflow.

When this PPK method is utilized, the horizontal positioning uncertainty is reduced to 0.1m instead of 0.5m which is typical of a traditional DGPS solution from the POS/MV. These uncertainty values are reflected in each vessel's HVF according to the positioning method required for the project. For specific details on PPK data in POSPac MMS, refer to the standard operating procedure "ERS_SOP_v11" in Appendix A of this report.

Applanix POS/MV

A basic requirement of multibeam hydrography is accurate ship's position and attitude data during data acquisition. *THOMAS JEFFERSON* uses inertial positioning and orientation sensors and U.S. Coast Guard Differential GPS (DGPS) for a highly accurate blended position and orientation solution.

THOMAS JEFFERSON, Survey Launch 3101, and Survey Launch 3102 are each equipped with Trimble DSM212L DGPS receivers. The DSM212L includes a 12-channel GPS receiver capable of receiving external RTCM correctors from a shore-based reference station. The DSM212L receivers are used for differential correctors to position only and not for actual positioning.

Inertial position calculations on *THOMAS JEFFERSON*, *Survey Launch 3101, and Survey Launch 3102* are provided by an Applanix POS/MV Model 320 v.4. The POS/MV 320 system includes dual GPS antennas, an inertial measurement unit (IMU), and data processor (PCS). The IMU measures linear and angular accelerations corresponding to the major motions of the vessel (heave, pitch, roll, yaw) and inputs this data to the PCS, where it is combined with a GPS position determined by carrier-phase differential measurements to give the final position solution.

According to the manufacturer's specifications, the inertial position/orientation solution has typical values of 0.02° true roll and pitch accuracy, 0.02° heading accuracy, 2m position accuracy, and 0.03 m/s velocity accuracy. These parameters are monitored in real time during acquisition using the POS/MV user interface software. These values were entered into the HVF and were used to compute the TPU of each sounding. In the TPU section of each vessel HVFs for OPR-E350-TJ-10, a 0.5 m/s corrector was added to the 0.03 m/s velocity accuracy to account for the tidal currents in the uncertainty calculations.

All acquisition platforms are configured for Precise Timing, a multibeam sonar acquisition configuration which synchronizes all data to the same time. The timing message is generated by the POS/MV which is received by both the acquisition computer and the RESON TPU. At the time of data acquisition, the POS/MV-generated time stamp is applied to the data instead of the system clock. Precise Timing reduces the variable effects of time latency and creates a single, measurable latency. This is verified during patch tests.

All platforms utilize True Heave (a long-period recording of vessel heave used to detect longer period sea swells that may not be detected during short-period heave calculations) for a post processed heave solution.

IMU's for *Thomas Jefferson, 3101,* and *3102* were all sent in during the winter inport 2009-2010 for tumble testing and calibration.

Notable Positioning and Orientation Equipment changes:

None

A.8 Sound Velocity Profiles

A Brooke Ocean Technology Moving Vessel Profiler (MVP) with an Applied Microsystems Smart Sound Velocity and Pressure (SV&P) sensors or a Seabird Electronics SBE-19 CTD were used to collect sound speed profile (SSP) data from *Thomas Jefferson*. Seabird Electronics SBE-19 CTD+ units were used to collect sound speed profile (SSP) data from Launches 3101 and 3102. SSP data were obtained at intervals frequent enough to reduce sound speed errors. The frequency of casts was based on observed sound speed changes from previously collected profiles and time elapsed since the last cast. Multiple casts were taken along a survey line to identify the rate and location of sound speed changes. Subsequent casts were made based on the observed trend of sound speed changes. As the sound speed profiles change, cast frequency and location are modified accordingly. Confidence checks of the sound speed profile casts were conducted weekly by comparing simultaneous casts taken with different Sound Velocity and Pressure sensors or with a Sound Velocity and Pressure sensor and a Seabird SBE-19 CTD.

Sound speed data and calibration records are included with the survey data in Section II of the Separates for each sheet's Descriptive Report.

Sea-Bird SBE19/19+ CTD Profilers

THOMAS JEFFERSON and Survey Launches 3101 and 3102 acquire water column sound velocity data using Sea-Bird Electronics SeaCat SBE19 and SBE19+ Conductivity-Temperature-Depth (CTD) profilers. Temperature is measured directly. Salinity is calculated from measured electrical conductivity. Depth is calculated from strain gauge pressure.

THOMAS JEFFERSON is equipped with a SeaCat SBE19 CTD profiler with strain gauge pressure sensor. The SBE19 is capable of CTD profiling at depths from 0-3400m. Post calibration drift is expected to be 0.02 °C yr^{-1}, 0.012S m^{-1} yr^{-1}, and 4.5 psia yr^{-1} for temperature, conductivity, and pressure, respectively. The SBE19 is deployed by hand or using the DT Marine Oceanographic winch for ship based acquisition.

Survey Launch 3101 and Survey Launch 3102 are each equipped with a SeaCat SBE19+ CTD profiler with strain gauge pressure sensor. The SBE19+ has a specified post-calibration temperature accuracy of 0.0005S m^{-1}, and strain-gauge pressure accuracy of 0.35 psia. Post calibration drift is expected to be 0.002 °C yr^{-1}, 0.004S m^{-1} yr^{-1}, and 0.168 psia yr^{-1} for temperature, conductivity, and pressure, respectively. The SBE19+ is capable of CTD profiling at depths from 0-350m. The SBE19+ is deployed by hand from Survey Launch 3101 and 3102.

All CTD instruments were returned to the manufacturer for calibration during the 2009-2010 winter in port period. See Appendix A for Calibration reports.

Sea Surface Sound Velocimeters

Unlike CTD profilers, sea surface sound velocimeters (SSVS) calculate sound velocity in water using two-way travel time. The typical SSVS consists of a transducer and a reflector at a known distance from the transducer. A pulse of known frequency is emitted, reflects at the reflector surface, and returns to the transducer. The two-way travel time is measured, and sound velocity derived from the two-way travel time. SSVS are required for multibeam systems that perform active beam steering at the transducer head. The RESON 7125 and RESON 7125-SV systems both require SSVS data.

The AML Smart SV&T Probe is a real-time time-of-flight sound velocimeter and thermistor sensor. The manufacturer specified sound velocity accuracy is 0.02 m/s and temperature accuracy is 0.03 °C. Empirical observations of drift show a sound velocity drift of approximately 0.5 m/s/yr and temperature drift of approximately 0.05 °C/yr. Aboard *THOMAS JEFFERSON*, the AML Smart SV&T probe is mounted in an insulated sea chest in the sonar void. Sea surface temperature and sound velocity values are output in real time to the SIMRAD EM1002 and RESON 7125 systems at a rate of 10 Hz.

The AML Smart SV&T Probe was returned to the manufacturer and calibrated during the 2009-2010 winter in-port period. See Appendix A for the calibration report.

RESON Sound Velocity Probe 70 (SVP)

The RESON SVP 70 is a real-time sea surface sound velocimeter. The manufacturer specified sound velocity accuracy is ±0.05 m/s. Sea surface sound velocity values are output to the RESON 7125-SV system at a rate of 20 Hz and lower. Data can be sent in real time to the RESON 7125-SV processor unit.

RESON SVP 70 was installed new this season on Launches 3101 and 3102.

Notable RESON SVP 70 equipment changes: None

ODOM Hydrographic Systems Digibar Pro

The Digibar Pro is a real-time time-of-flight sea surface sound velocimeter. The manufacturer specified sound velocity accuracy is 0.3 ms. Sea surface temperature and sound velocity values are output to the RESON 7125-SV system at a rate of 10 Hz. Data can be sent in real time to the RESON 7125-SV processor unit.

The units were returned to the manufacturer and calibrated during the 2009-2010 in port period. See Appendix A for the calibration report.

Notable digibar equipment changes:

Digibar is kept onboard Thomas Jefferson as a ready spare and was not used during OPR-E350-TJ-10.

Brooke Ocean Technology Moving Vessel Profiler 100

The Moving Vessel Profiler (MVP) (figure A-7) is a self-contained profiling system capable of sampling water column profiles to 100m depth. MVP-100 was mounted to the port stern quarter. Configuration parameters, offsets, and installation diagrams are included in Appendix A. The MVP consists of a computer-controlled high speed hydraulic winch, a cable metering, over-boarding and docking system, a conductor cable and a streamlined free fall fish (FFF) housing an Applied Microsystems "time of flight" SV&P Smart Sensor (see SV&P below) . The system as configured aboard the *THOMAS JEFFERSON* collects vertical profiles of sound velocity data while the ship is underway at survey speed. The unit is located on the fantail and is controlled remotely from the ship's acquisition room. The MVP is capable of importing its data directly into the Kongsberg SIMRAD EM 1002 multi-beam echosounder (MBES) at the time of acquisition. When using MVP casts in conjunction with the RESON 7125 MBES, sound velocity data is processed using Velocwin software, then applied in CARIS HIPS during post processing. During the Total Propagated Uncertainty step in processing, a sound speed uncertainty value of 1 is used to reflect the increased frequency of sound speed casts achieved with the MVP as opposed to a sound speed uncertainty value of 4 which is normally used when taking casts by hand every 4 hrs.

Figure A-8. MVP 100 on S-222

Notable equipment changes: None

AML – Sound Velocity & Pressure Smart Sensor (SV&P)

The SV&P Smart Sensor is the main instrument housed on the MVP free fall fish; it is designed to directly measure sound velocity and pressure in water. Its small size, extremely fast response time and high sampling rate make the sensor ideal for fast profiles or tow speeds. The sensor has internal calibration coefficients and outputs real-time data to allow a "plug and play" environment.

The Applied Microsystems Smart SV&P Sensor was calibrated by the manufacturer during the 2009-2010 winter import. See Appendix A for the calibration report.

A.9 Bottom Samplers

Two types of bottom samplers are used aboard *THOMAS JEFFERSON* for analyzing bottom sediments.

The Khalisco Mud Snapper model 214WA100 (figure A-6) may be deployed by one person by hand and is best used for shallow-water bottom samples acquired on the survey launches. (Figure A-8)

The Ponar Wildco model # 1728 sampler may be deployed by one person by hand and is sometimes used with the DT Marine Oceanographic winch for Ship based bottom sample acquisition. (Figure A-9)

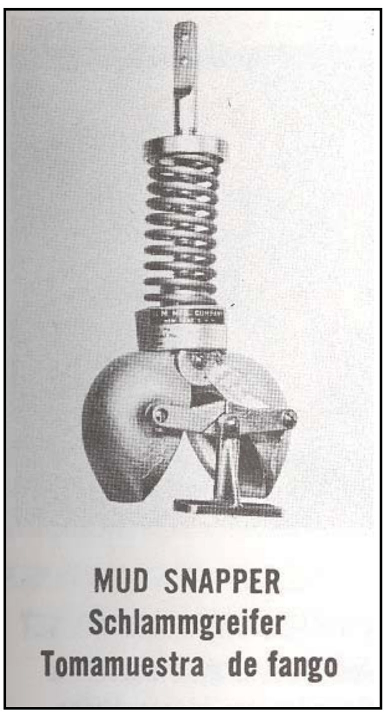


Figure A-9. Khalisco Mud Snapper Figure A-10. Ponar Grab Sampler

Data Collection and Processing Software

A.10 Software Systems

Acquisition Software

Multibeam data were acquired using **Hypack 2009A / 2010** software running on acquisition computers with the Windows XP operating system. Hypack is used to control real-time navigation, data time tagging and data logging. KLEIN 5000 side scan sonar data were acquired using KLEIN's **SonarPro** sonar software running on acquisition computers with the Windows XP operating system. Moving Vessel Profiler data were acquired using **Brooke Ocean Technology MVP** software running on a computer with the Windows XP operating system.

Data Processing: Post-acquisition multibeam processing was performed on board the *Thomas Jefferson* using processing computers with Windows XP operating systems, which run **CARIS HIPS** software. Side scan sonar data were reviewed for targets, side scan mosaics and contact generation in **CARIS HIPS** software; Side-scan contacts were correlated with multibeam data in NOAA's **Pydro** software. CTD and MVP data were processed using NOAA **Velocwin** software.

NOTE: Throughout this report wherever software is mentioned, it is inferred that the most current version of the software available was used. A complete list of all software versions and dates is provided in Appendix A of this report.

CARIS HIPS AND SIPS

CARIS HIPS (Hydrographic Information Processing System) is used for all initial processing of multibeam and vertical beam echosounder bathymetry data, including tide, sound velocity, and vessel offset correction and data cleaning. CARIS HIPS uses statistical modeling to create Bathymetry with Associated Statistical Error (BASE) surfaces in one of three ways: swath-angle weighted grids, uncertainty-weighted grids, and Combined Uncertainty and Bathymetry Estimator (CUBE) algorithm grids. Creation of grids as bathymetric products is discussed in section B of this report.

CARIS SIPS (Side-scan Information Processing System) is used for all processing of side-scan sonar imagery, including cable layback correction, slant range correction, contact selection, towpoint position, and mosaic generation.

HSTP PYDRO

HSTP PYDRO is a program for the classification of side-scan sonar and multibeam bathymetry contacts and for the creation of preliminary smooth sheets. Multibeam contacts (designated soundings), side-scan sonar contacts, and detached position contacts are analyzed, grouped, and assigned S-57 classifications. High resolution BASE surface data is entered into the program and excessed to survey scale. The final product is a Preliminary Smooth Sheet file (PSS), which is delivered to the Atlantic Hydrographic Branch as part of the final submission package.

Pydro Versions 7.3 and later have functionality for TCARI installed. TCARI is described in detail in section C.2.1. The TCARI file for the area is received from NOS Center for Operational Oceanographic Products and Services (CO-OPS) and loaded into Pydro along with the predicted, observed, or verified tide files for the corresponding stations. The project instructions will state whether TCARI is to be used on a project. TCARI was not used on OPR-E350-TJ-10.

Pydro is also used for chart comparisons, generation of chartlets, generation of Danger to Navigation reports, generation of appendices to the Descriptive Report, compilation of survey statistics, and generation of standard NOAA forms such as the Descriptive Report cover sheet.

HSTP VELOCWIN

HSTP Velocwin is a program for the processing of sound velocity casts. This program uses Sea-Bird Electronics SeaSoft software to convert hexadecimal SeaCat data into ASCII conductivity-temperature-depth data, and then converts the ASCII data into a depth-binned sound velocity file. Velocwin software is also used to process Moving Vessel Profiler (MVP) sound velocity data into a CARIS compatible format. Velocwin allows for batch processing of the numerous .calc files generated by the MVP during multibeam echosounder acquisition. The resulting .svp files are applied in CARIS HIPS during post-processing to correct for sound velocity variation within the water column. These sound velocity files are applied to the data in CARIS HIPS. Velocwin is also used to check the accuracy of sound velocity casts and to archive sound velocity information for the National Oceanographic Data Center.

MAPINFO Professional 10.0

MapInfo Professional is the Geographic Information System (GIS) software package used aboard *THOMAS JEFFERSON*. MapInfo is used for sheet management, line planning, final data analysis, and creating end-user plots.

CARIS Base Editor 2.3

Base Editor is used for feature preparation and compilation, surface review, and chart comparison.

A.11 Acquisition Procedures

Acquisition Types

All platforms acquire hydrographic data according to the Project Instructions for each survey. The Project Instructions for a given survey will specify the acquisition method desired, and the required coverage and give the field unit discretion as to the best method to achieve that coverage.

The following survey types are used during field operations by *THOMAS JEFFERSON* in the 2010 Field Season:

- Set Line Spacing
- Complete MBES Coverage
- Object Detection SSS Coverage
- Object Detection MBES Coverage

These coverage types are described in detail in the April 2009 Hydrographic Survey Specifications and Deliverables.

Line plans are designed by the field unit according to the coverage type specified in the Project Instructions. Line planning and coverage type will be discussed in detail in the Descriptive Report for each survey.

Crosslines are acquired as an additional confidence check to the performance of echosounder data. Crosslines are used to check sonar confidence and to provide a meaningful comparison between nadir beams and outer beams of a multibeam mainscheme acquisition line. Crosslines are compared to the mainscheme lines using the standard deviation layer of the grids in CARIS HIPS and Base Editor.

Acquisition speeds are adjusted to balance data quality, productivity, and energy efficiency. The Thomas Jefferson's bathymetric sonars typically produce densities above what is the required in Specs and Deliverables for "skunk striped" and complete coverage surveys at all survey speeds. Survey speeds are reduced as necessary to achieve object detection coverage in the 15-20m depth range.

B. QUALITY CONTROL

B.1 Quality Management

A systematic approach to Quality Management has been instituted aboard the *Thomas Jefferson*, starting well before the field season begins, to the final packaging of Survey Deliverables and delivery to AHB.

Clear and concise communication is critical at all stages of the survey, and is established between all relevant parties[1] at the earliest stage of the process. Figure 1 represents the parties involved at all stages of the Quality Management process.

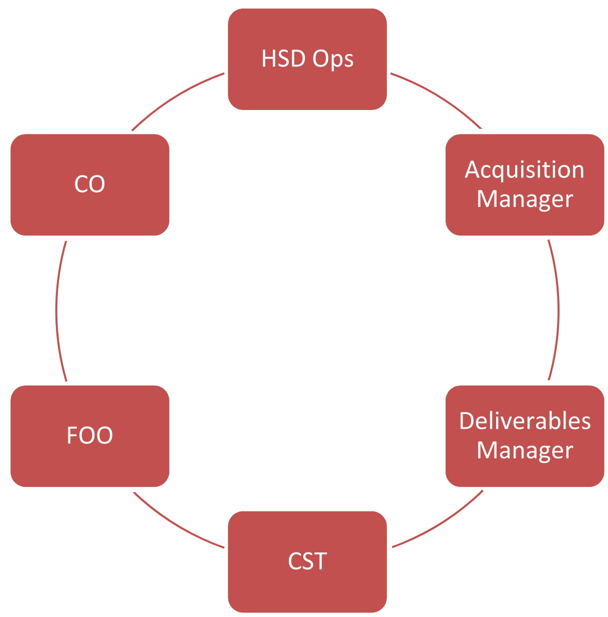


Figure B-1: Quality management loop

[1] Note on Personnel:
CO – Commanding Officer, FOO – Field Operations Officer, CST – Chief Survey Technician, HSD OPS – Hydrographic Surveys Division, Operations Branch

Below is a graphic showing the Quality review steps used aboard the *Thomas Jefferson*.

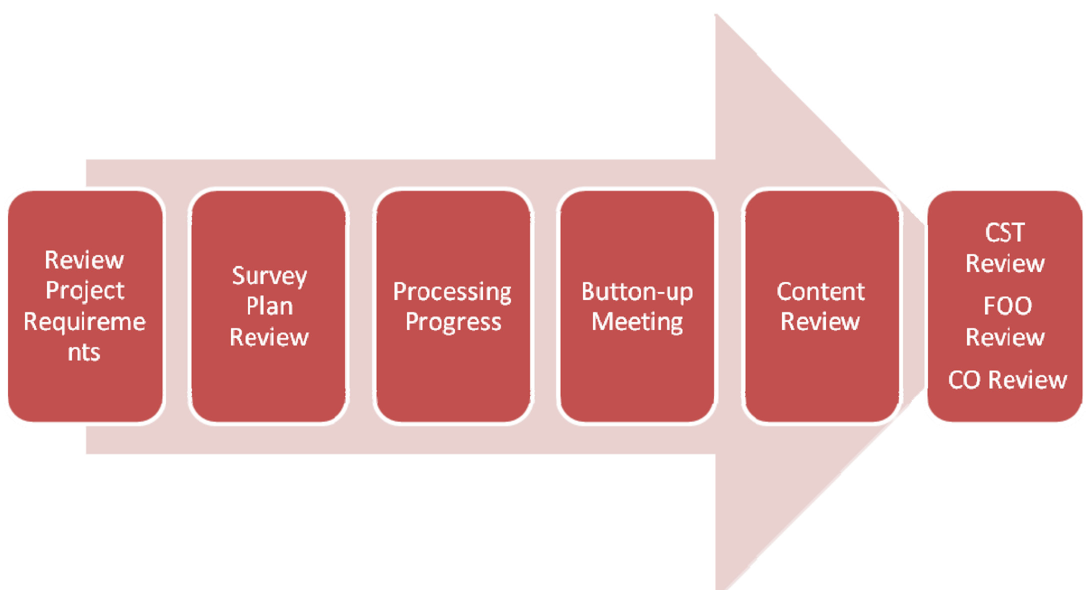


Figure B-2: Quality Review Stages

In the Review Project Requirements stage, the final project instructions are reviewed for specific criteria. Some of these are:

- Is the Survey fit for the Purpose?
- Are all charted features and AWOIS in the Composite Source File (CSF)?
- Are there any extraneous or unassigned features in CSF?
- Is the Survey a reasonable size (2 weeks)?
- Does the work assigned fit within allowed time period?
- Are the resources available for the job?
- Do we have the right equipment, spares, qualified staff, OT, software and specs?
- Are there any special requirements from HSD OPS?

If any of these elements are found to be in question, dialogue is opened with HSD OPS, in order to resolve them. Once these questions have been answered, the Acquisition manager can prepare the survey plan. This would include the following requirements:

- Line plans/Polygons, Crossline plans, Bottom Sample plan
- Feature requirements as addressed in the Composite Source File (CSF) or ENC.
- Safety of Operations, i.e. where we can and cannot go.
- The plans effectiveness and efficiency.
- Proper or maximum platform utilization.
- Survey Specific Sensor configurations, staffing plans, line plans, target files, etc.

All aspects of the survey plan are carefully reviewed by the CST, FOO and CO, and any required changes are initiated by the Acquisition manager before survey begins.

A weekly progress review of all planned and open surveys is conducted to evaluate and incorporate the following factors into the acquisition and deliverables schedule:

- Ship schedule (inports/transits)
- Completion rate, estimated survey end date
- Weather factors
- Equipment failures
- Processing backlog (if any)
- Server storage capacity and anticipated data acquisition rates

The goal is to continuously manage multiple surveys and to establish a projected ship date which accurately reflects all known factors. If processing is not keeping pace with acquisition, then additional resources can be deployed to reduce backlogs. This in turn allows for better quality assessment of collected data.

A Progress review of the survey occurs shortly before completion, with the following goals:

- Review remaining work

- Evaluate density coverage (5 Pings per grid node met for 95% of nodes?)
- Confirm all assigned features have coverage
- Prioritize remaining work for time remaining
- Adjust personnel and platform schedules as necessary
- Evaluate grids for systematic errors (Std Dev, Uncertainty)
- Review initial field sheet layout

After acquisition is complete and the Deliverables manager has applied final tides to all data, a Content Review is performed on the initial results of the survey, primarily surfaces and feature reports. Some of the particular items addressed are:

- Problematic artifacts in the child layers of the grids (Density, Std Dev, Hypothesis Count) that need to be addressed in the DR.
- Review feature report and advise changes or revisions.
- Consider any feature candidates for DtoN's.
- Determine any unusual acquisition or processing issues that need to be discussed in DR.

The final stage of the Quality Management system is a multiple review of the deliverables, by the CST, FOO and CO, each ensuring that all Specs have been met and that any revisions or changes identified in the Content Review have been made. These checks include:

- Examine finalized/threshold grids for flyers or unresolved systematic issues. Are they discussed in the DR?
- Final check of feature report inclusions, relevance, S-57 attribution, image quality and general completeness.
- Vetting of the final DR. Does it reflect the Content Review discussion?
- Housekeeping – are all the ancillary reports, documents and data included and in the proper place?

B.2 Data Management

A daily tracking of data has been developed to maintain data quality and integrity. Several forms identify and track the flow of data as it is collected and processed. These forms are presented in the Separates section under data acquisition and processing logs, included with the data for each survey.

During data collection, watch standers continuously monitor acquisition systems, checking for errors and alarms. Thresholds set in Hypack/Hysweep, POSPAC, RESON and SonarPro alert the watch stander by displaying alarm messages when error thresholds or tolerances are exceeded. These alarms, displayed as they occur, are reviewed and acknowledged on a case-by-case basis. Alarm conditions that may compromise survey data quality are corrected and then noted in acquisition log. Warning messages such as the temporary loss of differential GPS, excessive cross track error, or vessel speed approaching the maximum allowable survey speed are addressed by the watch stander and corrected before further data acquisition occurs.

Following data collection, initial processing begins on *Thomas Jefferson*. See figure B.3 for an example of the typical multibeam data processing procedures. The following checks are performed to insure proper data handling throughout the process:

- A one to one comparison of raw data to acquisition logs is performed.
- Correctors, including tide files, true heave, and SVP files are checked for completeness and accuracy.
- Application of all correctors is tracked by line and by application.

Figure B.3 shows the general processing flow for Multibeam data after collection.

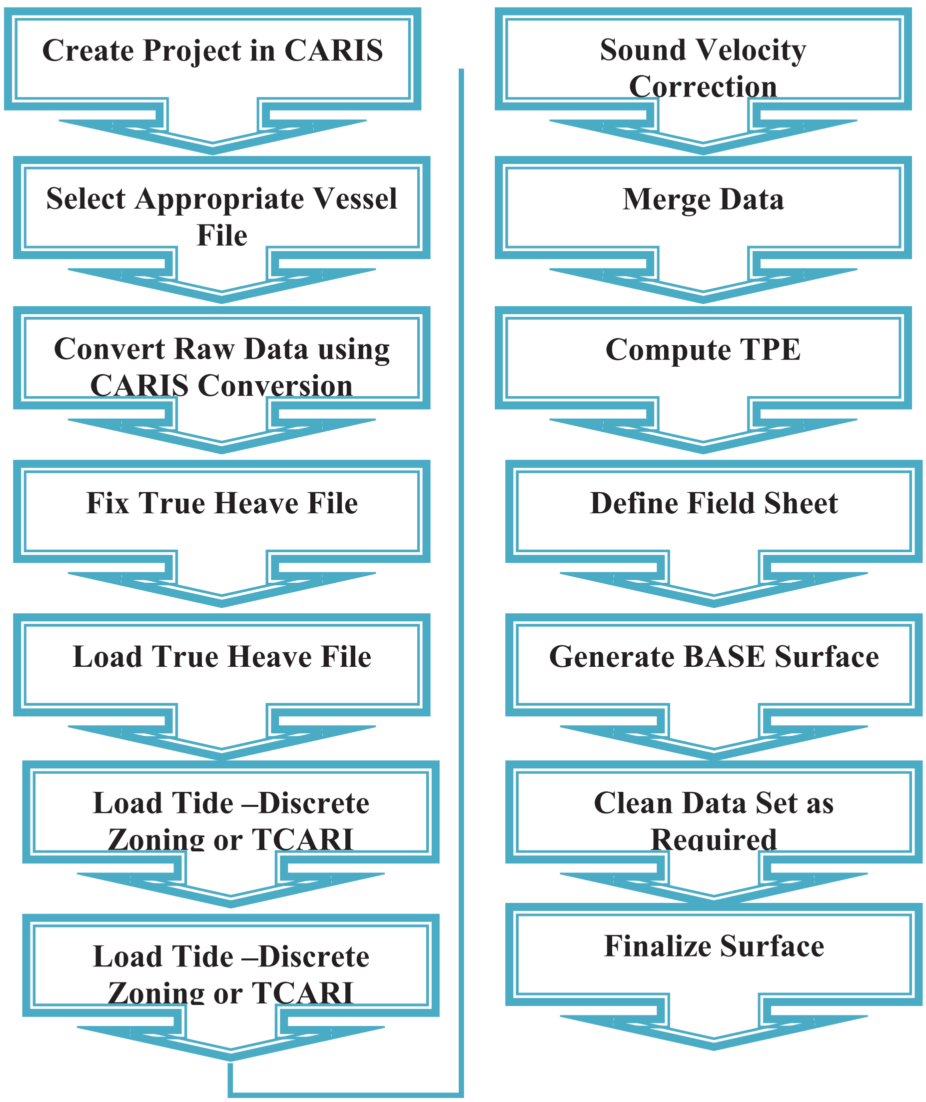


Figure B-3: MB Data processing flow

BASE surfaces are generated to ensure adequate data density, identify areas of high standard deviation, and note any obvious problems with correctors.

Results of the processing are reviewed to determine adequacy of data and sounding correctors. Additional processing in preparation of data deliverables includes the following steps:

- Generation of side scan Contact Files and Contact Plot
- Subset editing and review of multibeam data
- Application of verified tide correctors to multibeam data
- Application of true heave
- Cross line analysis of multibeam data
- Comparison with prior surveys
- Generation of shoal biased selected soundings at the scale of the survey
- Comparison with existing charts
- Quality control reviews of side scan data and contacts
- Final Coverage mosaic plots of side scan sonar data
- Correlation of side scan contacts with multibeam data
- Final quality control of all delivered data products

Processing and quality control procedures for multibeam and side scan data acquisition are described in detail below.

B.3 Bathymetry

Raw bathymetry data, (Simrad .all, Hypack .raw and .hsx) are converted into CARIS HDCS data format upon completion of daily acquisition. Conversion parameters vary for each data format, and are stored in the LogFile of each HDCS processed line folder. After data conversion, attitude, and navigation are reviewed for outliers, and true heave, water level, and sound velocity are applied. Bathymetry lines are then merged. Following merge, Total Propagated Uncertainty (TPU) is calculated for each sounding. For a more detailed explanation of TPU calculation of multibeam and vertical beam echosounder data, refer to Section 4.2.3.6 of the 2009 and 2010 NOAA Field Procedures Manuals.

Depending on acquisition type, MBES bathymetry may be processed using either an uncertainty-weighted navigation surface or a CUBE surface. Uncertainty-weighted BASE surfaces and CUBE surfaces are described in detail in the 2009 NOS Field Procedures Manual and the CARIS HIPS/SIPS Users Manual.

When the primary source of bathymetry for a survey area is a combination of VBES and MBES, a collection of finalized uncertainty-weighted mean bathymetric surfaces is generated as the product of the survey. CUBE is not permitted for this type of survey. When the primary source of bathymetry for this type of survey is set line spacing MBES data (also known as “skunk striped”), CUBE shall be used. The use of CUBE in this situation is required to guarantee proper nodal propagation distances as described in section 5.1.1.3, Gridded Data Specifications, of the 2009 Hydrographic Survey Specifications and Deliverables (HSSD) and 5.2.1, Gridded Data Specifications, of the 2010 HSSD. In most instances 95% of the nodes in a CUBE grid contain a minimum of 5 soundings/node to adequately represent the seafloor depth in a given area.

When Complete or Object Detection (OD) MB is the primary source of bathymetry, data are processed using CUBE grids. The use of CUBE is mandatory to ensure compliance with the specification described in the paragraph above. Table 1 shows the required resolution in various survey depths.

Object Detection Coverage *

Depth Range (m)	Resolution (m)
0-22	0.5
20-40	1

(Object Detection is rarely needed in depths greater than 30 meters).

Complete Multibeam Coverage*

Depth Range (m)	Resolution (m)
0-22	1
20-44	2
40-88	4
80-176	8
160-350	16
320-640	32

*Values from HSSD 2009

Each resolution has its own CUBE parameter settings, and the hydrographer uses the appropriate resolution based CUBE parameters settings when computing each grid. A CUBE Parameters .xml file is included in Appendix B.

However, the depth thresholds listed above from the 2010 Hydrographic Surveys Specification and Deliverables do not accurately capture the intended overlap between depth ranges. The following tables illustrate the depth thresholds used for all surveys.

Object Detection Coverage

Depth Range (m)	Resolution (m)
0-20	0.5
19-40	1

Complete Multibeam Coverage

Depth Range (m)	Resolution (m)
0-20	1
18-40	2
36-80	4
72-160	8
144-320	16
288-640	32

B.4 Error Modeling in CARIS HIPS

CARIS computes TPU based on both the static and dynamic measurements of the vessel. These values are based on the offsets tables found in Appendix B. As well, CARIS uses survey-specific information including a tidal zoning error estimate and speed of sound measurement errors. Offset values are entered into the CARIS *.hvf file. During processing, the tidal zoning and speed of sound measurement errors are applied. Tidal zoning values are provided with the Water Level Instructions, Tide Component Error Estimation included with the Hydrographic Survey Project Instructions. Instrument-specific values are obtained from either the CARIS TPU resource website or per HSD guidance. TPU Parameters for tide and sound speed are listed in the Descriptive Report.

B.5 Bathymetry Analysis and Feature Classification

Least depths of navigationally significant features are flagged as "designated soundings," which both identifies the object as a navigationally significant object for import into Pydro and forces the depth of the grid to match the least depth of the feature.

Following data cleaning in CARIS HIPS, Designated soundings and Side Scan contacts are inserted into a PYDRO Preliminary Smooth Sheet (PSS). DP and GP features are inserted using the "Generic Data Parser" tool. Images of contacts exported from CARIS are displayed in the Image Notebook Editor in PYDRO. Contacts are arranged by day and line and can be selected in the data "Tree" window. Information concerning a specific contact is reviewed in the Editor Notebook Window in PYDRO. This information includes contact positions, AWOIS item positions, contact cross references, and charting recommendations.

Contacts are classified according to type of contact (e.g. MBES, SSS, DP, etc), confidence, and proximity to other contacts. Although this will vary from survey to survey, the following general rules apply for classification of contacts:

- MBES contacts will be classified as primary contacts over SSS, DP, and GP contacts;

- If there are two or more MBES contacts for the same feature, the MBES contact of least depth is classified as the primary contact;

- If there is no bathymetry contact for a feature, then the SSS position will be classified as primary contact over DP and GP contacts;

- If there are two or more SSS contacts for the same feature, then the SSS contact that best represents the feature is classified as the primary contact;

- If there are no bathymetry or imagery contacts, then the DP contact that best represents the feature is classified as the primary contact.

Multiple representations of one distinct feature (e.g. contacts from two or more SSS lines on a known wreck) may be grouped. For a group of features, one representation is selected as the primary contact, and all others are selected as secondary contacts with respect to the primary contact.

Significant features are defined by the Hydrographic Survey Specifications and Deliverables as an object rising more than 1m above the seafloor in water depth of 0-20m, and an object rising 10% of depth above the seafloor in water depths greater than 20m. Either echosounder least depth or side-scan sonar acoustic shadow height may be used to determine height of an object off the water bottom. The following types of features are always significant contacts: wrecks, obstructions, pipelines, and piers and wharves.

Contacts appearing significant are further investigated with a MBES system capable of meeting NOAA object detection specifications. If there is no known least depth of good confidence on a significant feature, then the feature will be flagged as “Investigate.” Features with such a tag must be further developed, in order of preference, with multibeam echosounder, diver least depth gauge, or vertical beam echosounder.

Any items that are to be addressed in the Feature Report (Appendix II) of the Descriptive Report are flagged as “Report”. Examples of Report items include position of new or repositioned Aids to Navigation, permanent man-made features which do not pose a danger to surface navigation, or dynamic sedimentary bed forms which have not been previously noted on the chart. Items which have the “Report” flag set could also be further designated for inclusion in the Danger to Navigation Report by choosing the “DTON” flag. Dangers to Navigation are submitted to the Commanding Officer for review prior to submission to the Marine Charting Division (MCD).

After a feature is fully classified, primary features are flagged as “Resolved.” If a primary feature is flagged “Resolved,” then the secondary features correlated to that primary feature are automatically flagged “Resolved” and are given the same full classification as the primary feature.

B.6 Imagery

Side scan sonar data are converted from *.sdf (Sonarpro raw format) to CARIS HDCS. Processing side scan data includes examining and editing fish height, vessel heading (gyro), and vessel navigation records. When side scan sonar is towed, fish navigation is recalculated using CARIS SIPS. Tow point offsets (C-frame and cable out), fish depth, fish attitude, and water 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. The slant-range corrected side scan imagery data are closely examined for any targets. Targets-of-interest are evaluated as potential contacts based upon 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 and width, selecting contact position, and creating a contact snapshot (*.tif) image.

Side scan sonar coverage is determined by creating mosaics using Mosaic Editor in CARIS SIPS. Mosaic Editor uses the accurately modeled backscatter correction algorithms of the Geocoder engine to process source data. This processed imagery data is stored in SIPS as Georeferenced, Backscatter Rasters, or GeoBaRs. GeoBaRs are the basis for all mosaics created in SIPS. From the GeoBaRs, mosaics are created which can be examined and edited in Mosaic Editor. Once imagery has been corrected a full mosaic can be compiled from the data, If any deficiencies in the side scan sonar data are found, a holiday line file is created from the mosaics, and additional lines of SSS are acquired.

B.7 Survey Deliverables and Ancillary Product Generation

The ship's final bathymetric deliverables to the Atlantic Hydrographic Branch are a collection of BASE surfaces, the Pydro PSS (including S-57 feature classifications), the Descriptive Report, side scan sonar mosaics (when applicable), and two sun-illuminated digital terrain models of the multibeam bathymetry. The resolution of surfaces varies according to acquisition type specified in the Project Instructions.

The Pydro Preliminary Smooth Sheet (PSS) contains a set of features and other data which best represent the survey area at survey scale. Along with the Descriptive Report, the PSS is the ship's record of the survey, from which the final survey product is created at the Atlantic Hydrographic Branch

C. Corrections to Echo Soundings

C.1 Sound Velocity

SSVS data are used by the flat faced sonars to calculate launch and receive angles to generate observed depths. No further corrections to echosoundings are done during processing using the SSVS data. The sea surface sound velocity sensors are discussed in Section A and will not be discussed further in this section.

CTD Profiles

Sound velocity profiles for the *THOMAS JEFFERSON* and for Launches *3101* and *3102* are processed using the program HSTP Velocwin version 8.96 which generates sound velocity profiles for CARIS HIPS. Sound velocity correctors are applied to MBES and VBES soundings in CARIS HIPS during post processing only.

The speed of sound through water is determined by a minimum of one cast per week (although one per day is usually acquired) for VBES acquisition and one cast every three to four hours of MBES acquisition, in accordance with the NOS Hydrographic Surveys Specifications and Deliverables (HSSD). Casts are conducted more frequently when changing survey areas, or when environmental conditions such as changes in weather, tide, current, or significant spatial and/or temporal variation in the speed of sound is detected in the survey area that would warrant additional sound velocity profiles.

The sound velocity casts are extended in HSTP Velocwin and applied to all bathymetric data in CARIS HIPS during post processing.

Brooke Ocean MVP

The SV data acquired by the MVP is transmitted to a raw SV file folder, where the hydrographer conducts a basic check of the data for correct day number, sound velocity data, and file format/integrity. The SV cast may also be graphically viewed and compared with other casts using the Sound Velocity vs. Depth graph in the MVP controller software.

Like CTD casts, MVP casts are processed and/or extended for use in CARIS HIPS using HSTP Velocwin.

C.2 Water Level Correctors

Soundings are initially reduced to Mean Lower-Low Water (MLLW) using preliminary (observed) water level data. Data may be obtained from the primary tide gauge through the Center for Operational Oceanographic Products and Services (CO-OPS) website. Observed water level files are converted to CARIS tide files (.tid) and/or text files and applied to all sounding data using either discrete tide zoning in CARIS HIPS or the TCARI module in Pydro. The type of water level correction used in a survey is specified in the Water Level Instructions, provided by CO-OPS.

When discrete tide zoning is specified in the Tide Note, THOMAS JEFFERSON personnel use verified water levels and final tide zoning from the Zone Definition File (ZDF) provided by CO-OPS for hydrographic product generation.

C.2.1 TCARI

Tidal Constituents and Residuals Interpolator (TCARI) grid files, when applicable, are submitted to THOMAS JEFFERSON as part of the Project Instruction package. A TCARI grid is computed using the shoreline, a limiting boundary, and the positions of two or more water level gauges. Harmonic constants, residual water levels, and gauge weights are interpolated for each grid point, using the data from the water level gauges as control points. Water level corrections are applied in Pydro using the TCARI tools found in Pydro 7.xx and beyond. When using TCARI for datum reduction, water level corrections are not applied to echosounder data in CARIS. Following TCARI water level correction in Pydro, data is merged and processed as described in Section B.

C.3 Multibeam Calibration Procedures

Heave, pitch, roll, yaw, and navigation latency biases for each vessel are corrected during a multibeam bias calibration test (patch test). MBES vessel offsets, dynamic draft correctors, and system bias values are contained in HIPS Vessel Files (HVFs). These offsets and biases are applied to the sounding data during processing in CARIS HIPS. A Patch Test or verification of certain biases is typically performed at the start of each project before acquiring MBES data in the new survey area. The HVFs and patch test data are included with the processed data accompanying this report. Results of the Patch Test for each vessel can be found in Appendix C.

C.4 Vessel Offsets and Dynamic Draft Correctors

A partial re-survey of *THOMAS JEFFERSON* vessel offsets was conducted on 10 March 2005 by NGS personnel, and no changes in offsets have occurred since then. The procedure and results of the 2005 re-survey may be found in Appendix C of this report.

Preliminary static draft measurements are made at the beginning of each leg. Static draft for *THOMAS JEFFERSON* is measured using a sight tube located in lower survey stores in the vicinity of frame 33. Additional static draft measurements are made as needed with changing conditions, such as changes in the ship's ballasting or loading.

Vessel offset measurements were made on *HSL 3101* on January 13, 2010 by NGS personnel. The NGS survey measured from established benchmarks on the vessel back to the reference point, in this case, the cross hairs on top of the IMU. From the surveyed benchmarks, the new RESON 7125SV, SSVS, and Odom CV200 installation offsets were measured using a steel tape. The Klein 5000 side scan was surveyed in a similar manner and offsets for the "heavy weight" and "light weight" systems were recorded.

Static draft measurements for HSL 3101 and HSL 3102 are determined using a sight tube to measure the waterline with respect to the reference point on the top of the IMU. These measurements are made at the beginning and end of each working day while the vessel is dead in the water.

Vessel offset measurements were also made on *HSL 3102* on January 13, 2010 by NGS personnel. The NGS survey measured from established benchmarks on the vessel back to the reference point on top of the IMU in the same manner as the survey of HSL 3101. From the surveyed benchmarks, the new RESON 7125SV, SSVS, and Odom CV200 installation offsets were measured using a steel tape. The Klein 5000 side scan was surveyed in a similar manner and offsets for the "heavy weight" and "light weight" systems were recorded.

Dynamic Draft

During the 2010 hydrographic systems readiness review, *Thomas Jefferson* performed an evaluation of an Elipsoid Referenced Survey (ERS) method for measuring dynamic draft for the ship, HSL 3101, and HSL 3102. This method has been termed Ellipsoid Referenced Dynamic Draft Measurement (ERDDM). The Echosounder method of determining dynamic draft was used to verify ERDDM results. Post-processed Smoothed Best Estimate Trajectory (SBET) altitude heights with respect to the ellipsoid were created in POSPac MMS 5.3 and used to measure dynamic draft. The Echosounder method is described in the 2009 and 2010 FPM section 1.4.2.1. 2.1.

The ERDDM was conducted by acquiring POSPac data while acquiring survey lines for the Echosounder method. The Echosounder method was modified slightly to provide additional drift values to isolate the effects of tide. This was achieved by going all stop at the end of each line and drifting dead in the water for 1 – 3 minutes. These all stop values provided visual break points for reference in the continuous POSPac data that was logged for the duration of survey operations for the day. During the ERDDM for HSL 3101, at rest periods were not acquired at the end of some of the lines. In these instances, vessel heading was used for visual break points in the POSPac data.

For the Echosounder method, all multibeam data were processed using standard procedures in Caris HIPS. Dynamic draft was computed for each RPM level. The speed at each RPM was calculated by querying the speed of the lines run at that RPM and taking the average (note, this differs from using the median value as detailed in FPM 1.4.2.1.2.1). Three different regions on the line were sampled for depth soundings; the regions were at 1/4, 1/2, and 3/4 along the line. The sampled regions were queried by line for depth soundings. Depth soundings acquired at similar RPMs were combined and the median depth sounding and the average depth were found. This approach was utilized to provide an additional "sanity" check on the data. This sounding was used in the calculation of the vessel draft. To determine the change in vessel draft at each speed the difference between the median depth sounding at that speed and the median depth sounding at drift speed was found. Dynamic draft for each vessel was computed by three different people and the results were averaged and the standard deviations between each individual's calculations were recorded. See Appendix C for tabulated results.

For the ERS method, the POSPac data was processed in POSPac MMS 5.3 and an SBET file was created. The vessel speed and the altitude plots were examined and data corresponding to the lines described in the Echosounder method above were exported into a spreadsheet and analyzed. The average vessel speed for each line and the average difference between at speed altitudes and at rest altitudes were computed and used to create a dynamic draft table.

Comparisons of the results of the Echosounder method and the ERDDM method indicated that there was greater variability in the Echosounder method of determining dynamic draft. The ERDDM method matched the trends of the Echosounder method extremely well for the ship and for HSL 3102. However, the dynamic draft for HSL 3101 had a great amount of variability between individual examiners and between echosounder and ERDDM methods. Because the ERDDM is less subjective it was deemed to be a more accurate and repeatable measurement. For this reason, ERDDM values were entered into the HVFs for all vessels for the 2010 field season. See Appendix C of this report for tabulated results.

Appendix A

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:	57041	**Date of Report:**	12/23/2009
Model Number:	SBE 19Plus	**Serial Number:**	19P33589-4486

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: 12/23/2009 Drift since last cal: -0.00006 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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:	57041	**Date of Report:**	12/17/2009
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: 12/17/2009 Drift since last cal: -0.00134 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: 4487
CALIBRATION DATE: 23-Dec-09

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.227720e-003
a1 = 2.562184e-004
a2 = 5.700844e-007
a3 = 1.218943e-007

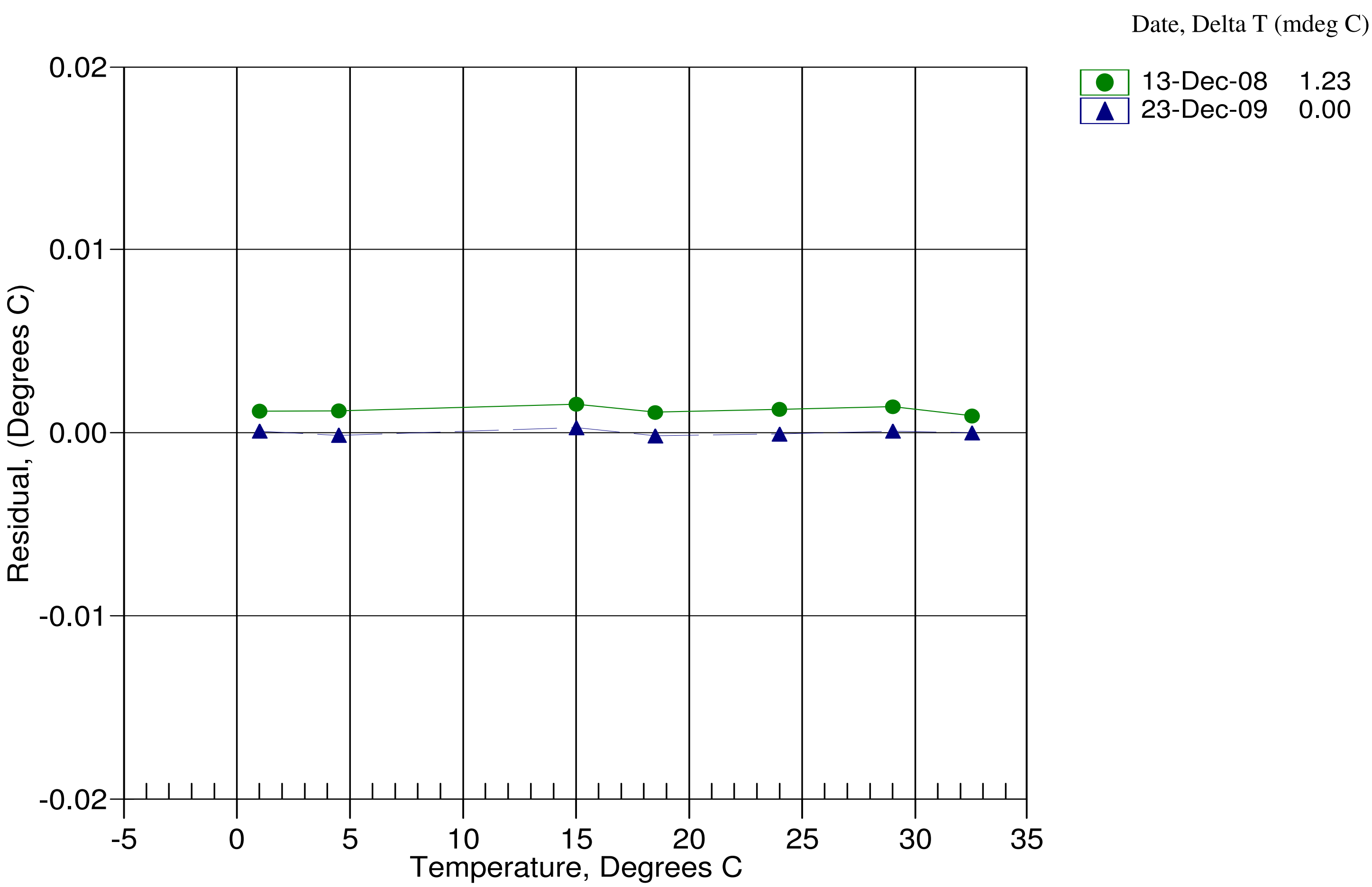
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	713474.441	1.0001	0.0001
4.5000	638157.017	4.4999	-0.0001
15.0000	447167.610	15.0003	0.0003
18.5000	394903.119	18.4998	-0.0002
24.0000	323263.085	23.9999	-0.0001
29.0000	268210.644	29.0001	0.0001
32.5000	234744.034	32.5000	-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



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: 4486
CALIBRATION DATE: 23-Dec-09

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.296457e-003
a1 = 2.514754e-004
a2 = 1.317289e-006
a3 = 9.670557e-008

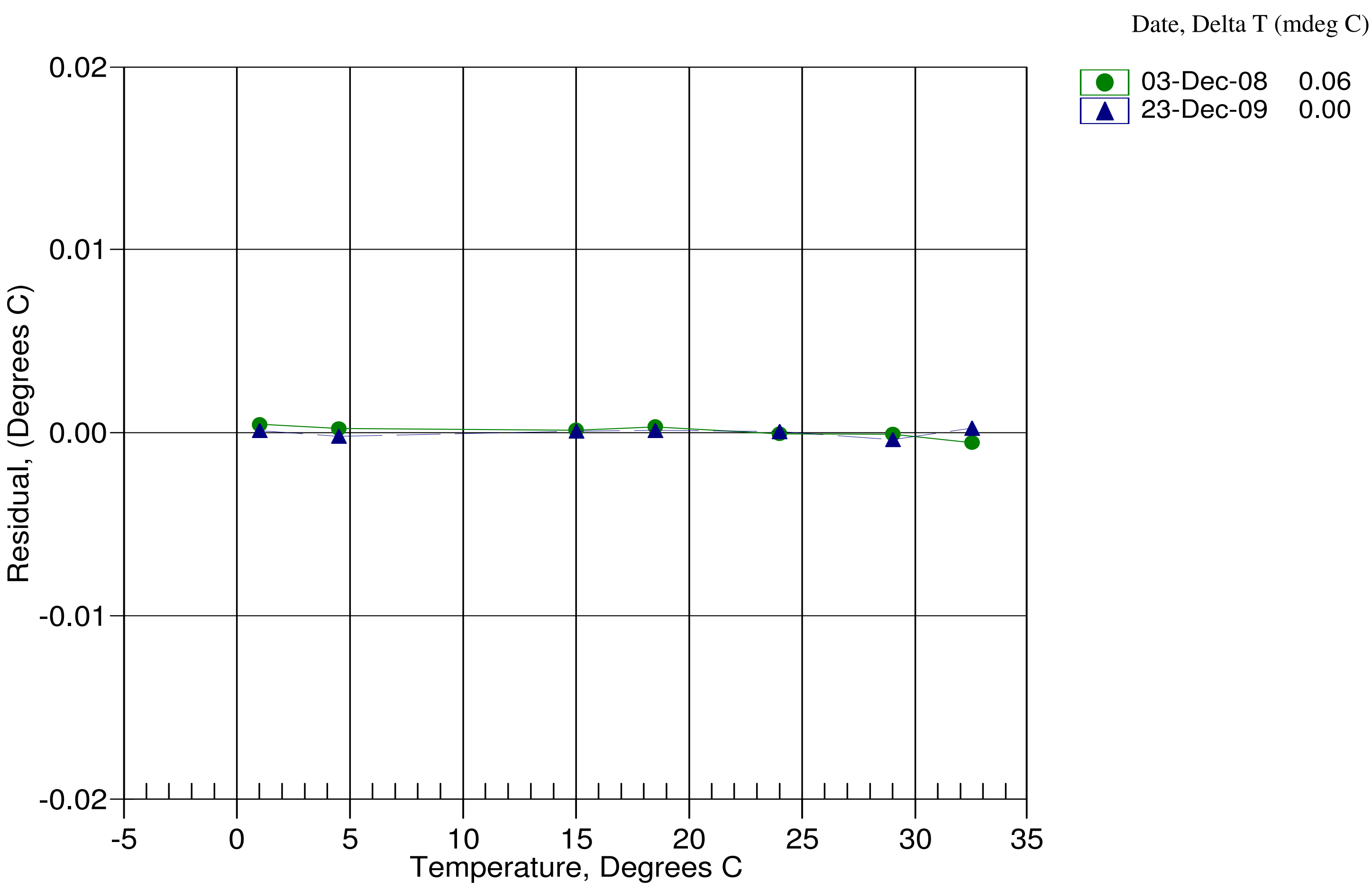
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	604365.068	1.0001	0.0001
4.5000	535793.102	4.4998	-0.0002
15.0000	366326.576	15.0001	0.0001
18.5000	321006.220	18.5001	0.0001
24.0000	259606.017	24.0001	0.0001
29.0000	212969.661	28.9996	-0.0004
32.5000	184835.288	32.5002	0.0002

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



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SENSOR SERIAL NUMBER: 4487
CALIBRATION DATE: 22-Dec-09

SBE19plus PRESSURE CALIBRATION DATA
508 psia S/N 2837

COEFFICIENTS:

PA0 =	7.750613e-002	PTCA0 =	5.244329e+005
PA1 =	1.555474e-003	PTCA1 =	4.506914e+000
PA2 =	7.105278e-012	PTCA2 =	-9.364100e-002
PTEMPA0 =	-7.448119e+001	PTCB0 =	2.498675e+001
PTEMPA1 =	4.921478e+001	PTCB1 =	-5.000000e-005
PTEMPA2 =	-4.131304e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.65	533849.0	1.9	14.65	-0.00
104.90	591847.0	1.9	104.90	-0.00
204.92	656069.0	1.9	204.89	-0.01
304.92	720267.0	1.9	304.90	-0.00
404.93	784438.0	1.9	404.93	-0.00
504.93	848549.0	1.9	504.92	-0.00
404.95	784466.0	1.9	404.97	0.00
304.94	720317.0	1.9	304.98	0.01
204.95	656121.0	1.9	204.97	0.00
104.97	591896.0	1.9	104.97	-0.00
14.65	533860.0	1.9	14.66	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2.21	534142.85
29.00	2.14	534146.32
24.00	2.04	534148.25
18.50	1.92	534149.37
15.00	1.85	534139.29
4.50	1.63	534113.21
1.00	1.55	534099.52

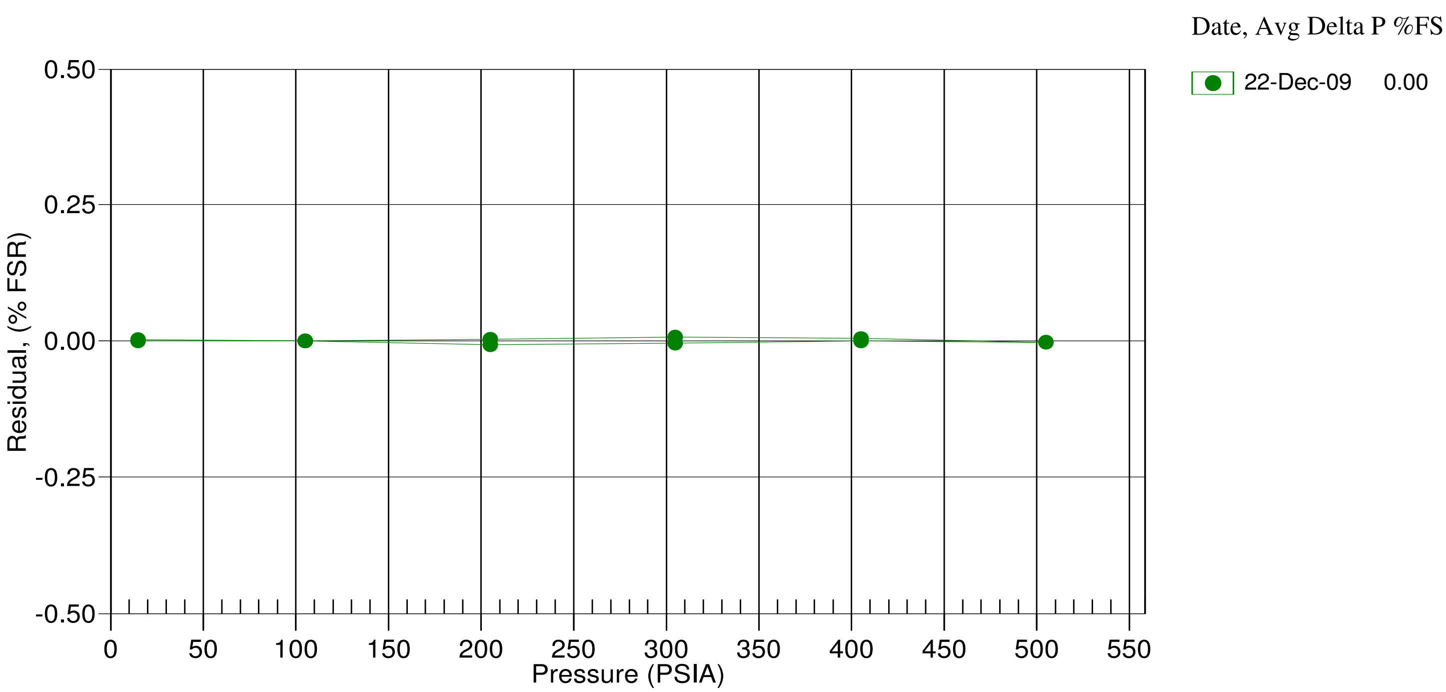
TEMP(ITS90)	SPAN(mV)
-5.00	24.99
35.00	24.98

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



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SENSOR SERIAL NUMBER: 4486
CALIBRATION DATE: 22-Dec-09

SBE19plus PRESSURE CALIBRATION DATA
508 psia S/N 2799

COEFFICIENTS:

PA0 = 3.393557e-002
PA1 = 1.549577e-003
PA2 = 7.090297e-012
PTEMPA0 = -7.542327e+001
PTEMPA1 = 4.833625e+001
PTEMPA2 = -2.486078e-001

PTCA0 = 5.246614e+005
PTCA1 = 2.803268e+000
PTCA2 = -8.906986e-002
PTCB0 = 2.468737e+001
PTCB1 = -7.250000e-004
PTCB2 = 0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.65	534110.0	1.9	14.65	0.00
104.90	592301.0	1.9	104.90	0.00
204.92	656732.0	1.9	204.88	-0.01
304.92	721144.0	1.9	304.90	-0.00
404.93	785529.0	1.9	404.93	0.00
504.93	849846.0	1.9	504.91	-0.00
404.95	785560.0	1.9	404.98	0.01
304.94	721191.0	1.9	304.97	0.01
204.95	656783.0	1.9	204.96	0.00
104.97	592349.0	1.9	104.97	-0.00
14.65	534118.0	1.9	14.66	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2.26	534375.39
29.00	2.19	534381.55
24.00	2.08	534392.60
18.50	1.96	534399.70
15.00	1.89	534399.37
4.50	1.67	534386.75
1.00	1.59	534380.38

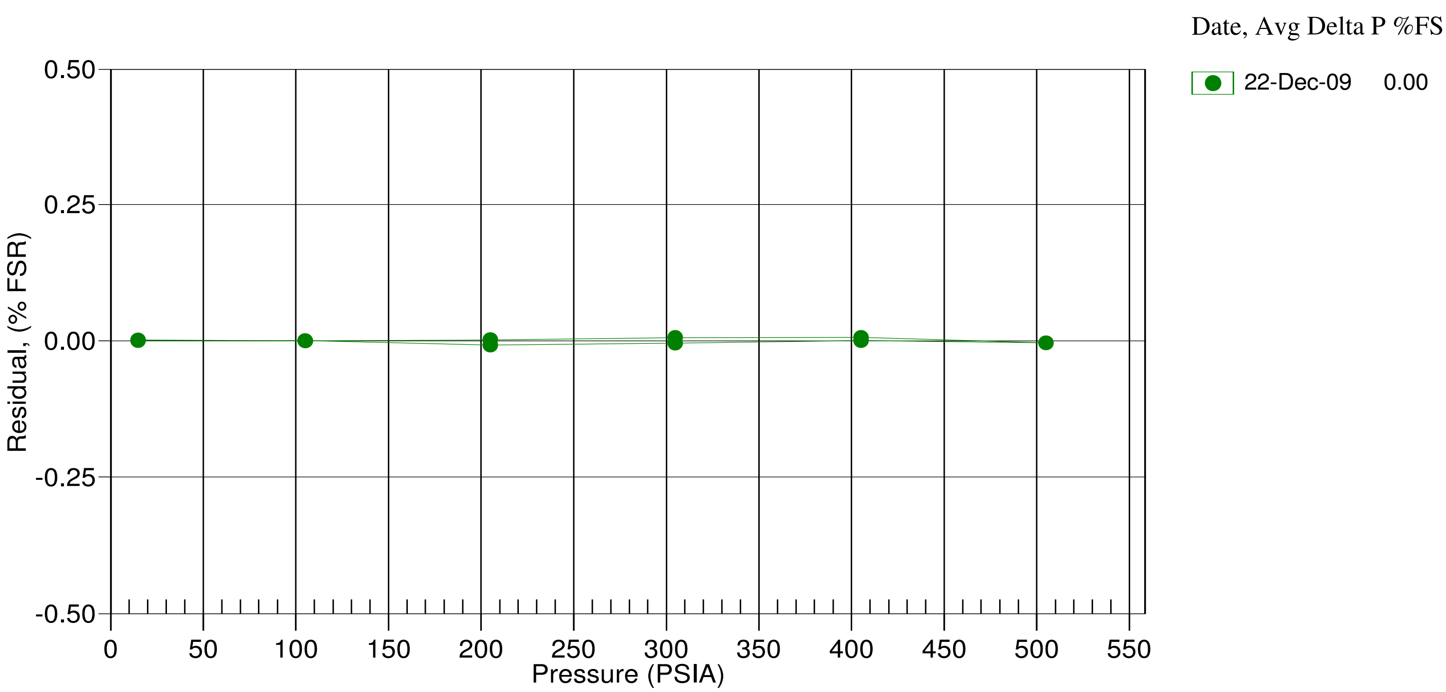
TEMP(ITS90)	SPAN(mV)
-5.00	24.69
35.00	24.66

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



SEA-BIRD ELECTRONICS, INC.

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SENSOR SERIAL NUMBER: 4487
CALIBRATION DATE: 23-Dec-09

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

COEFFICIENTS:

g = -1.021037e+000
h = 1.393412e-001
i = -1.422501e-004
j = 3.071693e-005

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

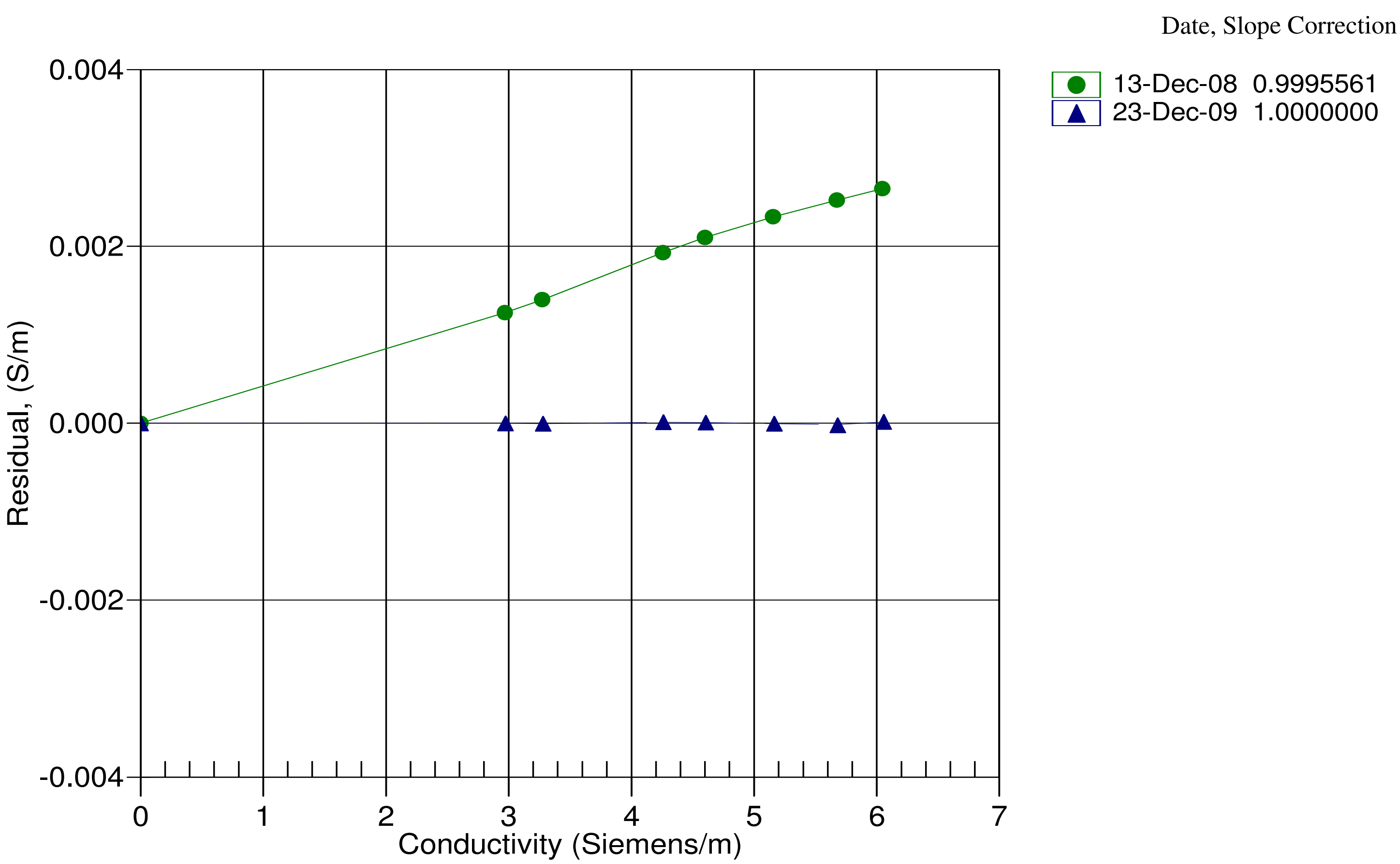
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2708.51	0.0000	0.00000
1.0000	34.7729	2.97261	5351.32	2.9726	-0.00000
4.5000	34.7530	3.27934	5552.27	3.2793	-0.00001
15.0000	34.7100	4.25995	6150.07	4.2600	0.00001
18.5000	34.7005	4.60466	6346.57	4.6047	0.00001
24.0000	34.6895	5.16185	6651.62	5.1618	-0.00001
29.0000	34.6811	5.68266	6924.29	5.6826	-0.00002
32.5000	34.6737	6.05393	7112.13	6.0539	0.00001

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



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SENSOR SERIAL NUMBER: 4486
CALIBRATION DATE: 23-Dec-09

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

COEFFICIENTS:

g = -1.028915e+000
h = 1.433578e-001
i = -1.871225e-004
j = 3.484124e-005

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

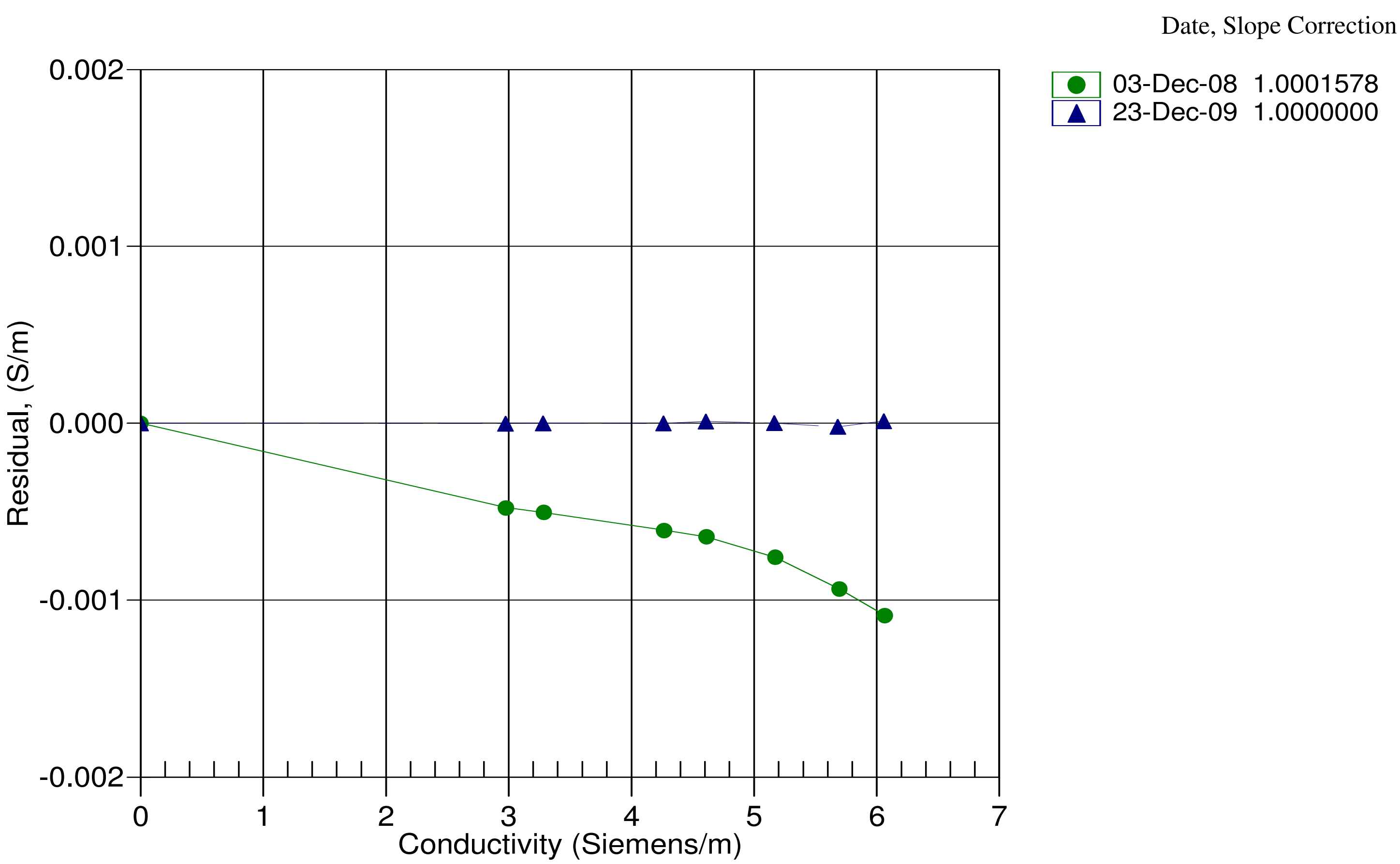
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2681.39	0.0000	0.00000
1.0000	34.7729	2.97261	5283.56	2.9726	-0.00000
4.5000	34.7530	3.27934	5481.64	3.2793	-0.00000
15.0000	34.7100	4.25995	6070.93	4.2600	-0.00000
18.5000	34.7005	4.60466	6264.65	4.6047	0.00001
24.0000	34.6895	5.16185	6565.41	5.1618	0.00000
29.0000	34.6811	5.68266	6834.25	5.6826	-0.00002
32.5000	34.6737	6.05393	7019.45	6.0539	0.00001

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



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SENSOR SERIAL NUMBER: 0285
CALIBRATION DATE: 17-Dec-09

SBE19 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.12520288e-003
h = 5.75807754e-004
i = -3.77214324e-007
j = -2.94509038e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.64763863e-003
b = 5.70457202e-004
c = 6.99565870e-006
d = -2.94498788e-006
f0 = 2297.604

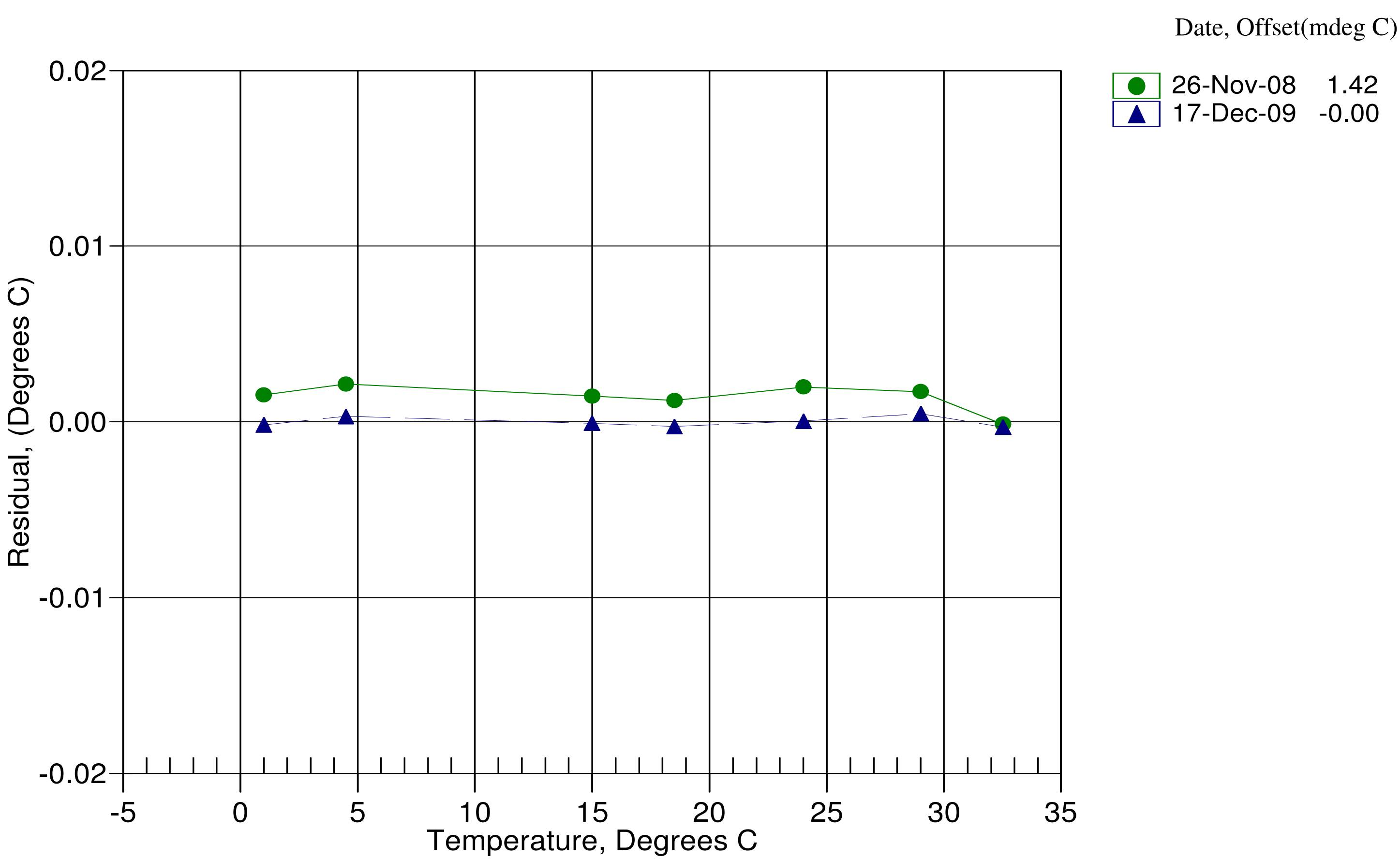
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2297.604	0.9997	-0.00018
4.5000	2490.756	4.5003	0.00031
14.9999	3139.176	14.9998	-0.00008
18.5000	3379.584	18.4997	-0.00026
24.0000	3783.314	24.0001	0.00005
29.0000	4178.917	29.0005	0.00046
32.5000	4472.551	32.4997	-0.00030

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 IPTS-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



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SENSOR SERIAL NUMBER: 0285
CALIBRATION DATE: 23-Dec-09

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

QUADRATIC COEFFICIENTS:

PA0 = 2.491889e+003
PA1 = -6.503495e-001
PA2 = -4.657968e-008

STRAIGHT LINE FIT:

M = -6.503692e-001
B = 2.491608e+003

PRESSURE PSIA	INST OUTPUT(N)	COMPUTED PSIA	ERROR %FS	LINEAR PSIA	ERROR %FS
14.84	3807.0	15.33	0.01	15.65	0.02
1015.07	2271.0	1014.70	-0.01	1014.62	-0.01
2015.36	735.0	2013.86	-0.03	2013.59	-0.04
3015.42	-805.0	3015.39	-0.00	3015.16	-0.01
4015.41	-2342.0	4014.75	-0.01	4014.77	-0.01
5015.55	-3881.0	5015.19	-0.01	5015.69	0.00
4015.25	-2344.0	4016.05	0.02	4016.07	0.02
3015.26	-807.0	3016.69	0.03	3016.46	0.02
2015.11	733.0	2015.16	0.00	2014.89	-0.00
1015.05	2270.0	1015.36	0.01	1015.27	0.00
14.84	3808.0	14.68	-0.00	15.00	0.00

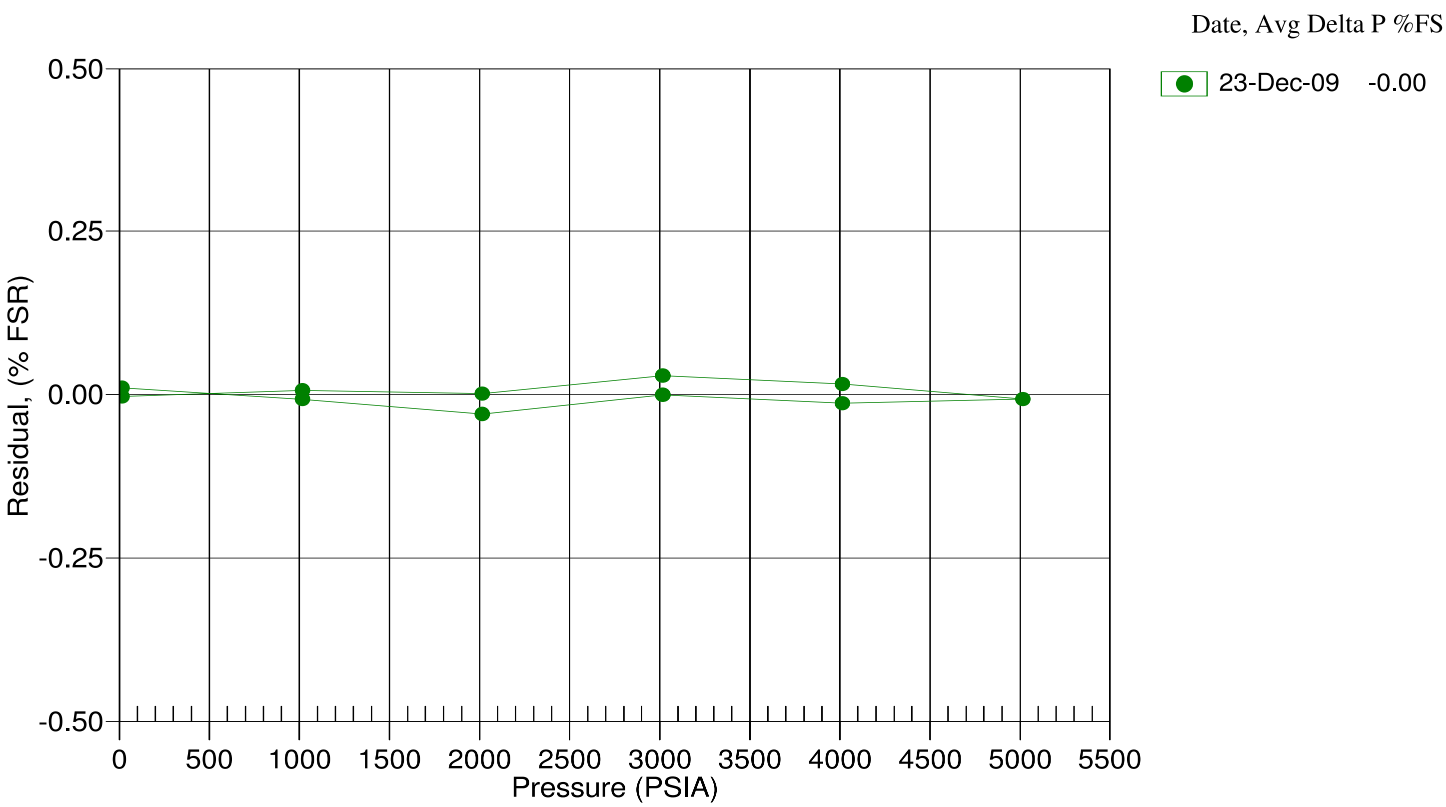
Straight Line Fit:

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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SENSOR SERIAL NUMBER: 0285
CALIBRATION DATE: 17-Dec-09

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

GHIJ COEFFICIENTS

g = -4.07971557e+000
h = 4.86612139e-001
i = 1.27342373e-003
j = -2.76779215e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 2.35233136e-002
b = 4.59105653e-001
c = -4.06199418e+000
d = -1.02469719e-004
m = 2.2
CPcor = -9.5700e-008 (nominal)

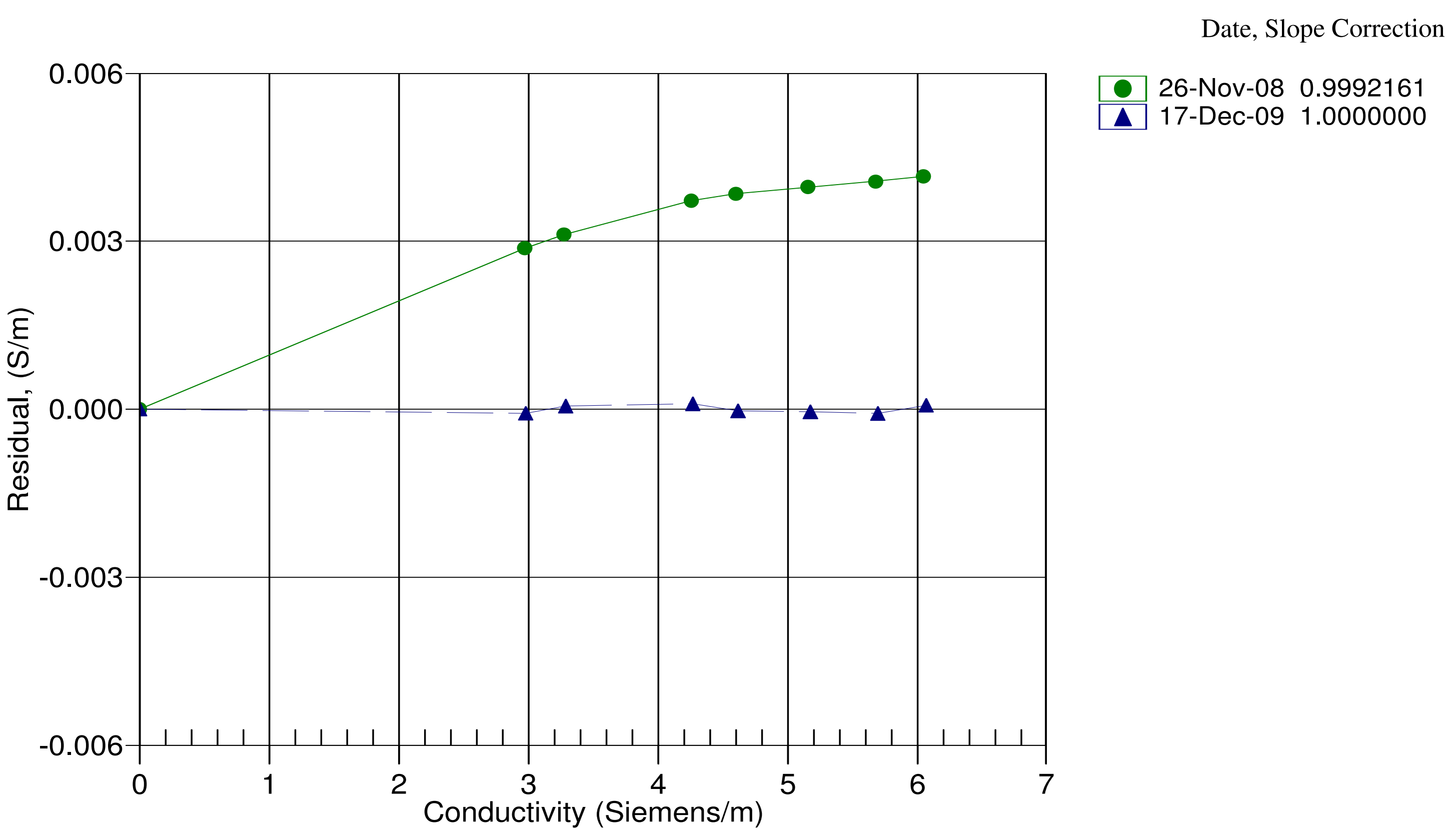
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88531	0.00000	0.00000
0.9999	34.8410	2.97787	8.26832	2.97779	-0.00007
4.5000	34.8208	3.28511	8.63296	3.28516	0.00006
14.9999	34.7776	4.26736	9.70555	4.26745	0.00010
18.5000	34.7681	4.61266	10.05492	4.61263	-0.00003
24.0000	34.7575	5.17085	10.59517	5.17080	-0.00005
29.0000	34.7505	5.69275	11.07615	5.69268	-0.00007
32.5000	34.7451	6.06498	11.40676	6.06505	0.00007

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



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

Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	57041	**Date of Report:**	12/23/2009
Model Number:	SBE 19Plus	**Serial Number:**	19P33589-4487

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: 12/23/2009 Drift since last cal: -0.00110 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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Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	57041	**Date of Report:**	12/23/2009
Model Number:	SBE 19Plus	**Serial Number:**	19P33589-4486

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: 12/23/2009 Drift since last cal: +0.00040 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.

SBE

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Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	57041	**Date of Report:**	12/17/2009
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: 12/17/2009 Drift since last cal: -0.00190 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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Temperature Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	57041	**Date of Report:**	12/23/2009
Model Number:	SBE 19Plus	**Serial Number:**	19P33589-4487

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: 12/23/2009 Drift since last cal: -0.00119 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 Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 57041

Customer Information:

Company	Atlantic Marine Center	**Date**	1/7/2010
Contact	David Miles		
PO Number	Credit card		

Serial Number	05M0613
Model Number	SBE 05M

Services Requested:

1. Evaluate/Repair Instrumentation.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.

Special Notes:

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

Service Report

RMA Number 57041

Customer Information:

Company	Atlantic Marine Center	**Date**	1/7/2010
Contact	David Miles		
PO Number	Credit card		

Serial Number	05M0614
Model Number	SBE 05M

Services Requested:

1. Evaluate/Repair Instrumentation.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.

Special Notes:

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

Service Report

RMA Number 57041

Customer Information:

Company	Atlantic Marine Center	**Date**	1/7/2010
Contact	David Miles		
PO Number	Credit card		

Serial Number	192472-0285
Model Number	SBE 19

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Calibrated the pressure sensor.
4. Performed complete system check and full diagnostic evaluation.

Special Notes:

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

Service Report

RMA Number 57041

Customer Information:

Company	Atlantic Marine Center	**Date**	1/7/2010
Contact	David Miles		
PO Number	Credit card		

Serial Number	19P33589-4486
Model Number	SBE 19Plus

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Calibrated the pressure sensor.
4. Performed complete system check and full diagnostic evaluation.

Special Notes:

SBE

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

Service Report

RMA Number 57041

Customer Information:

Company	Atlantic Marine Center	**Date**	1/7/2010
Contact	David Miles		
PO Number	Credit card		

Serial Number	19P33589-4487
Model Number	SBE 19Plus

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Calibrated the pressure sensor.
4. Performed complete system check and full diagnostic evaluation.

Special Notes:

Certificate of Calibration

004988

Customer:	NOAA - Marine Operations Center Atlantic
Asset Serial Number:	004988
Asset Type:	004988 (Smart SV&P)
Calibrated Pressure Range:	1000 dBar

Certification Date:	03/03/2010 (dd/mm/yyyy)
Certified By:	

AML Oceanographic

Robert Haydock,
President
AML Oceanographic

AML Oceanographic certifies that the equipment described above has been calibrated with equipment referenced to traceable standards. Any repairs / calibrations completed on this instrument were approved by the instrument owner under purchase order.

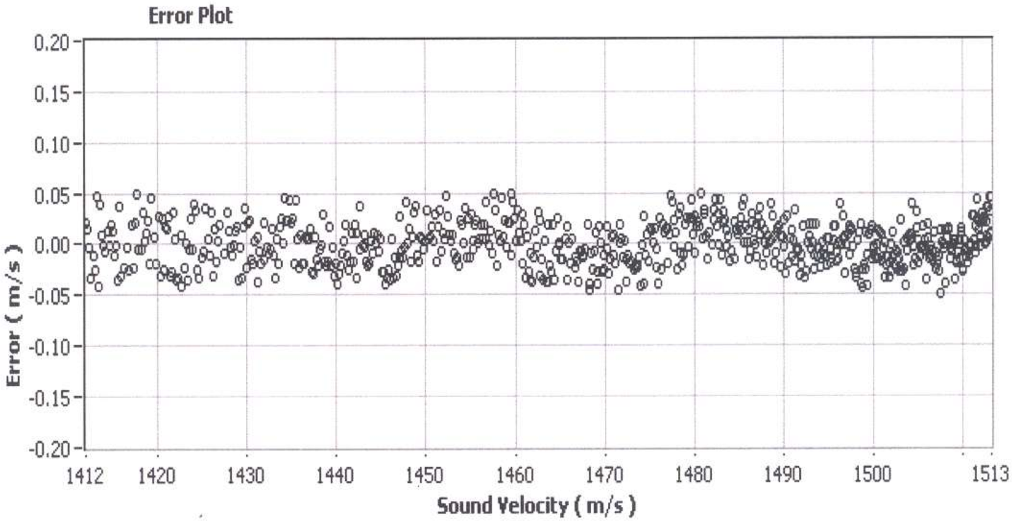
This instrument has been recalibrated. Please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software (ie. Smart Talk) that you use. Instrument configuration files are available at our Client Service & Support Portal (see web address below).

For a complete service history of this instrument, please consult our on-line Client Service & Support Portal at http://www.AMLoceanographic.com/customers/index.htm

AML Oceanographic
2071 Malaview Avenue
Sidney, B.C. V8L 5X6 CANADA
Tel: +1-250-656-0771 Fax: +1-250-655-3655

Sound Velocity Calibration

Date	03/03/10
S/N	004988
Calibrator	Matt Tradewell
RMS Error	0.021
Range	1400 to 1550 m/s



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

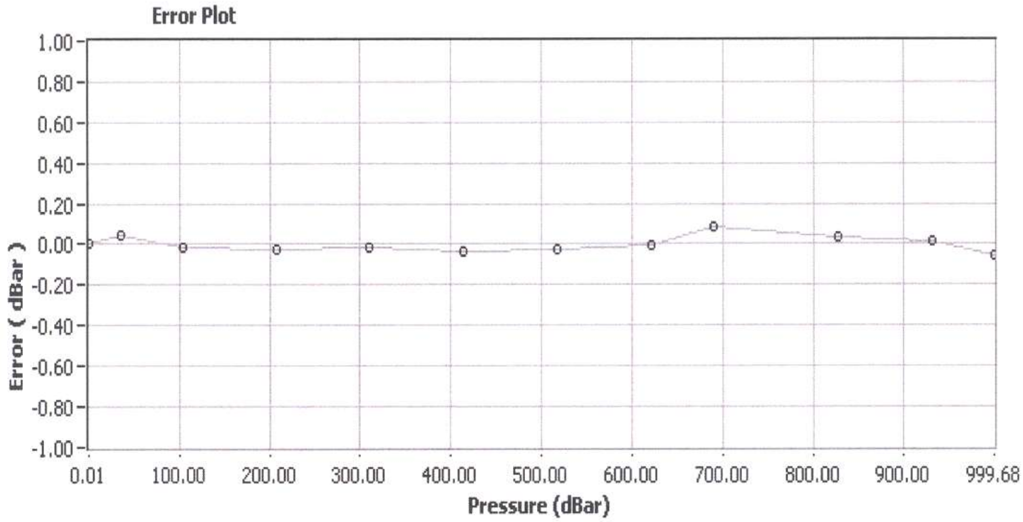
A=1.528480E+3	G=0.000000E+00
B=-1.113298E+2	H=0.000000E+00
C=7.920088E+0	I=0.000000E+00
D=-2.512577E-1	J=0.000000E+00
E=0.000000E+00	K=0.000000E+00
F=0.000000E+00	L=0.000000E+00

AML OCEANOGRAPHIC
Xchange your old ideas

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@amloceanographic.com Web: http://www.amloceanographic.com

Pressure Calibration

Date	03/03/10
S/N	004988
Calibrator	Matt Tradewell
RMS Error	0.038
Range	1000 dBar



dBar=A+B*T+C*T^2+D*T^3+(E+F*T+G*T^2+H*T^3)*Raw+(I+J*T+K*T^2+L*T^3)*Raw^2

A=-1.569606E+3	G=-7.050158E-8
B=-8.337370E-1	H=-5.412054E-9
C=2.784933E-3	I=8.560448E-9
D=1.651412E-4	J=-2.154370E-11
E=4.768699E-2	K=-1.798432E-12
F=2.482477E-5	L=3.779060E-14

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Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@amloceanographic.com Web: http://www.amloceanographic.com

Certificate of Calibration

005340

Customer:	NOAA - Marine Operations Center Atlantic
Asset Serial Number:	005340
Asset Type:	005340 (Smart SV&P)
Calibrated Pressure Range:	1000 dBar

Certification Date:	03/03/2010 (dd/mm/yyyy)
Certified By:	

Robert Haydock
AML Oceanographic

Robert Haydock,
President
AML Oceanographic

AML Oceanographic certifies that the equipment described above has been calibrated with equipment referenced to traceable standards. Any repairs / calibrations completed on this instrument were approved by the instrument owner under purchase order.

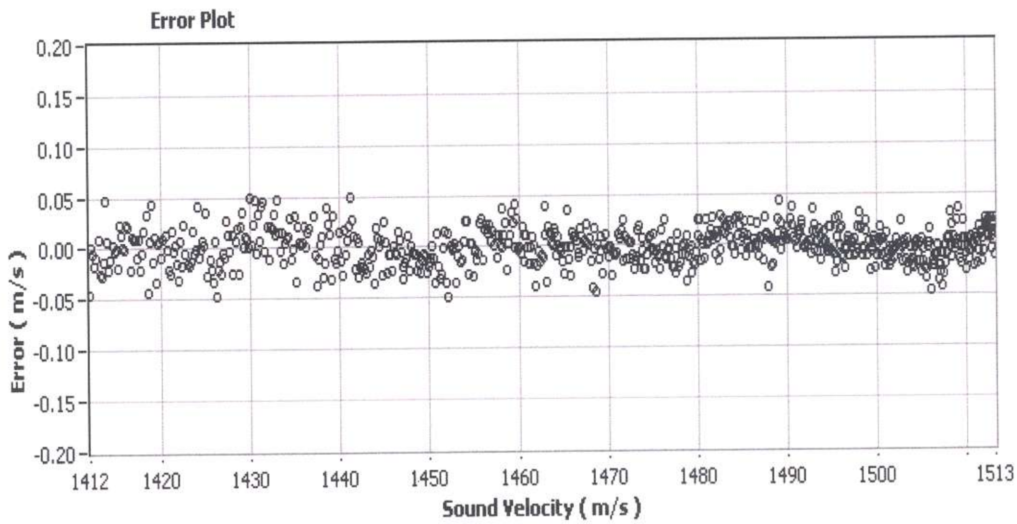
This instrument has been recalibrated. Please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software (ie. Smart Talk) that you use. Instrument configuration files are available at our Client Service & Support Portal (see web address below).

For a complete service history of this instrument, please consult our on-line Client Service & Support Portal at http://www.AMLoceanographic.com/customers/index.htm

AML Oceanographic
2071 Malaview Avenue
Sidney, B.C. V8L 5X6 CANADA
Tel: +1-250-656-0771 Fax: +1-250-655-3655

Sound Velocity Calibration

Date	03/03/10
S/N	005340
Calibrator	Matt Tradewell
RMS Error	0.017
Range	1400 to 1550 m/s



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

A=1.532244E+3	G=0.000000E+00
B=-1.075733E+2	H=0.000000E+00
C=8.066954E+0	I=0.000000E+00
D=-5.996156E-1	J=0.000000E+00
E=0.000000E+00	K=0.000000E+00
F=0.000000E+00	L=0.000000E+00

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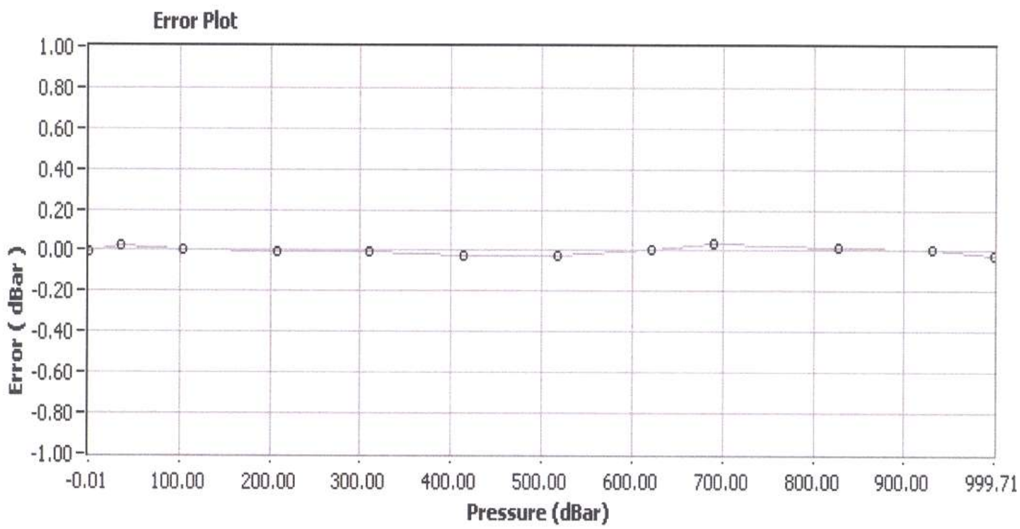
Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@amloceanographic.com Web: http://www.amloceanographic.com

Pressure Calibration

Date	03/03/10
S/N	005340
Calibrator	Matt Tradewell
RMS Error	0.019
Range	1000 dBar



dBar=A+B*T+C*T^2+D*T^3+(E+F*T+G*T^2+H*T^3)*Raw+(I+J*T+K*T^2+L*T^3)*Raw^2

A=-1.595904E+3	G=-5.509664E-7
B=-8.060861E-1	H=-5.614648E-9
C=1.770315E-2	I=-1.423031E-9
D=8.473935E-5	J=-2.103035E-10
E=5.239851E-2	K=3.934629E-12
F=3.746474E-5	L=2.935759E-14

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Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@amloceanographic.com Web: http://www.amloceanographic.com

Certificate of Calibration

004823

Customer: NOAA - Marine Operations Center Atlantic

Asset Serial Number: 004823

Asset Type: 004823 (Smart SV & T)

Calibrated Pressure Range: ________

Certification Date: 03/03/2010 (dd/mm/yyyy)

Certified By:

Robert Haydock,
President
AML Oceanographic

AML Oceanographic certifies that the equipment described above has been calibrated with equipment referenced to traceable standards. Any repairs / calibrations completed on this instrument were approved by the instrument owner under purchase order.

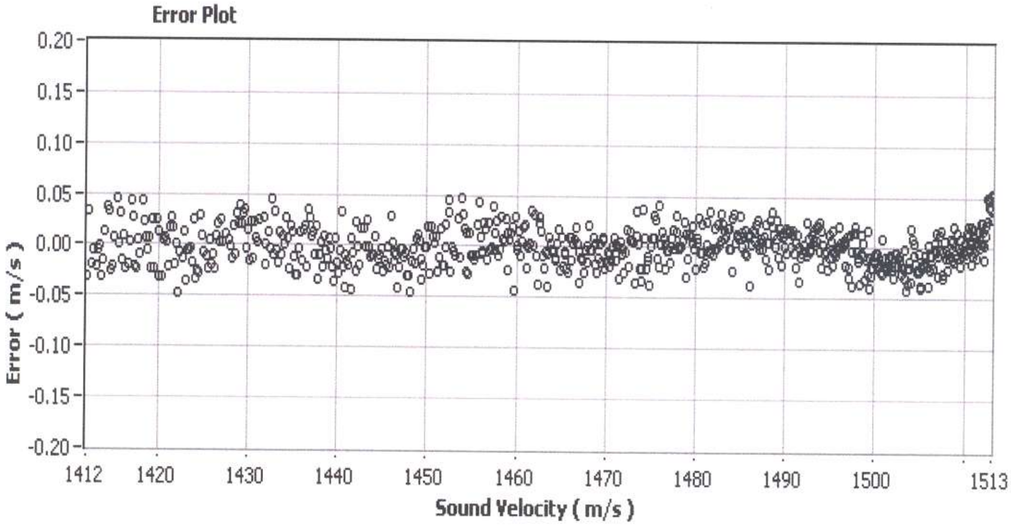
This instrument has been recalibrated. Please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software (ie. Smart Talk) that you use. Instrument configuration files are available at our Client Service & Support Portal (see web address below).

For a complete service history of this instrument, please consult our on-line Client Service & Support Portal at http://www.AMLoceanographic.com/customers/index.htm

AML Oceanographic
2071 Malaview Avenue
Sidney, B.C. V8L 5X6 CANADA
Tel: +1-250-656-0771 Fax: +1-250-655-3655

Sound Velocity Calibration

Date	03/03/10
S/N	004823
Calibrator	Matt Tradewell
RMS Error	0.019
Range	1400 to 1550 m/s



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

A=1.525934E+3	G=0.000000E+00
B=-1.063321E+2	H=0.000000E+00
C=7.683077E+0	I=0.000000E+00
D=-4.442355E-1	J=0.000000E+00
E=0.000000E+00	K=0.000000E+00
F=0.000000E+00	L=0.000000E+00

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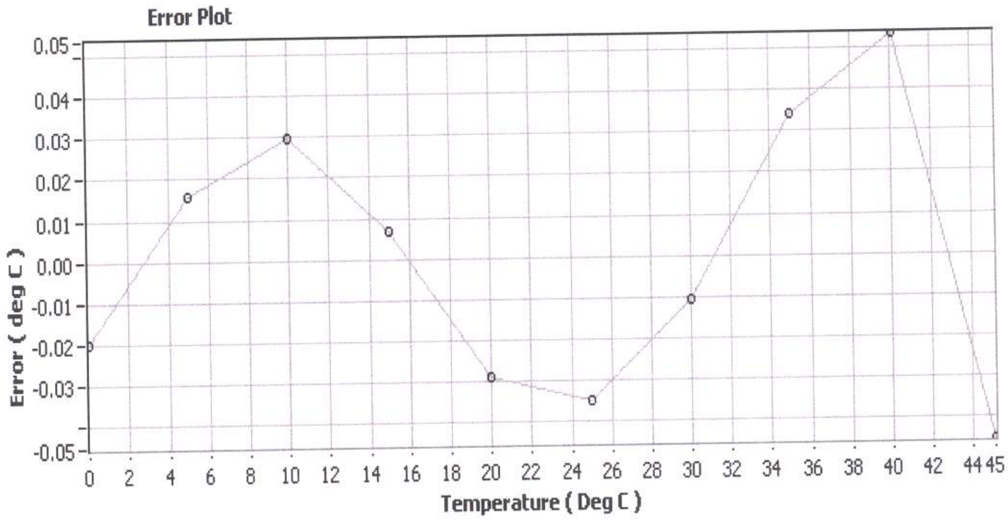
2071 Malaview Ave West, Sidney, British Columbia, Canada V8L 5X6
Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@amloceanographic.com Web: http://www.amloceanographic.com

Temperature Calibration

Date	03/03/10
S/N	004823
Calibrator	Matt Tradewell
RMS Error	0.0314
Range	+2 to +45 Deg C



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

A=-4.918355E+1	G=0.000000E+00
B=3.158552E-3	H=0.000000E+00
C=-5.503856E-8	I=0.000000E+00
D=5.588734E-13	J=0.000000E+00
E=0.000000E+00	K=0.000000E+00
F=0.000000E+00	L=0.000000E+00

AML OCEANOGRAPHIC
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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@amloceanographic.com Web: http://www.amloceanographic.com

Spare - In ET Stores 8/11/09

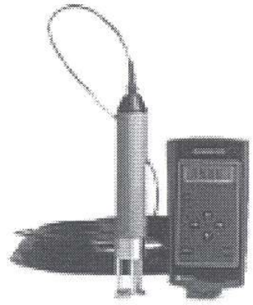
Date:
Jul 17, 2009

Serial #:
98129-071709

DIGIBAR CALIBRATION REPORT

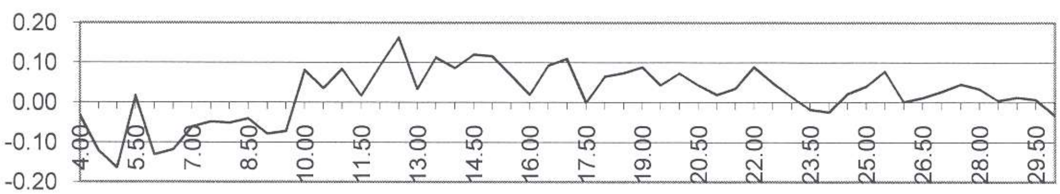
version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5544.91	1421.59	-0.03
4.50	1423.90	5553.33	1423.78	-0.12
5.00	1426.15	5561.83	1425.99	-0.16
5.50	1428.38	5571.09	1428.40	0.02
6.00	1430.58	5578.98	1430.45	-0.13
6.50	1432.75	5587.39	1432.63	-0.12
7.00	1434.90	5595.87	1434.84	-0.06
7.50	1437.02	5604.08	1436.97	-0.05
8.00	1439.12	5612.13	1439.07	-0.05
8.50	1441.19	5620.14	1441.15	-0.04
9.00	1443.23	5627.86	1443.15	-0.08
9.50	1445.25	5635.66	1445.18	-0.07
10.00	1447.25	5643.93	1447.33	0.08
10.50	1449.22	5651.34	1449.26	0.04
11.00	1451.17	5659.02	1451.26	0.08
11.50	1453.09	5666.16	1453.11	0.02
12.00	1454.99	5673.76	1455.09	0.09
12.50	1456.87	5681.25	1457.03	0.16
13.00	1458.72	5687.88	1458.76	0.03
13.50	1460.55	5695.22	1460.67	0.11
14.00	1462.36	5702.07	1462.45	0.09
14.50	1464.14	5709.06	1464.26	0.12
15.00	1465.91	5715.82	1466.02	0.12
15.50	1467.65	5722.33	1467.71	0.07
16.00	1469.36	5728.74	1469.38	0.02
16.50	1471.06	5735.54	1471.15	0.09
17.00	1472.73	5742.04	1472.84	0.11
17.50	1474.38	5747.97	1474.38	0.00
18.00	1476.01	5754.49	1476.08	0.07
18.50	1477.62	5760.71	1477.69	0.07
19.00	1479.21	5766.87	1479.29	0.09
19.50	1480.77	5772.72	1480.81	0.04
20.00	1482.32	5778.78	1482.39	0.07
20.50	1483.84	5784.53	1483.89	0.04
21.00	1485.35	5790.22	1485.36	0.02
21.50	1486.83	5795.99	1486.86	0.04
22.00	1488.29	5801.83	1488.38	0.09
22.50	1489.74	5807.23	1489.79	0.05
23.00	1491.16	5812.57	1491.17	0.01
23.50	1492.56	5817.85	1492.55	-0.02
24.00	1493.95	5823.15	1493.93	-0.02
24.50	1495.32	5828.58	1495.34	0.02
25.00	1496.66	5833.83	1496.70	0.04
25.50	1497.99	5839.08	1498.07	0.08
26.00	1499.30	5843.82	1499.30	0.00
26.50	1500.59	5848.82	1500.60	0.01
27.00	1501.86	5853.77	1501.89	0.03
27.50	1503.11	5858.66	1503.16	0.05
28.00	1504.35	5863.36	1504.38	0.03
28.50	1505.56	5867.93	1505.57	0.01
29.00	1506.76	5872.57	1506.77	0.01
29.50	1507.94	5877.09	1507.95	0.01
30.00	1509.10	5881.41	1509.07	-0.03



Odom Hydrographic Systems, Inc.
1450 SeaBoard Avenue, Baton Rouge, Louisiana 70810-6261, USA
Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

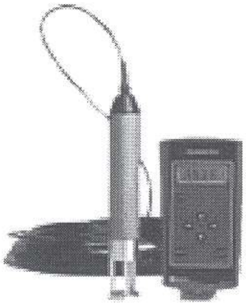
Date:
Jul 17, 2009

Serial #:
98129-071709

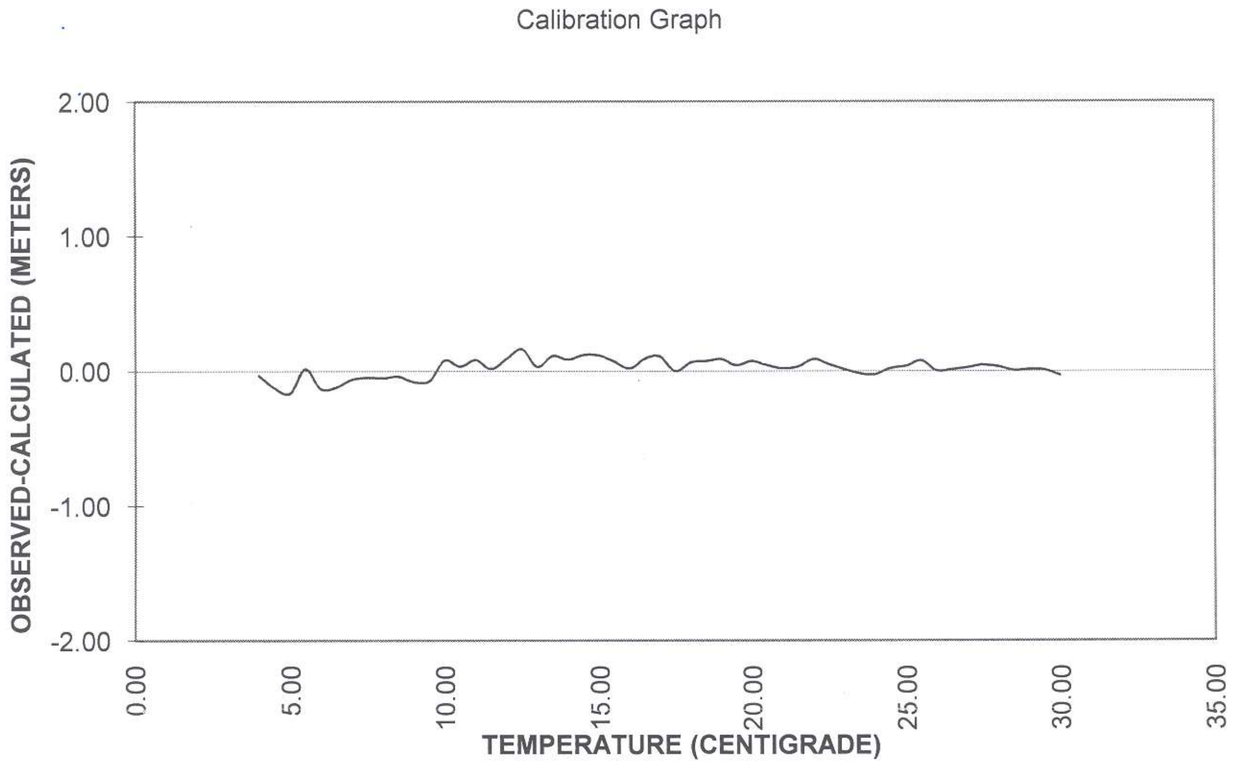
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



Burn these numbers to EPROM:	Gradient	**3328**
	Intercept	**200**



The instruments used in this calibration have been calibrated to the published manufacturer specifications using standards traceable to NIST, to consensus standards, to ratio methods, or to acceptable values of natural physical constants that meets the requirements of ANSI/NCSL Z540-1, ISO 9001, ISO 10012 and ISO 17025. Certificate/traceability numbers: 0002-2655.00-23491-001, 0002-2655.00-23491-002. ID#'s:294,295,762,172,56

Odom Hydrographic Systems, Inc.
1450 SeaBoard Avenue, Baton Rouge, Louisiana 70810-6261, USA
Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

TELEDYNE ODOM HYDROGRAPHIC
A Teledyne Technologies Company

Digibar

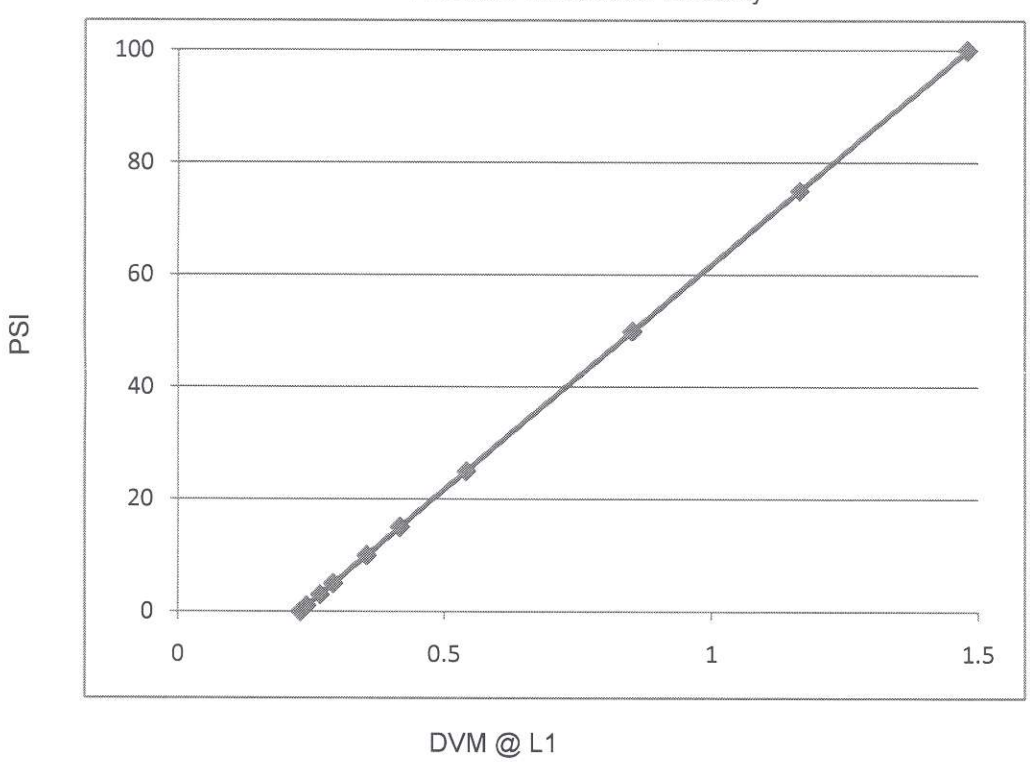
Date	7/17/2009
Serial #	98129
SW Version	1.08
Cable Length	SPECIAL

Press Transducer	48659
Zero Voltage	.23
Span Volage	2.73
Mid-Scale Voltage	1.48
R5	3.9K
R9	10K
Gradient	3328
Intercept	200

Max psi:	200 psi
Velocity Check:	√
Depth Check:	√
Communications:	√
External Power:	NA

Board Identification	Serial #
Power Supply	
Control PCB	
LCD	
Probe Sensor	
Probe Controller	
Airmar Transducer	

Pressure Transducer Linearity



Transducer Linearity	
PSI	DVM@L1
0	0.23
1	0.242
3	0.267
5	0.292
10	0.354
15	0.417
25	0.541
50	0.853
75	1.166
100	1.48

-B310L

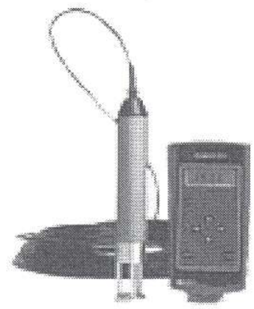
Date:
Jul 15, 2009

Serial #:
98032-071509

DIGIBAR CALIBRATION REPORT

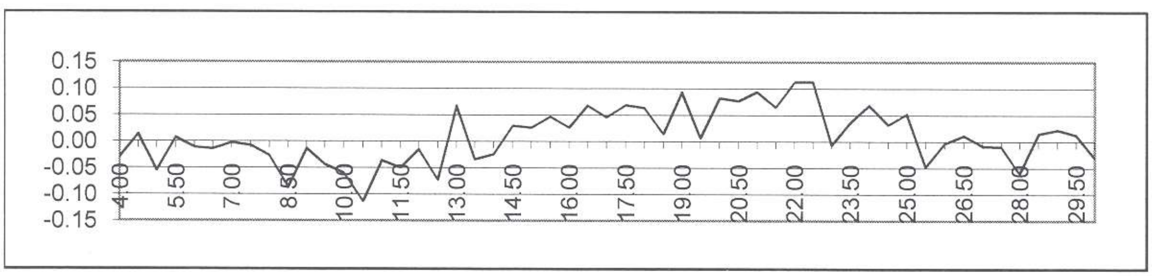
version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL	TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5547.13	1421.59	-0.03	17.50	1474.38	5744.42	1474.45	0.07
4.50	1423.90	5555.80	1423.91	0.01	18.00	1476.01	5750.48	1476.07	0.06
5.00	1426.15	5563.95	1426.10	-0.05	18.50	1477.62	5756.30	1477.63	0.01
5.50	1428.38	5572.49	1428.39	0.01	19.00	1479.21	5762.52	1479.30	0.09
6.00	1430.58	5580.63	1430.57	-0.01	19.50	1480.77	5768.04	1480.78	0.01
6.50	1432.75	5588.73	1432.74	-0.01	20.00	1482.32	5774.09	1482.40	0.08
7.00	1434.90	5596.79	1434.90	0.00	20.50	1483.84	5779.76	1483.92	0.08
7.50	1437.02	5604.69	1437.01	-0.01	21.00	1485.35	5785.44	1485.44	0.09
8.00	1439.12	5612.44	1439.09	-0.03	21.50	1486.83	5790.87	1486.89	0.07
8.50	1441.19	5619.95	1441.10	-0.09	22.00	1488.29	5796.51	1488.41	0.11
9.00	1443.23	5627.86	1443.22	-0.01	22.50	1489.74	5801.90	1489.85	0.11
9.50	1445.25	5635.29	1445.21	-0.04	23.00	1491.16	5806.77	1491.15	-0.01
10.00	1447.25	5642.68	1447.19	-0.06	23.50	1492.56	5812.17	1492.60	0.04
10.50	1449.22	5649.84	1449.11	-0.11	24.00	1493.95	5817.46	1494.02	0.07
11.00	1451.17	5657.40	1451.14	-0.04	24.50	1495.32	5822.42	1495.35	0.03
11.50	1453.09	5664.53	1453.05	-0.05	25.00	1496.66	5827.52	1496.71	0.05
12.00	1454.99	5671.75	1454.98	-0.01	25.50	1497.99	5832.10	1497.94	-0.05
12.50	1456.87	5678.54	1456.80	-0.07	26.00	1499.30	5837.15	1499.29	0.00
13.00	1458.72	5685.98	1458.79	0.07	26.50	1500.59	5842.02	1500.60	0.01
13.50	1460.55	5692.43	1460.52	-0.03	27.00	1501.86	5846.69	1501.85	-0.01
14.00	1462.36	5699.21	1462.34	-0.02	27.50	1503.11	5851.36	1503.10	-0.01
14.50	1464.14	5706.07	1464.17	0.03	28.00	1504.35	5855.78	1504.29	-0.06
15.00	1465.91	5712.63	1465.93	0.03	28.50	1505.56	5860.60	1505.58	0.02
15.50	1467.65	5719.20	1467.69	0.05	29.00	1506.76	5865.10	1506.78	0.02
16.00	1469.36	5725.53	1469.39	0.03	29.50	1507.94	5869.47	1507.95	0.01
16.50	1471.06	5732.01	1471.12	0.07	30.00	1509.10	5873.65	1509.07	-0.03
17.00	1472.73	5738.17	1472.78	0.05					



Odom Hydrographic Systems, Inc.
1450 SeaBoard Avenue, Baton Rouge, Louisiana 70810-6261, USA
Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

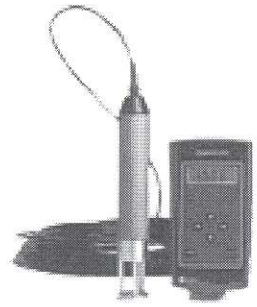
Date:
Jul 15, 2009

Serial #:
98032-071509

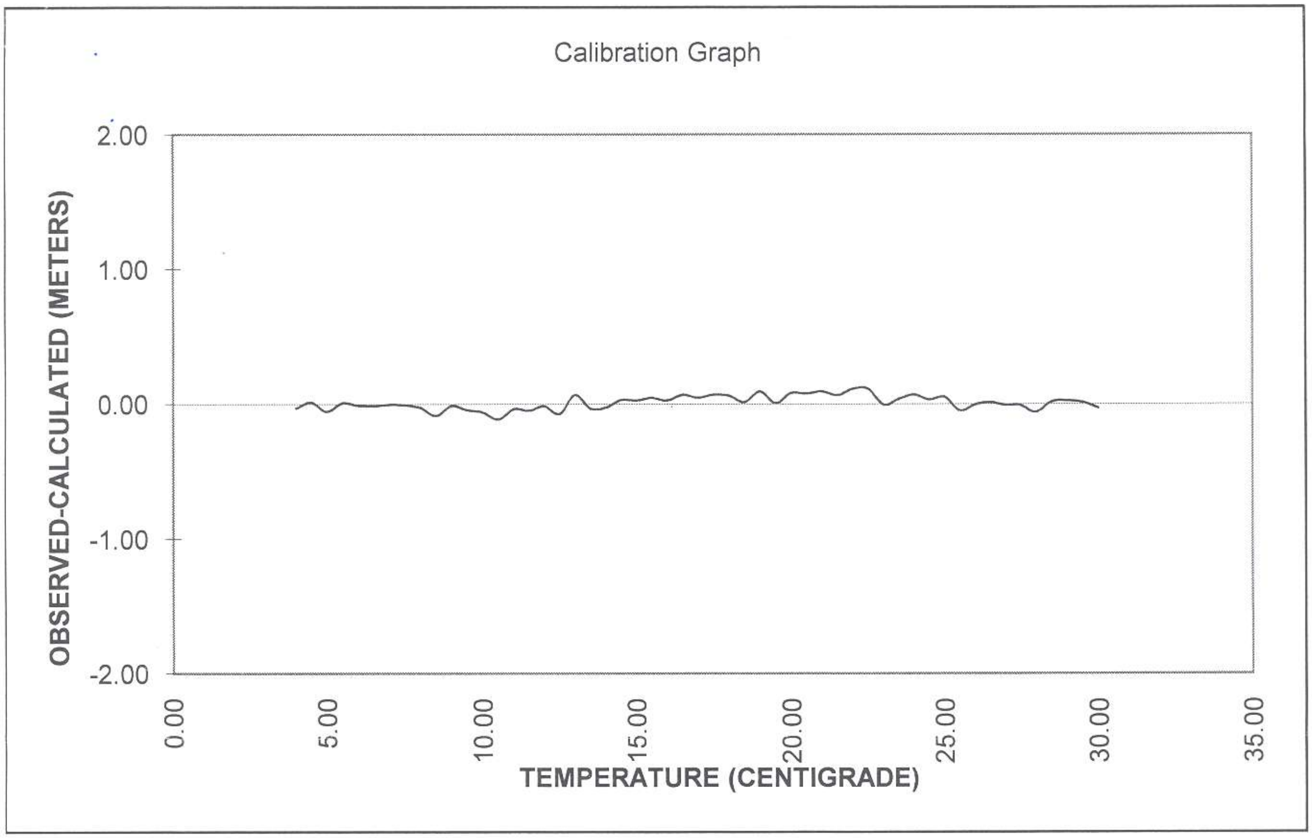
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



Burn these numbers to EPROM:	Gradient	**3430**
	Intercept	**647**

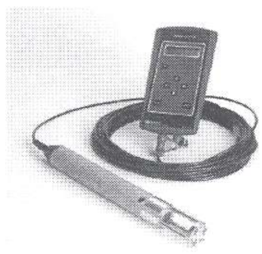


The instruments used in this calibration have been calibrated to the published manufacturer specifications using standards traceable to NIST, to consensus standards, to ratio methods, or to acceptable values of natural physical constants that meets the requirements of ANSI/NCSL Z540-1, ISO 9001, ISO 10012 and ISO 17025. Certificate/traceability numbers: 0002-2655.00-23491-001, 0002-2655.00-23491-002. ID#'s:294,295,762,172,56

Odom Hydrographic Systems, Inc.
1450 SeaBoard Avenue, Baton Rouge, Louisiana 70810-6261, USA
Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

Digibar

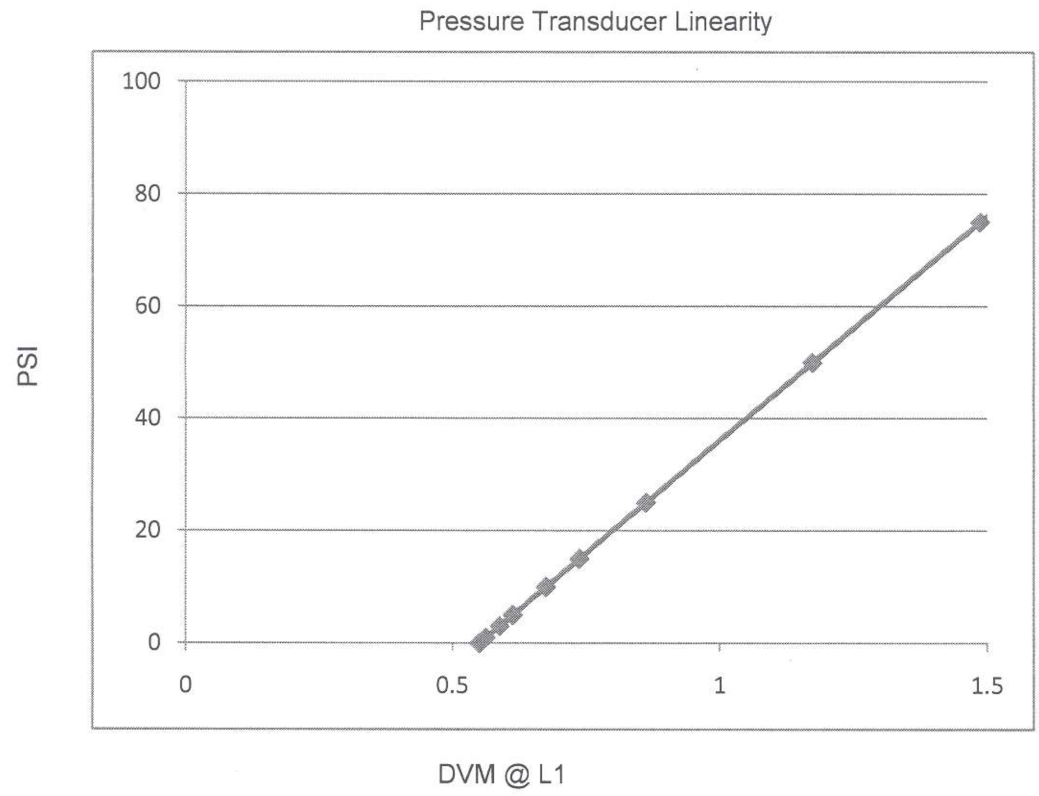


Date	7/16/2009
Serial #	98032
SW Version	1.08
Cable Length	20m

Board Identification	Serial #
Power Supply	
Control PCB	
LCD	
Probe Sensor	
Probe Controller	
Airmar Transducer	1622991

Press Transducer	51266
Zero Voltage	.55
Span Volage	3.05
Mid-Scale Voltage	1.8
R5	3.9K
R9	10K
Gradient	3430
Intercept	647

Max psi:	75psi
Velocity Check:	√
Depth Check:	√
Communications:	√
External Power:	NA



Transducer Linearity	
PSI	DVM@L1
0	0.55
1	0.562
3	0.587
5	0.612
10	0.674
15	0.737
25	0.861
50	1.174
75	1.487
100	1.8

applanix
A TRIMBLE COMPANY

Certificate of Conformance

Applanix Corporation certifies that the material listed below has been tested in accordance with approved test procedures and was found to meet or exceed published specifications.

1)	Description:	**IMU LN200**
	Applanix Part Number:	**10002416**
	IMU Serial Number:	**407301 (Top Hat # 356)**

Return Material Authorization #: L09-051

Customer: NOAA
Atlantic Branch at MOC

Bruce A Francis

Certified By:
Bruce Francis
Customer Support Engineer

2 February, 2010

Date:

applanix
A TRIMBLE COMPANY

Certificate of Conformance

Applanix Corporation certifies that the material listed below has been tested in accordance with approved test procedures and was found to meet or exceed published specifications.

1)	Description:	**IMU LN200**
	Applanix Part Number:	**10002416**
	IMU Serial Number:	**410461 (Top Hat # 352)**

Return Material Authorization #: L09-051

Customer: NOAA
Atlantic Branch at MOC

Bruce A Francis

Certified By:
Bruce Francis
Customer Support Engineer

2 February, 2010

Date:

Certificate of Conformance

Applanix Corporation certifies that the material listed below has been tested in accordance with approved test procedures and was found to meet or exceed published specifications.

1)	Description:	**IMU LN200**
	Applanix Part Number:	**10000770**
	IMU Serial Number:	**402952 (Top Hat # 146)**

Return Material Authorization #: L09-051

Customer: NOAA
Atlantic Branch at MOC

2 February, 2010

Certified By:
Bruce Francis
Customer Support Engineer

Date:

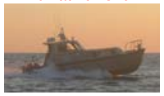
Hydrographic Vessel Inventory

Field Unit: THOMAS JEFFERSON

Effective Date: 4/3/2007

Ship Updated Through: 5/7/2009

SURVEY VESSELS

Vessel Name	NOAA Ship Thomas Jefferson 	TJ Launch 3101 	TJ Launch 3102 
Hull Number	S 222	3101	3102
Call Letters	WTEA		
Manufacturer	Halter Marine, Inc. Moss Point, Miss	Metalcraft Marine Inc. Kingston, Ontario	Metalcraft Marine Inc. Kingston, Ontario
Year of Construction	1991	2005	2005
Type of Construction	Welded steel hull	Aluminum hull	Aluminum hull
Length Overall	208 ft. (63.4 m)	31 ft.	31 ft.
Beam	45 ft. (13.7 m)	10 ft. 8 inches	10 ft. 8 inches
Draft, Maximum	14 ft. (4.3 m)	5 ft. 2 inches	5 ft. 2 inches
Date of Effective Full Vessel Static Offset Survey	10-Mar-05	19-Aug-05	25-Aug-05
Organization which Conducted the Effective Full Offset Survey	NGS	NGS	NGS
Date of Last Partial Survey or Offset Verification & Methods Used	10-Mar-2006 optical level	-	-
Date of Last Static Draft Determination & Method Used	4-April-2009 Bubble Method	19-Apr-2009 Bubble Method	27-Apr-2009 Bubble Method
Date of Last Settlement and Squat Measurements & Method Used	5-April-2009 reference surface method	19 April-2009 reference surface method	27-Apr-2009 reference surface method
Additional Information			

Hydrographic Vessel Inventory

Field Unit: THOMAS JEFFERSON

Effective Date: 4/3/2007

Ship Updated Through: 5/7/2009

SURVEY VESSELS

Vessel Name	NOAA Ship Thomas Jefferson	NOAA Survey Launch 3101	NOAA Survey Launch 3102				
Hull Number	S 222	3101	3102				
Call Letters	WTEA						
Manufacturer	Halter Marine, Inc. Moss Point, Miss	Metalcraft Marine Inc. Kingston,	Metalcraft Marine Inc. Kingston,				
Year of Construction	1991	2005	2005				
Type of Construction	Welded steel hull	Aluminum hull	Aluminum hull				
Length Overall	208 ft. (63.4 m)	31 ft.	31 ft.				
Beam	45 ft. (13.7 m)	10 ft. 8 inches	10 ft. 8 inches				
Draft, Maximum	14 ft. (4.3 m)	5 ft. 2 inches	5 ft. 2 inches				
Date of Effective Full Vessel Static Offset Survey	10-Mar-05	19-Aug-05	25-Aug-05				
Organization which Conducted the Effective Full Offset Survey	NGS	NGS	NGS				
Date of Last Partial Survey or Offset Verification & Methods	10-Mar-2006 optical level	-	-				
Date of Last Static Draft Determination & Method Used	4-April-2009 Bubble Method	19-Apr-2009 Bubble Method	27-Apr-2009 Bubble Method				
Date of Last Settlement and Squat Measurements &	5-April-2009 reference surface method	19 April-2009 reference surface method	27-Apr-2009 reference surface method				
Additional Information							

Acquisiton Computer Software

	Date of application	TJ	3101	3102
Hypack/Hysweep	March-10	v2010	v2009a	v2009a
Sonarpro	February-10	v11.2	v11.2	v11.2
Velocwin	April-09	v8.96	v8.95	v8.91
Applanix MV POSView	December-09	v4.3.4.0	v5.1.0.2	v4.0.2.0
TSIP Talker	August-09	v2.00	v7.00	v2.00
MVP	September-09	V 2.351	n/a	n/a
SIS	July-07	v3.4.3		

Processing Computers Software

	Date of application	Versions
CARIS Hips snd Sips	March-19	7.0 SP1, hotfix 4
CARIS Bathy Database	March-10	2.3, hotfix 17
Windows Professional	March-10	SP3
Microsoft Office 2007	March-10	current
Mapinfo March-10		10.0
Adobe March-10		9.0
Pydro	March-10	9.10v 2824

Hydrographic Hardware Inventory

Field Unit: Thomas Jefferson (S-222)

SONAR AND SOUNDING EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD # / ACM #**
Reson	7P Processor	50357	CD0001044551
	Lower Control Unit	61206	None
	Projector	1908203	None
	Reciever, EM7200-1	808042	CD0000825373
Kongsberg	EM 1002	Processor: 227	CD0001474854
		Transducer: 222	AMC-A010656
Klein	5500 high speed high resolution side scan sonar towfish	280	CD0001776003
	Top Side Processor Unit	135	CD0000825295
	5500 SSS Spare	319	
	Spare Top Side Procesing Unit	138	CD0000825294
Odom	Echotrac MKII	9656	CD0000656528

POSITIONING & ATTITUDE EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Trimble	DSM212L	0220227516	CD0000658032
Trimble	DSM212L	0220159716	CD0000832703
Applanix	POS/ MV	PCS - 2321	CD0001472952
Applanix	POS M/V	IMU - 146	CD0001284522

SOUND SPEED MEASUREMENT EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Seabird	SBE 19 SVP	192472-285	CD0001776086
Applied Micro Systems	Smart SV+T SSVS	4823	A011827
Brooke Ocean Technology LTD	Sensor 1	5340	None
	MVP PU	10332	CD0200825374
	"Fish 1"	10535	None
	"Fish 2"	10333	None
	MVP Computer	0127560	None
	Sensor 2	4988	None
	Deck Unit	10332	None

TIDES & LEVELING EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Lietz / Sokkisha	B1 Automatic Level	7423	None
Carl Zeiss	Ni 2 Level	20606	None

Hydrographic Hardware Inventory

Field Unit: Launch 3102

Effective Date: March 01, 2010

Updated Through:April 26, 2010

SONAR AND SOUNDING EQUIPMENT

Manufacturer	Model	Serial Number	CD Number
Reson	SeaBat 7125-SV TPU	1812031	CD0001529723
	SeaBat 7125-SV X-Ducer	2008027	CD000152972x
Klein	5500 LW ss towfish	322	N/A
	Top Side Processor Unit	136	CD0000825297
Odom	Echotrac CV-200	2917	

POSITIONING & ATTITUDE EQUIPMENT

Manufacturer	Model	Serial Number	CD Number
Trimble	DSM212L	0220168291	CD0000819685
Applanix	POS/MV	2562	CD0000156714
		IMU - 356	CD0001474855

SOUND SPEED MEASUREMENT EQUIPMENT

Manufacturer	Model	Serial Number	CD Number
Seabird	SBE 19 Plus SVP	19P33589-4487	CD0001776088

Hydrographic Hardware Inventory

Field Unit: Launch 3101

Effective Date: March 01, 2010

Updated Through:April 26, 2010

SONAR AND SOUNDING EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Reson	SeaBat 7125-SV TPU	1812018	CD0001527832
	SeaBat 7125-SV X-Ducer	2008044	CD0001776100
Klein	5500 LW ss towfish	292	N/A
	Top Side Processor Unit	137	CD0000825292
Odom	Echotrac CV-200	3260	

POSITIONING & ATTITUDE EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Trimble	DSM212L	0220243252	CD0001606186
Applanix	POS M/V	2320	CD0000825559
		IMU - 352	none

SOUND SPEED MEASUREMENT EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Seabird	SBE 19 Plus SVP	19P33589-4486	CD0001776087

Hydrographic Hardware Inventory

Field Unit: Thomas Jefferson (S-222)

SONAR AND SOUNDING EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD # / ACM #**
Reson	7P Processor	50357	CD0001044551
	Lower Control Unit	61206	None
	Projector	1908203	None
	Reciever, EM7200-1	808042	CD0000825373
Kongsberg	EM 1002	Processor: 227	CD0001474854
		Transducer: 222	AMC-A010656
Klein	5500 high speed high resolution side scan sonar towfish	280	CD0001776003
	Top Side Processor Unit	135	CD0000825295
	5500 SSS Spare	319	
	Spare Top Side Procesing Unit	138	CD0000825294
Odom	Echotrac MKII	9656	CD0000656528

POSITIONING & ATTITUDE EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Trimble	DSM212L	0220227516	CD0000658032
Trimble	DSM212L	0220159716	CD0000832703
Applanix	POS/ MV	PCS - 2321	CD0001472952
Applanix	POS M/V	IMU - 146	CD0001284522

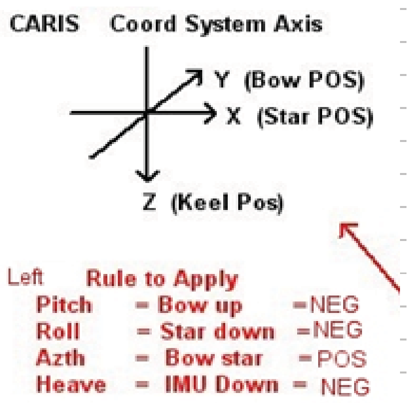
SOUND SPEED MEASUREMENT EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Seabird	SBE 19 SVP	192472-285	CD0001776086
Applied Micro Systems	Smart SV+T SSVS	4823	A011827
Brooke Ocean Technology LTD	Sensor 1	5340	None
	MVP PU	10332	CD0200825374
	"Fish 1"	10535	None
	"Fish 2"	10333	None
	MVP Computer	0127560	None
	Sensor 2	4988	None
	Deck Unit	10332	None

TIDES & LEVELING EQUIPMENT			
Manufacturer	**Model**	**Serial Number**	**CD Number**
Lietz / Sokkisha	B1 Automatic Level	7423	None
Carl Zeiss	Ni 2 Level	20606	None

Appendix B

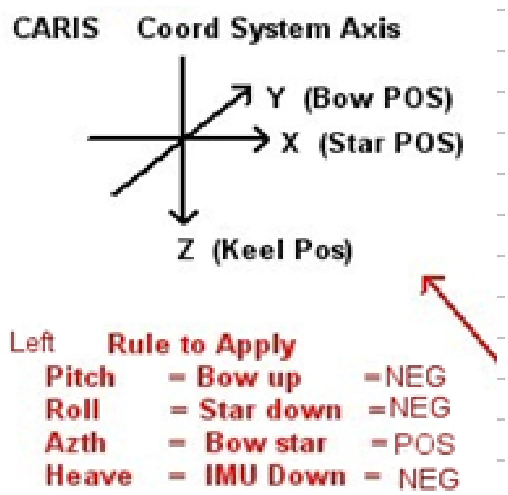
S222 CARIS Offsets 2010

ITEM	DESCRIPTION	X_AXIS	Y_AXIS	Z_AXIS
1	Optical Reference unit	0	-0.844	-0.116
2	POS/MV IMU	0.000	0.000	0.000
3	Port POS/MV Aero Antenna 1 Phase Center	1.560	-10.282	-22.320
4	Stbd POS/MV Aero Antenna 2 Phase Center	3.563	-10.166	-22.336
5	EM 1002 transducer	2.384	-0.560	5.153
6	200 khz transducer	0.494	-1.902	4.980
7	24 khz transducer	2.213	-2429.000	4.663
8	SSS block NGS Aug extension	6.374	-42.553	-4.797
9	Waterline	n/a	n/a	0.570
10	7125 STD transducer	8.499	-2.364	5.064

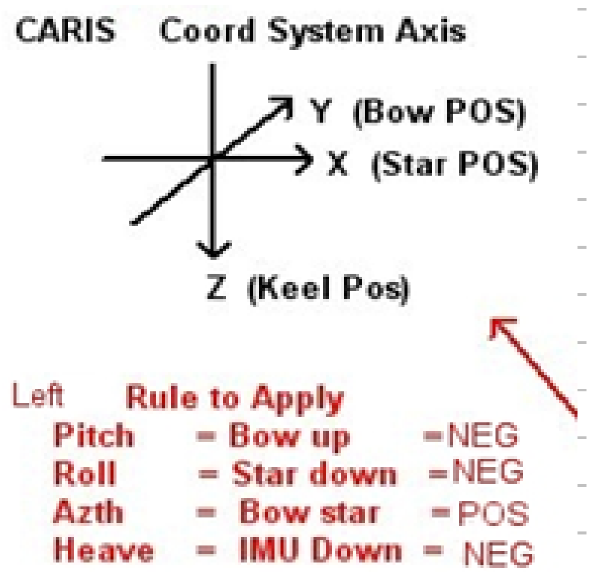


3101 CARIS Offsets 2010

ITEM	DESCRIPTION	X_AXIS	Y_AXIS	Z_AXIS
1	POS/MV IMU	0.000	0.000	0.000
2	Port POS/MV Aero Antenna 1 Phase Center	-0.791	-0.735	-3.830
3	Stbd POS/MV Aero Antenna 2 Phase Center	-0.716	-0.738	-3.855
4	Reson 7125-SV 400kHz (Accoustic center)	-0.472	0.072	0.541
5	Reson 7125-SV 200kHz (Accoustic center)	-0.321	0.071	0.541
6	Klein 5000 Heavy weight	0.489	0.080	0.534
7	Klein 5500 Light weight	0.494	0.540	0.600
8	Odom CV-200	-1.030	0.947	0.122
9	Waterline	N/A	N/A	-0.225



3102 CARIS Offsets 2010				
ITEM	**DESCRIPTION**	**X_AXIS**	**Y_AXIS**	**Z_AXIS**
1	POS/MV IMU	0.000	0.000	0.000
2	Port POS/MV Aero Antenna 1 Phase Center	-0.649	-0.842	-3.814
3	Stbd POS/MV Aero Antenna 2 Phase Center	0.792	-0.840	-3.791
4	Reson 7125-SV 400kHz (Accoustic center)	-0.522	-0.033	0.545
5	Reson 7125-SV 200kHz (Accoustic center)	-0.368	-0.033	0.545
6	Klein 5500 Light weight	0.463	-0.020	0.617
7	Odom CV-200	-1.004	0.867	0.140
8	Waterline	N/A	N/A	-0.225



Appendix C

BAR CHECK	**Date**	**3/14/2010**	**Lat**	**Willards Pt Anchorage**	**WL=**	**-0.232**
Vessel	**3101**		**Lon**		**Units**	**Meters**
Personnel	Glomb	Krebs	Kosenko			
TD guide	**RP-imu**	**imu TD**	**Rail RP-TD**		**Hypack File**	
S222 VB Port Side	**7.73**	**4.98**	**12.712**			
S222 7125 Star Side	**7.80**	**4.984**	**12.78**		NOTES	
S222 1002 Star Side	**7.80**	**5.153**	**12.95**			
3101 Port Side	**1.18**	**0.122**	**1.30**			
3101 Port SideMB 400/200	**1.22**	**0.541**	**1.76**	<<		
3102 Port SideVB	**1.25**	**0.151**	**1.42**			
3102 Port SideMB 400/200	**1.21**	**0.545**	**1.76**			

ES Type	**Time**	**MB Raw Depth**	**BAR Reading at WL= at RAIL= X**	**Value of Rail**	**Vel corr**	**Bar -rail**	**mb +vel corr**	**diff mb to bar**
7125 200khz	204315	4.44	6	**1.76**	-0.1	4.24	4.34	0.10
7125 200khz	204417	5.33	7	**1.76**	-0.1	5.24	5.23	-0.01
7125 200khz	204449	6.4	8	**1.76**	-0.1	6.24	6.3	0.06
7125 200khz	204425	7.35	9	**1.76**	-0.2	7.24	7.15	-0.09
7125 200khz	204550	8.35	10	**1.76**	-0.2	8.24	8.15	-0.09
7125 200khz	205640	7.26	9	**1.76**	-0.2	7.24	7.06	-0.18
7125 200khz	204650	6.4	8	**1.76**	-0.1	6.24	6.3	0.06
7125 200khz	204750	5.39	7	**1.76**	-0.1	5.24	5.29	0.05
7125 200khz	204820	4.29	6	**1.76**	-0.1	4.24	4.19	-0.05
							AVG	-0.02

BAR CHECK	Date	3/14/2010	Lat	Willards Pt Anchorage	WL=	-0.232
Vessel	3101		Lon		Units	Meters
Personnel	Glomb	Krebs	Koscinco			
TD guide	RP-imu	imu TD	Rail RP-TD		Hypack File	
S222 VB Port Side	7.73	4.98	12.712			
S222 7125 Star Side	7.80	4.984	12.78		NOTES	
S222 1002 Star Side	7.80	5.153	12.95			
3101 Port Side	1.18	0.122	1.30			
3101 Port SideMB 400/200	1.22	0.541	1.76			
3102 Port SideVB	1.25	0.151	1.42			
3102 Port SideMB 400/200	1.21	0.545	1.76			

			BAR Reading					
		MB Raw	at WL=					
ES Type	Time	Depth	at RAIL= X	Value of Rail	Vel corr	Bar -rail	mb +vel corr	diff mb to bar
7125 400khz	203530	7.53	9	**1.76**	-0.2	7.24	7.33	0.09
7125 400khz	203600	8.23	10	**1.76**	-0.2	8.24	8.03	-0.21
7125 400khz	203640	9.54	11	**1.76**	-0.2	9.24	9.34	0.10
7125 400khz	203720	8.28	10	**1.76**	-0.2	8.24	8.08	-0.16
7125 400khz	203800	7.23	9	**1.76**	-0.2	7.24	7.03	-0.21
							Avg	0.14

BAR CHECK	Date	3/14/2010	Lat	Willards Pt Anchorage		WL=	-0.232	
Vessel	3101		Lon			Units	Meters	
Personnel	ST Glomb	AB Krebs	ENS Kosenko					
TD guide	**RP-imu**	**imu TD**	**Rail RP-TD**		**Hypack File**			
S222 VB Port Side	**7.73**	**4.98**	**12.712**		**Checked by**	**PL**		
S222 7125 Star Side	**7.80**	**4.984**	**12.78**		NOTES			
S222 1002 Star Side	**7.80**	**5.153**	**12.95**					
3101 Port Side	**1.18**	**0.122**	**1.30**					
3101 Port SideMB 400/200	**1.22**	**0.541**	**1.76**					
3102 Port SideVB	**1.25**	**0.151**	**1.42**					
3102 Port SideMB 400/200	**1.21**	**0.545**	**1.76**					
			BAR Reading					
		MB Raw	**at WL=**					
ES Type	**Time**	**Depth**	**at RAIL= X**	**Value of Rail**	**Vel corr**	**Bar -rail**	**mb +vel corr**	**diff mb to bar**
ETCV200	190930	0	3	**1.30**	0	1.70	0	-1.70
ETCV200	191020	2.95	4	**1.30**	-0.1	2.70	2.85	0.15
ETCV200	191143	3.94	5	**1.30**	-0.1	3.70	3.84	0.14
ETCV200	191259	5.95	7	**1.30**	-0.2	5.70	5.75	0.05
ETCV200	191954	4.89	6	**1.30**	-0.2	4.70	4.69	-0.01
ETCV200	192031	3.9	5	**1.30**	-0.1	3.70	3.8	0.10
ETCV200	192102	2.89	4	**1.30**	-0.1	2.70	2.79	0.09
ETCV200							AVG	0.09
ETCV200	N/A	N/A	6	**1.30**	-0.1	4.70	#VALUE!	#VALUE!
ETCV200		N/A	3	**1.30**	-0.1	1.70	#VALUE!	#VALUE!

BAR CHECK	Date	3/13/2010	Lat	30 54 54.8	WL=	-0.235	
Vessel	3102		Lon	076 20 12.5	Units	Meters	
Personnel	Lewit	Palmer	Anderson				
TD guide	RP-imu	imu TD	Rail RP-TD		Hypack File	100-1810.hsx	
S222 VB Port Side	7.73	4.98	12.712		Draft= IMU/TD + WL		
S222 7125 Star Side	7.80	4.984	12.78		NOTES		
S222 1002 Star Side	7.80	5.153	12.95				
3101 Port Side	1.18	0.122	1.30				
3101 Port SideMB 400/200	1.22	0.541	1.76				
3102 Port SideVB	1.25	0.151	1.42				
3102 Port SideMB 400/200	1.21	0.545	1.76		Possible miss align bar reading by 1m		

ES Type	Time	MB Raw Depth	BAR Reading at WL= at RAIL= x	Value of Rail or draft	Vel corr	Bar -rail	mb +vel corr	diff mb to bar
7125 400 khz	181226	N/A	1	1.76	0	#REF!	#VALUE!	#VALUE!
7125 400 khz	181302	1.25	2	1.76	0	0.24	1.25	1.01
7125 400 khz	181337	2.21	3	1.76	0	1.24	2.21	0.97
7125 400 khz	181402	3.24	4	1.76	-0.1	2.24	3.14	0.90
7125 400 khz	181429	4.21	5	1.76	-0.1	3.24	4.11	0.87
7125 400 khz	181500	5.24	6	1.76	-0.1	4.24	5.14	0.90
7125 400 khz	181553	4.24	5	1.76	-0.1	3.24	4.14	0.90
7125 400 khz	181622	3.21	4	1.76	0	2.24	3.21	0.97
7125 400 khz	181648	2.18	3	1.76	0	1.24	2.18	0.94
7125 400 khz	181717	1.25	2	1.76	0	0.24	1.25	1.01
							AVG	0.94

Less 1m
0.01
-0.03
-0.10
-0.13
-0.10
-0.10
-0.03
-0.06
0.01

BAR CHECK	Date		Lat	30 54 54.8	WL=	-0.235		
Vessel	3102		Lon	076 20 12.5	Units	Meters		
Personnel	Lewit	Palmer	Anderson					
TD guide	RP-imu	imu TD	Rail RP-TD		Hypack File	100-1826.HSX		
S222 VB Port Side	7.73	4.98	12.712					
S222 7125 Star Side	7.80	4.984	12.78		NOTES			
S222 1002 Star Side	7.80	5.153	12.95					
3101 Port Side	1.18	0.122	1.30					
3101 Port SideMB 400/200	1.22	0.541	1.76					
3102 Port SideVB	1.25	0.151	1.42					
3102 Port SideMB 400/200	1.21	0.545	1.76		HSRR 2010			

ES Type	Time	MB Raw Depth	BAR Reading at WL= at RAIL= X	Value of Rail	Vel corr	Bar -rail	mb +vel corr	diff mb to bar
7125 200 khz	182830	N/A	2	1.76	0	0.24	#VALUE!	#VALUE!
7125 200 khz	182929	1.43	3	1.76	0	1.24	1.43	0.19
7125 200 khz	182958	2.29	4	1.76	0	2.24	2.29	0.05
7125 200 khz	183026	3.32	5	1.76	-0.1	3.24	3.22	-0.02
7125 200 khz	183052	4.29	6	1.76	-0.1	4.24	4.19	-0.05
7125 200 khz	183126	3.35	5	1.76	-0.1	3.24	3.25	0.01
7125 200 khz	183154	2.31	4	1.76	0	2.24	2.31	0.07
7125 200 khz	183222	1.43	3	1.76	0	1.24	1.43	0.19
7125 200 khz	183245	N/A	2	1.76	0	0.24	#VALUE!	0.06
							AVG	0.07469388

BAR CHECK	Date	3/14/2010	Lat	Willards Pt Anchorage	WL=	-0.232
Vessel	3101		Lon		Units	Meters
Personnel	Lewit	Palmer	Anderson			

TD guide	RP-imu	imu TD	Rail RP-TD
S222 VB Port Side	7.73	4.98	12.712
S222 7125 Star Side	7.80	4.984	12.78
S222 1002 Star Side	7.80	5.153	12.95
3101 Port Side	1.18	0.122	1.30
3101 Port SideMB 400/200	1.22	0.541	1.76
3102 Port SideVB	1.25	0.151	1.42
3102 Port SideMB 400/200	1.21	0.545	1.76

Hypack File	

NOTES

			BAR Reading					
		MB Raw	at WL=					
ES Type	Time	Depth	at RAIL= X	Value of Rail	Vel corr	Bar -rail	mb +vel corr	diff mb to bar
ETCV200	190930	N/A	3	**1.42**	0	1.58	#VALUE!	#VALUE!
ETCV200	191020	2.95	4	**1.42**	-0.1	2.58	2.85	0.27
ETCV200	191143	3.94	5	**1.42**	-0.1	3.58	3.84	0.26
ETCV200	191259	5.95	7	**1.42**	-0.1	5.58	5.85	0.27
ETCV200	191954	4.89	6	**1.42**	-0.1	4.58	4.79	0.21
ETCV200	192031	3.9	5	**1.42**	-0.1	3.58	3.8	0.22
ETCV200	192102	2.89	4	**1.42**	-0.1	2.58	2.79	0.21
ETCV200		N/A	3	**1.42**	-0.1	1.58	#VALUE!	0.24
ETCV200							AVG	0.24

BAR CHECK	Date	3/26/2010	Lat	36 59 01	WL=	0.275
Vessel			Lon	76 20 06	Units	Meters
Personnel	Lewit, Daniel, Van Hoy					

TD guide	RP-imu	imu TD	Rail RP-TD
S222 VB Port Side	7.73	4.98	12.712
S222 7125 Star Side	7.80	4.984	12.66
S222 1002 Star Side	7.80	5.153	12.95
3101 Port Side	1.18	0.122	1.30
3101 Port SideMB 400/200	1.22	0.541	1.76
3102 Port SideVB	1.25	0.151	1.42
3102 Port SideMB 400/200	1.21	0.545	1.76

Hypack File	archeck_015_1700.hsx
Checked By	

NOTES

WX = Squall, increased winds & Currents Pospac file = HSRR_S222_085_pospac.000 DN 085 Test abandoned due to weather. Thirty knot wind with gust to 40 knots.

			BAR Reading			Formulas are in these three columns		
		MB Raw						
ES Type	Time	Depth	at RAIL= X	Value of Rail	Vel corr	*Bar -rail*	*mb +vel corr*	*diff mb to bar*
7125 400 kHz	1700.51	2.41	15.00	12.66	0.20	*2.34*	*2.61*	*0.27*
7126 400 kHz	1704.30	3.79	16.00	12.66	0.20	*3.34*	*3.99*	*0.65*
7127 400 kHz	1705.54	3.63	17.00	12.66	-0.30	*4.34*	*3.33*	*-1.01*
7128 400 kHz	1706.30	4.58	18.00	12.66	-0.30	*5.34*	*4.28*	*-1.06*
7129 400 kHz	1707.48	6.29	19.00	12.66	-0.30	*6.34*	*5.99*	*-0.35*
						0.00	*0.00*	*0.00*
						0.00	*0*	*0.00*
						0.00	*0*	*0.00*
						0.00	*0*	*0.00*
						0.00	*0*	*0.00*
						0.00	*0*	*0.00*
						0.00	*0*	*0.00*
						0.00	*0*	*0.00*

AVG	*0.32*

Start Logging Data . Have bar lowered to a mark that matches the rail RP. At each level record time, bar, and depth readings. Continue lowering to a series of desired depths and then reverse the process and raise the bar recording time, bar, and depth readings.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3101
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): LT Davidson

MULTIBEAM SYSTEM INFORMATION

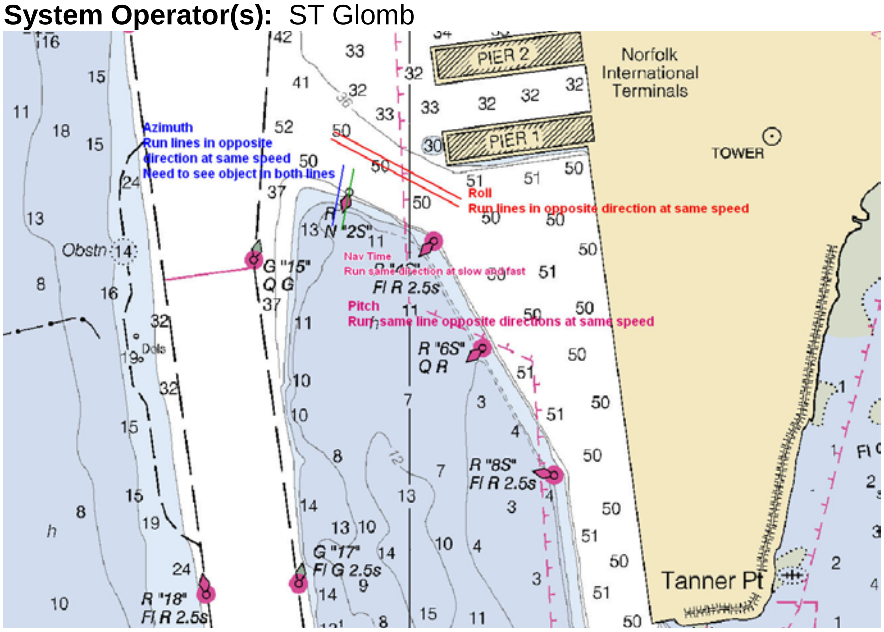
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 400khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality:
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): ST Glomb



DATA ACQUISITION INFORMATION			
Line Number	Heading	Speed	Test
100_1633	122	3.8 m/s	Roll
100A1636	299	4.1 m/s	Roll
102_1638	120	3.9 m/s	Precise Time
102_1641			Not Used
101_1644	190	3.9 m/s	Yaw
101_1647			Not Used
103A1649	12	3.7 m/s	Pitch
103_1651			Not Used
101_1734			Not Used
103_1738	191	3.9 m/s	Pitch/Yaw

TEST RESULTS

Precise Time (Nav): -0.000
Pitch bias: +1.860
Roll bias: -0.440
Yaw Bias: +0.520

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5.

PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in *2010_TJ_patch_test_evaluations_all_platforms.pdf* have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3101
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): ST Glomb

MULTIBEAM SYSTEM INFORMATION

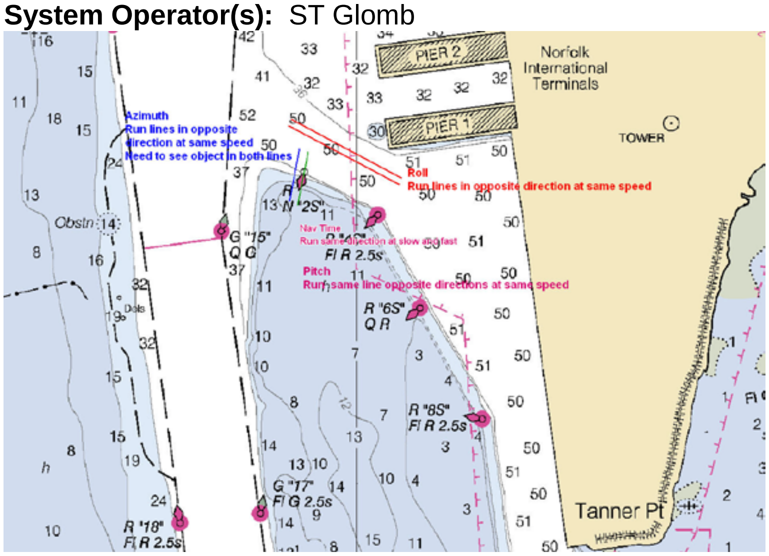
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 400khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: ,
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): ST Glomb



DATA ACQUISITION INFORMATION

Line Number	Heading	Speed m\s
101_1644 Navigation time	191	3.9
101_1647 Navigation time	191	2.0
103A_1649 Pitch	11	3.5
103_1651 Pitch	191	3.6
100_1633 Roll	118	3.7

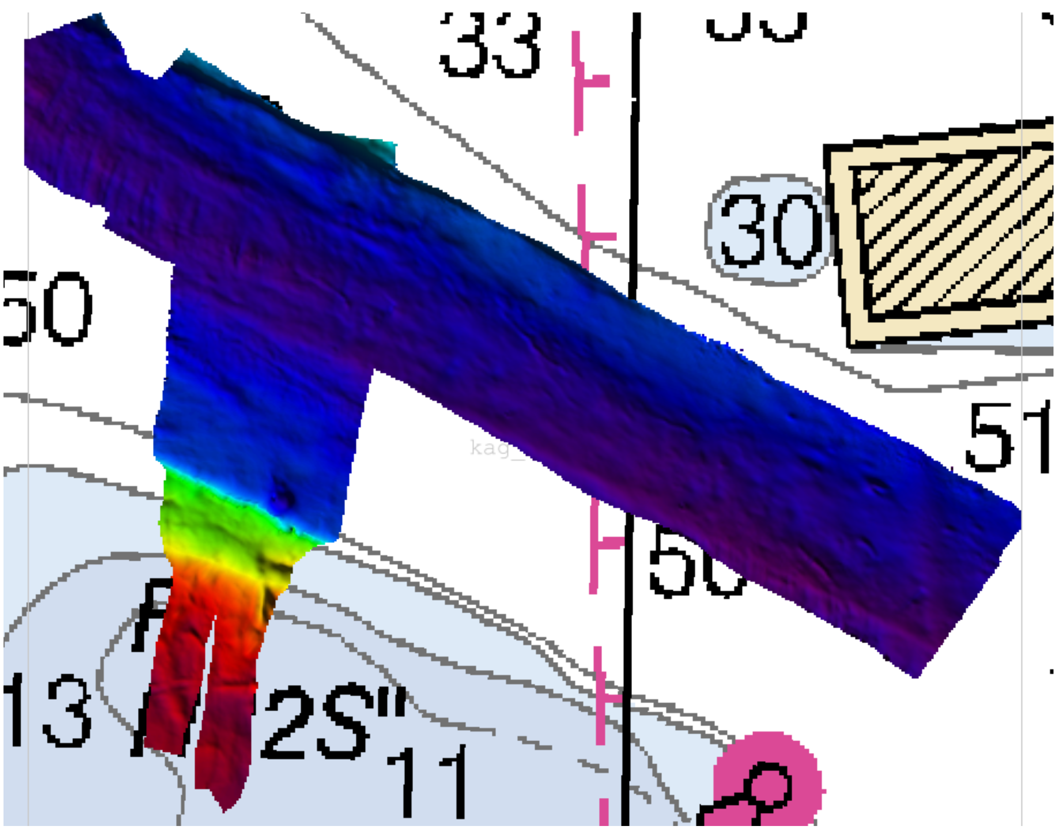
100A_1636 Roll	298	3.5
101_1644 Yaw	191	3.9
103_1738 Yaw	191	3.9

TEST RESULTS

Precise Time (Nav): 0.00
Pitch bias: 0.60
Roll bias: -0.40
Yaw Bias: 0.10

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3101
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): AHB James J Miller

MULTIBEAM SYSTEM INFORMATION

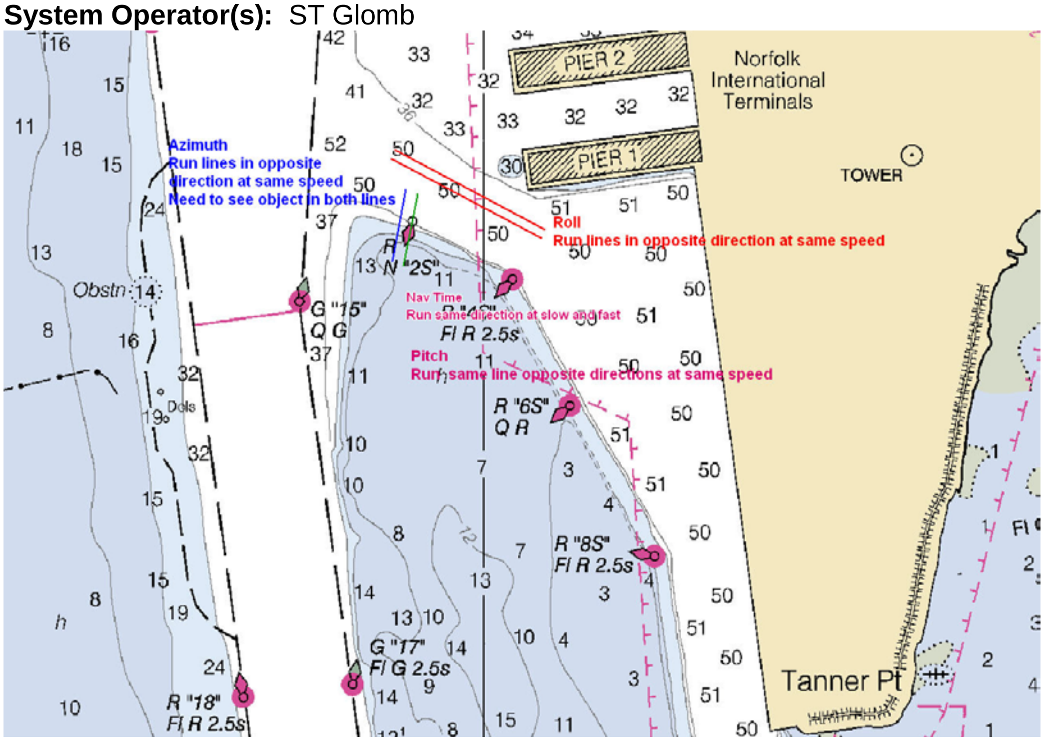
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125-SV 400kHz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount
Description of Positioning System: POS/MV version 4 w/ Precise Timing
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay
Sub-Locality:
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): ST Glomb



DATA ACQUISITION INFORMATION			
Line Number	**Heading**	**Speed**	**Test**
100_1633	122	3.8 m/s	-
100A1636	299	4.1 m/s	Precise Timing
102_1638	120	3.9 m/s	Roll
102_1641	299	3.7 m/s	Roll
101_1644	190	3.9 m/s	-
101_1647	192	2.0 m/s	-
103A1649	12	3.7 m/s	Pitch, Yaw
103_1651	189	3.5 m/s	Pitch
101_1734	197	3.5 m/s	Yaw
103_1738	191	3.9 m/s	-

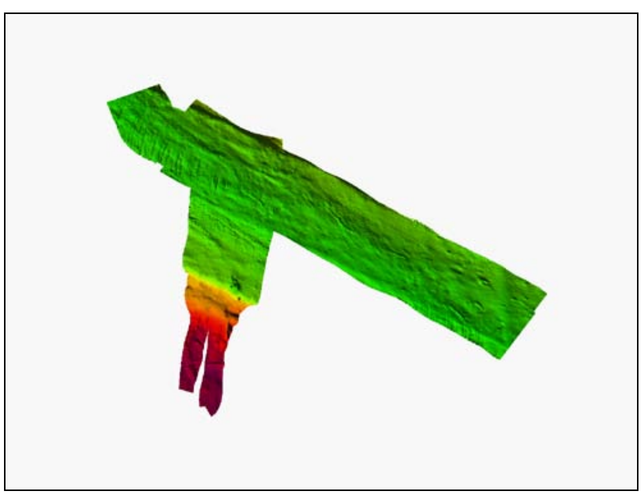
TEST RESULTS

Precise Time (Nav): -0.000
Pitch bias: +1.640
Roll bias: -0.420
Yaw Bias: +1.680

NARRATIVE

*** For 7125 precise timing - The determined precise time value will be entered in the swath section with the opposite sign. All other motion data will be entered with the same value and sign as derived in the calibration procedure.**

The image below depicts a 0.5m CUBE surface of the patch test area after the calibrated values were entered in the .HVF and the lines had their correctors reapplied (SVP, merge, TPU, recomputation of the CUBE surface). Vertical exaggeration is 5.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3101
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): LT Davidson

MULTIBEAM SYSTEM INFORMATION

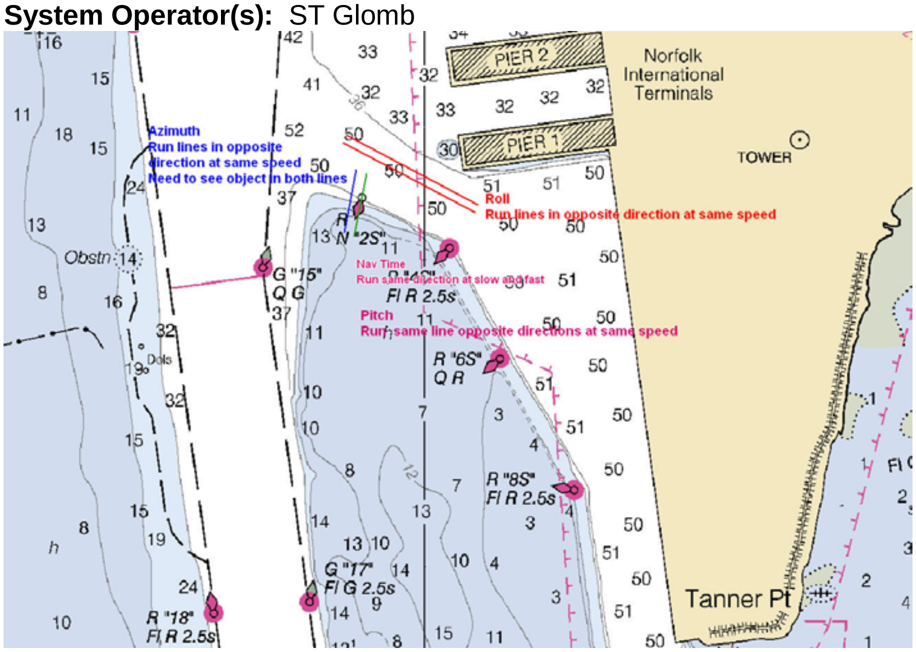
Sonar Serial Number: 2008027
Processing Unit Serial Number: 1812031
Processor: Reson 7125-SV TPU
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 200khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration: DN 069 March 10, 2010

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: NIT, near Tanner Pt, Elizabeth River, Norfolk, VA ,
Bottom Type: Sand and Mud
Approximate Average Water Depth: 10-15m
System Operator(s): ST Glomb



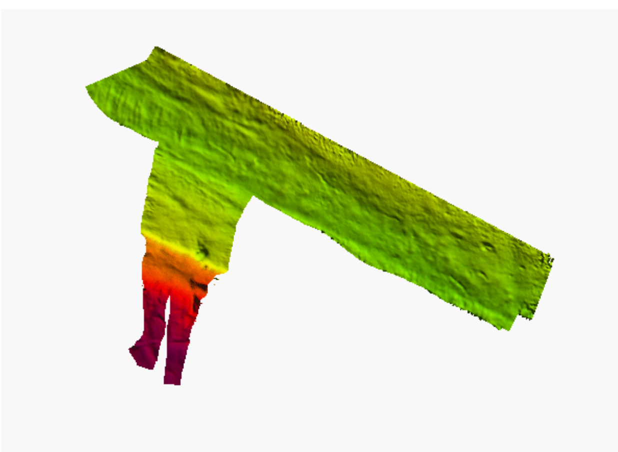
DATA ACQUISITION INFORMATION			
Line Number	**Heading**	**Speed**	**Test**
100_1743	**119**	**4.1 m/s**	
100_1747	**299**	**4.1 m/s**	
102A1749	**119**	**3.8 m/s**	**Roll**
102_1752	**299**	**3.9 m/s**	**Precise Time/Roll**
101_1755	**191**	**3.6 m/s**	
103_1757	**16**	**3.9 m/s**	**Pitch**
101_1759	**190**	**2.1 m/s**	
101_1803	**193**	**3.6 m/s**	
103A1805	**192**	**3.7 m/s**	**Pitch**

TEST RESULTS

Precise Time (Nav): -0.000
Pitch bias: +1.560
Roll bias: -0.210
Yaw Bias: -0.000

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5. *No target for Yaw was found, but 0.00 indicates a reasonable value until better data becomes available.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3101
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): AHB James J Miller

MULTIBEAM SYSTEM INFORMATION

Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125-SV 200kHz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount
Description of Positioning System: POS/MV version 4 w/ Precise Timing
Date of Most Recent Positioning System Calibration: First of the Season

TEST INFORMATION

Locality: Approaches to Chesapeake Bay
Sub-Locality:
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): ST Glomb

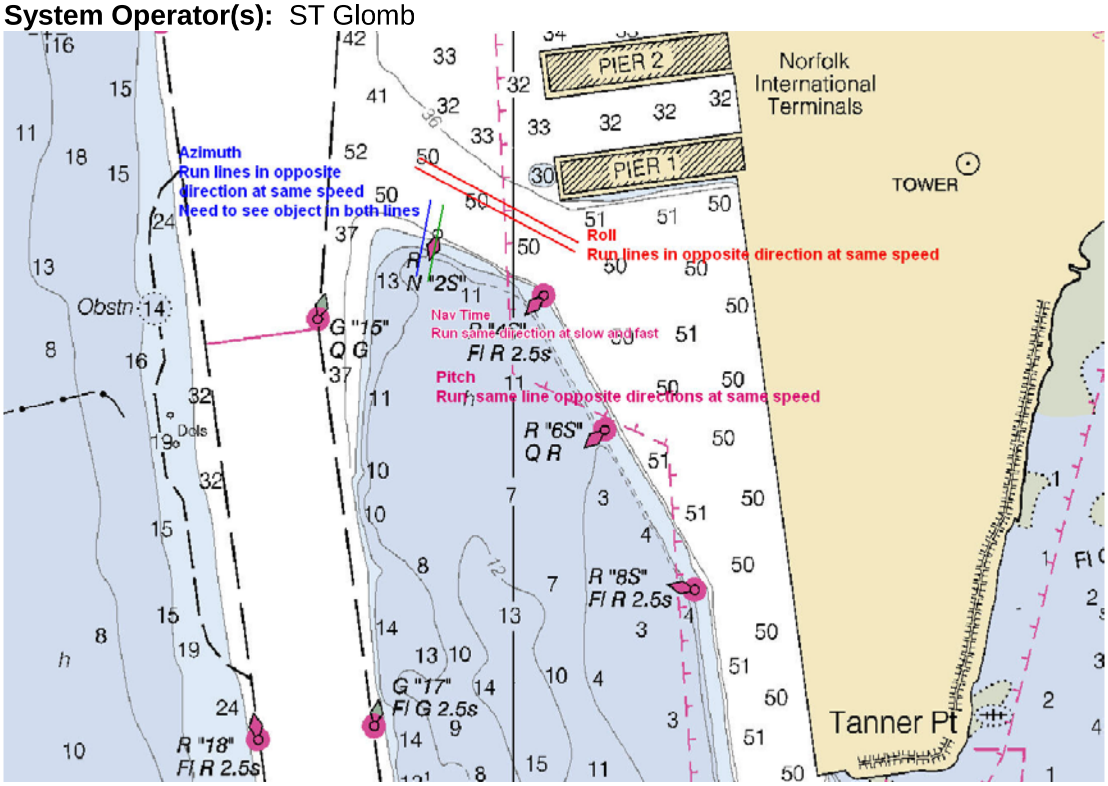


Figure 1 – Patch test area off Tanner Pt in the Elizabeth River, Norfolk, VA

DATA ACQUISITION INFORMATION			
Line Number	Heading	Speed	Test
100_1743	119	4.1 m/s	Roll
100_1747	299	4.1 m/s	Roll
102A1749	119	3.8 m/s	Precise Time
102_1752	299	3.9 m/s	-
101_1755	191	3.6 m/s	-
103_1757	16	3.9 m/s	Pitch, Yaw
101_1759	190	2.1 m/s	-
101_1803	193	3.6 m/s	Yaw
103A1805	192	3.7 m/s	Pitch

TEST RESULTS

Precise Time (Nav): -0.000
Pitch bias: +1.430
Roll bias: -0.230
Yaw Bias: -0.650

NARRATIVE

Note:

*** For 7125 precise timing - The determined precise time value will be entered in the swath section with the opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure.**

The image below depicts a 0.5m CUBE surface of the patch test area after the calibrated values were entered in the .HVF and the lines had their correctors reapplied (SVP, merge, TPU, recomputation of the CUBE surface). Vertical exaggeration is 5.

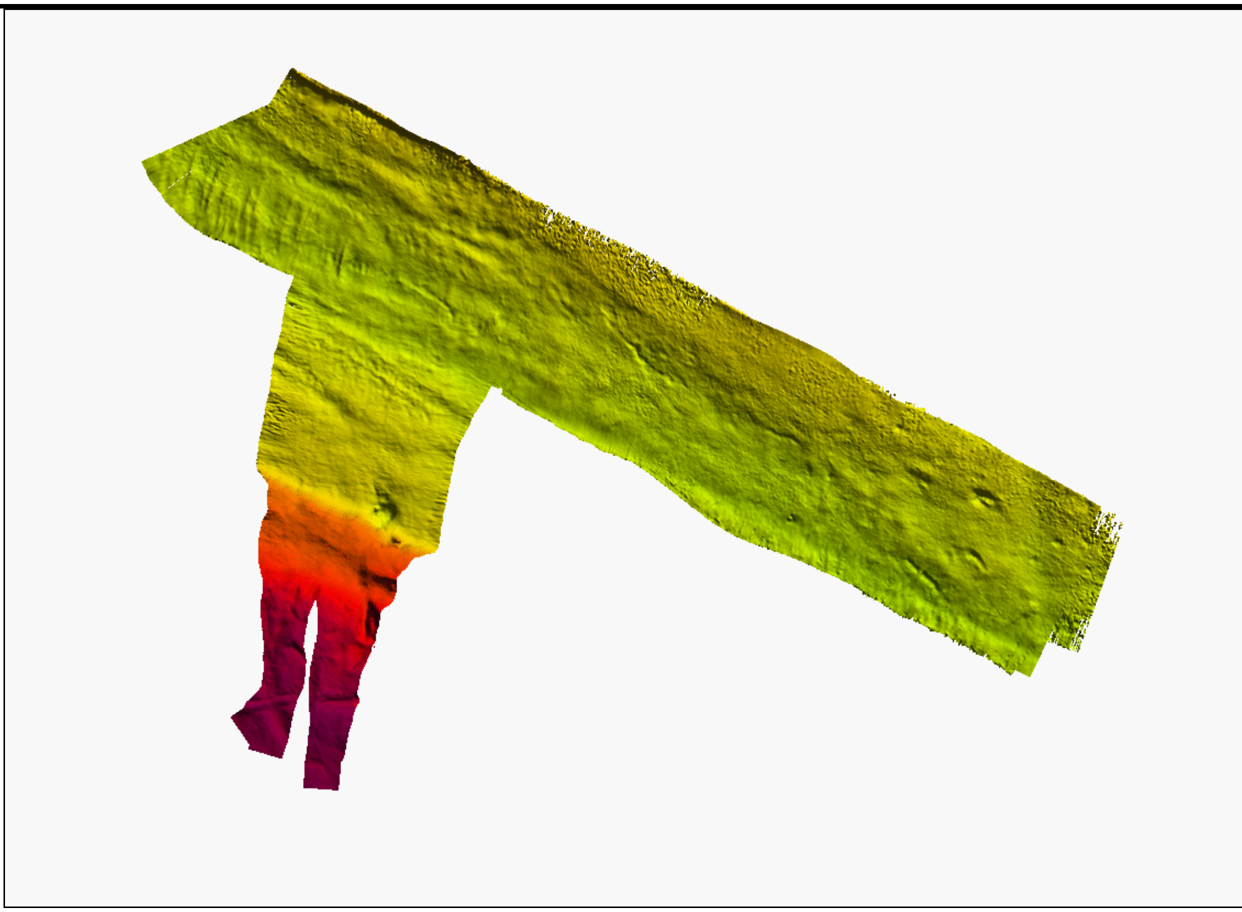


Figure 2 – 0.5m CUBE surface of patch test area

PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in *2010_TJ_patch_test_evaluations_all_platforms.pdf* have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3101
Date of Test: March 12, 2010, DN 071
Calibrating Hydrographer(s): CST Wright

MULTIBEAM SYSTEM INFORMATION

Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 400khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: ,
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): ST Glomb

DATA ACQUISITION INFORMATION

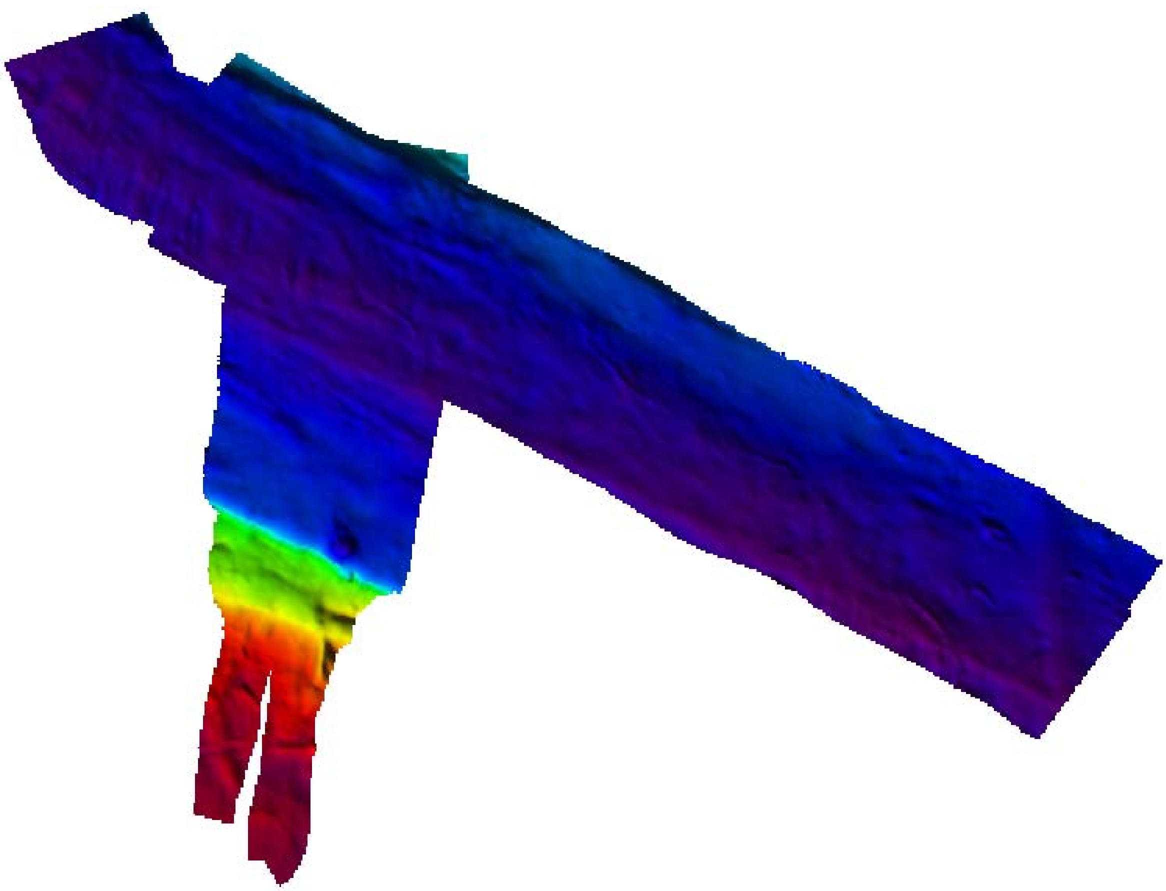
Line Number	Heading	Speed m\s
100A_1636 Precise Time	299	4.1
103A_1649 Pitch	12	3.67
103_1651 Pitch	188	3.5
100_1633 Roll	122	3.8
100A_1636 Roll	299	4.1
101_1734 Yaw	197	3.49
103_1651 Yaw	188	3.50

TEST RESULTS

Precise Time (Nav): -0.00
Pitch bias: 1.20
Roll bias: -0.41
Yaw Bias: 0.90

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5. The patch test lines from DN071 were re-acquired on DN073 because there appeared to be a timing problem which prevented the motion data from being properly applied. While processing the lines acquired on DN073, it was discovered that the roll compensated RESON 7125-SV HVF was still applying roll data upon conversion. Once the HVF was modified so that roll would not be applied, the lines from DN071 were re-processed. The image below was used to demonstrate that applying roll to a roll compensated system was the source of the original motion artifacts. The values from this patch test were not used in the final HVF decision process.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3101
Date of Test: March 12, 2010, DN 071
Calibrating Hydrographer(s): CST Wright

MULTIBEAM SYSTEM INFORMATION

Sonar Serial Number: 2008027
Processing Unit Serial Number: 1812031
Processor: Reson 7125-SV TPU
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 200khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration: DN069 10MAR2010

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: Vicinity of the pilot pick area North of Cape Henry
Bottom Type: Sand and Mud
Approximate Average Water Depth: 10-15m
System Operator(s): ST Glomb

DATA ACQUISITION INFORMATION

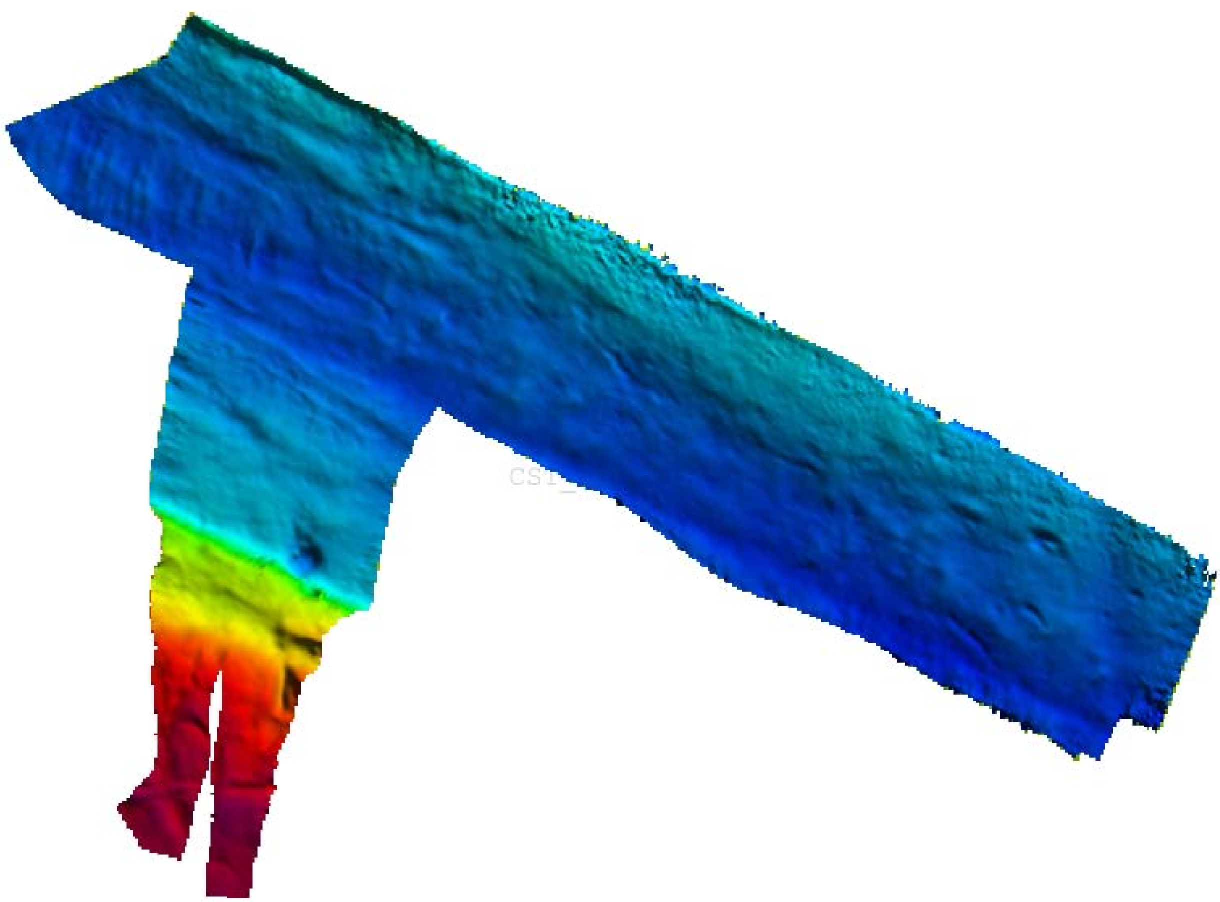
Line Number	Heading	Speed m\s
100_1743 Precise Time	119	4.08
103_1757 Pitch	16	3.9
103A1805 Pitch	192	3.7
100_1743 Roll	119	4.08
100_1747 Roll	298	4.07
103A1805 Yaw	192	3.7
101_1803 Yaw	192	3.6

TEST RESULTS

Precise Time (Nav): **-0.00**
Pitch bias: **1.50**
Roll bias: **-0.23**
Yaw Bias: **0.80**

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5. The patch test lines from DN071 were re-acquired on DN073 because there appeared to be a timing problem which prevented the motion data from being properly applied. While processing the lines acquired on DN073, it was discovered that the roll compensated RESON 7125-SV HVF was still applying roll data upon conversion. Once the HVF was modified so that roll would not be applied, the lines from DN071 were re-processed. The image below was used to demonstrate that applying roll to a roll compensated system was the source of the original motion artifacts. The values from this patch test were not used in the final HVF decision process.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3101

Date of Test: March 13, 2010, DN 072

Calibrating Hydrographer(s): ST Glomb

MULTIBEAM SYSTEM INFORMATION

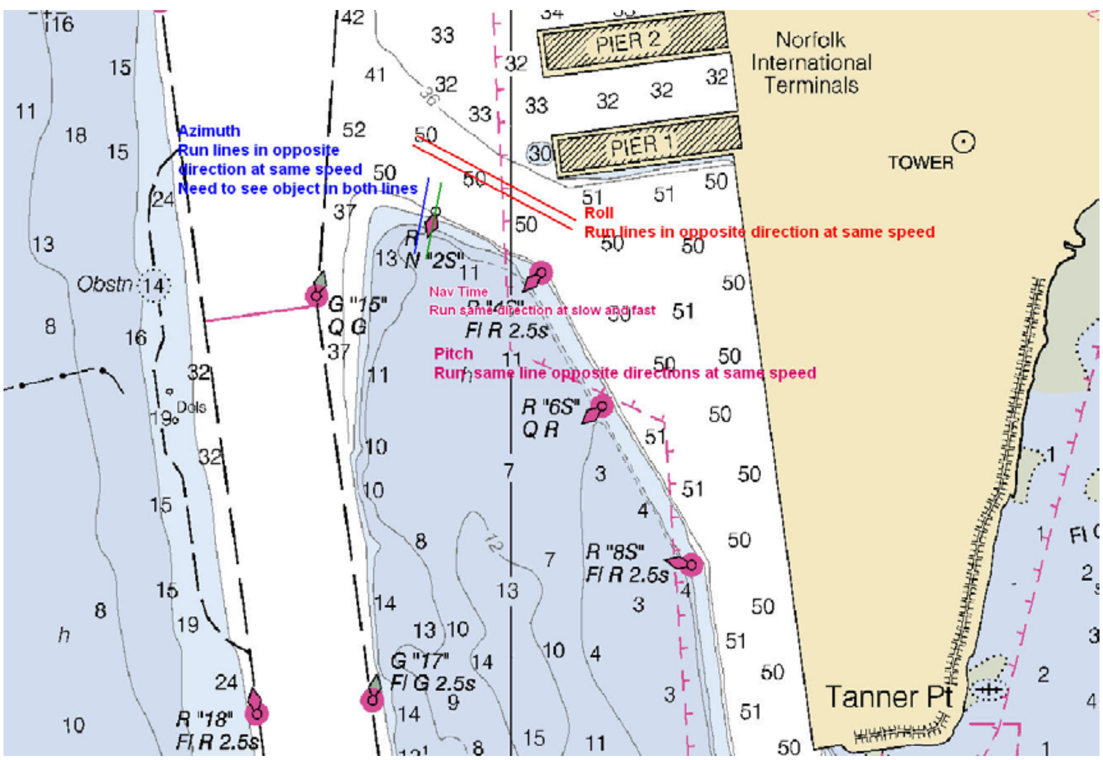
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 200khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: ,
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): ST Glomb



DATA ACQUISITION INFORMATION

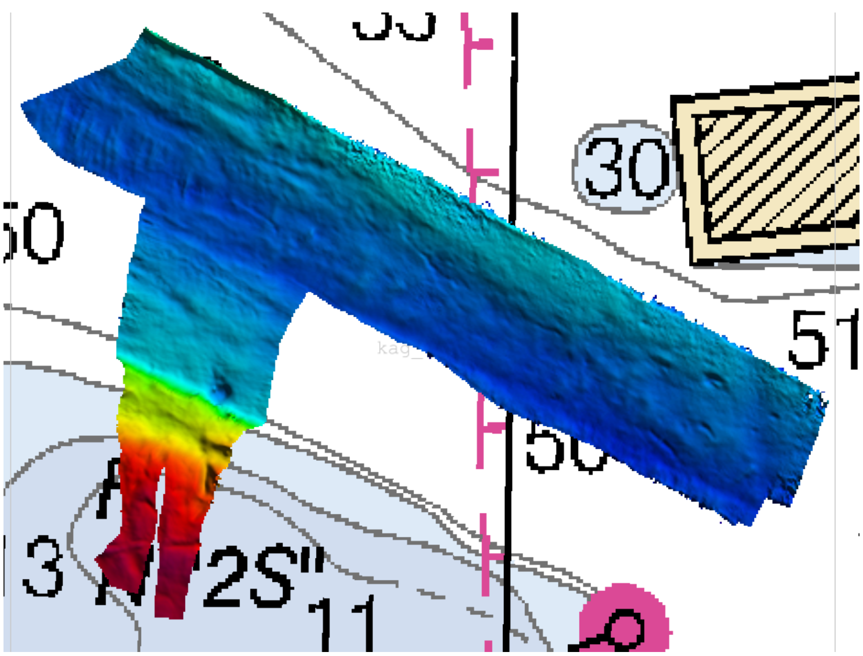
Line Number	Heading	Speed m\s
101_1755 Navigation time	191	3.3
101_1759 Navigation time	191	2.1
103_1757 Pitch	11	4.0
103A_1805 Pitch	191	3.7
100_1743 Roll	118	4.0
100_1747 Roll	298	4.0
101_1803 Yaw	191	3.6
103A_1805 Yaw	191	3.7

TEST RESULTS

Precise Time (Nav): 0.00
Pitch bias: 1.40
Roll bias: 0.00
Yaw Bias: unable to find the feature

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

ultibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3102
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): ST Glomb

MULTIBEAM SYSTEM INFORMATION

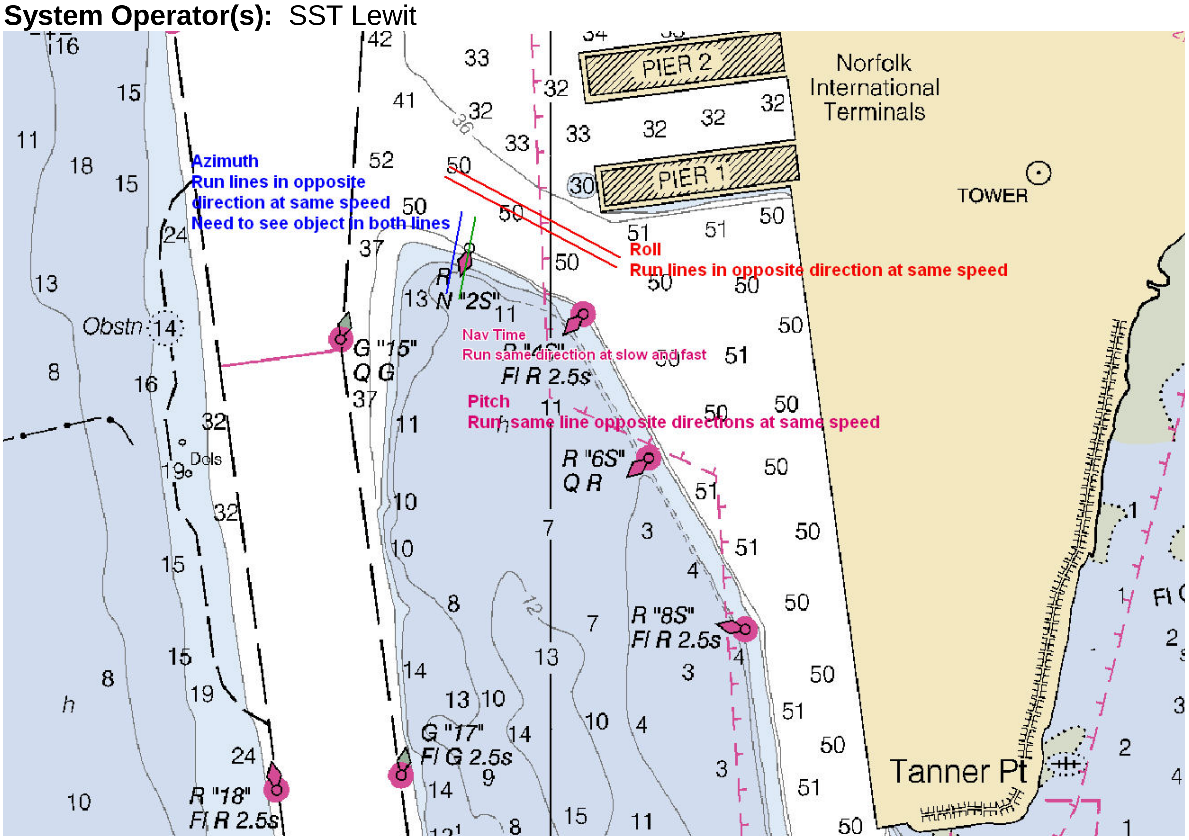
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 400khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: Elizabeth River, near Tanner Point
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): SST Lewit



DATA ACQUISITION INFORMATION

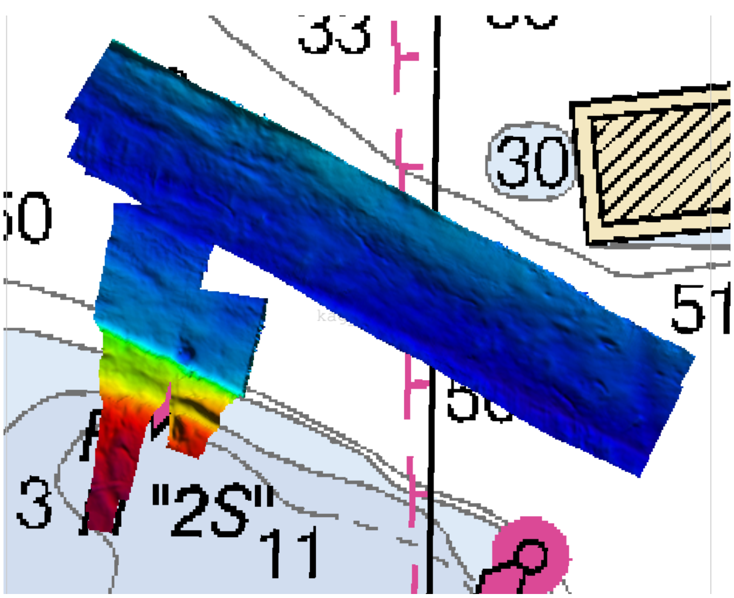
Line Number	Heading	Speed m\s
103_1901 Navigation time	191	3.2
103_1909 Navigation time	191	4.0
103_1909 Pitch	191	4.0
103_1911 Pitch	011	3.8
100_1836 Roll	118	4.1
100_1839 Roll	298	3.9
150_1928 Yaw	192	4.5
151_1931 Yaw	192	4.3

TEST RESULTS

Precise Time (Nav):	**0.20**
Pitch bias:	**-1.00**
Roll bias:	**-0.90**
Yaw Bias:	**-0.80**

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3102
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): CST Wright

MULTIBEAM SYSTEM INFORMATION

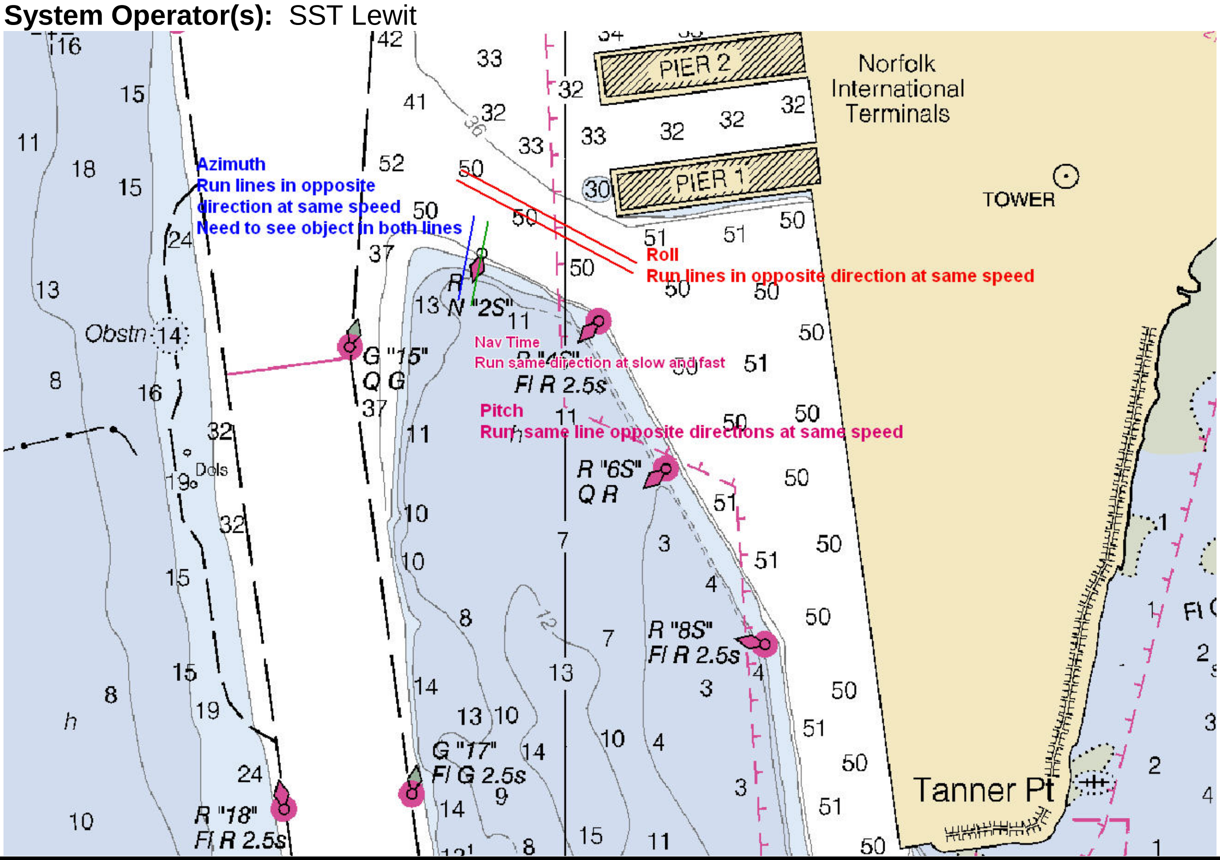
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 400khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: Elizabeth River, near Tanner Point
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): SST Lewit



DATA ACQUISITION INFORMATION

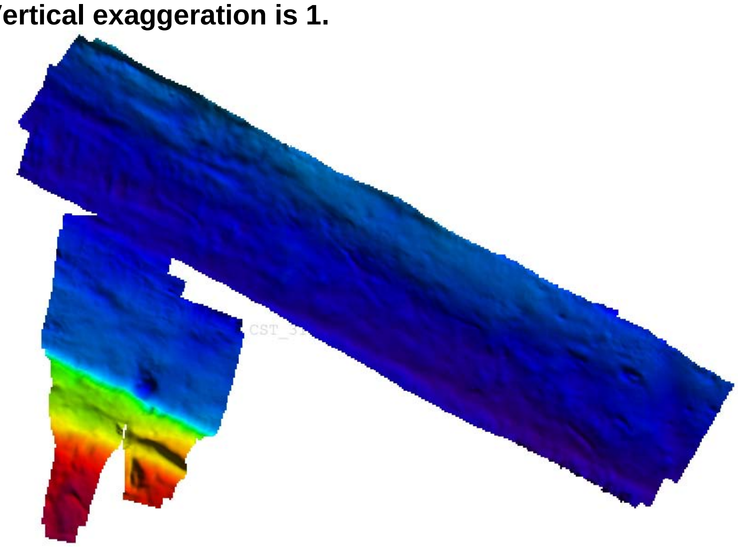
Line Number	Heading	Speed
102_1843 Roll	118	7.7
102_1847 Roll	298	7.4
150_1928 Pitch	192	7.5
150_1932 Pitch	12	7.7
150_1928 Yaw	192	7.5
151_1931 Yaw	192	9.4

TEST RESULTS

Precise Time (Nav): 0.00
Pitch bias: 1.90
Roll bias: -0.92
Yaw Bias: -0.90

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 1.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3102
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): SST Lewit

MULTIBEAM SYSTEM INFORMATION

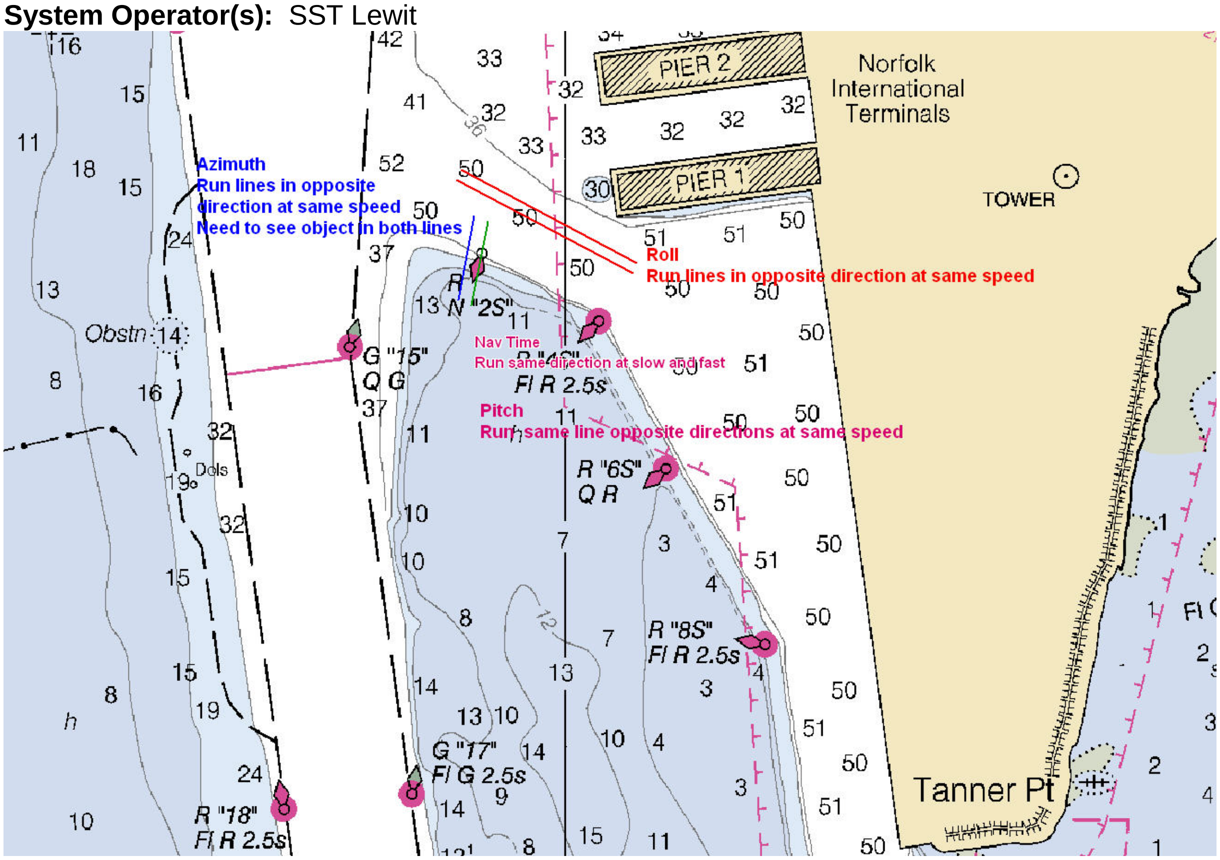
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 200khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: ,
Bottom Type: sandy,
Approximate Average Water Depth: 10-15m
System Operator(s): SST Lewit



DATA ACQUISITION INFORMATION		
Line Number	**Heading**	**Speed**
100-2000 Precise Time and Roll	119	7.6
100-2003 Precise Time and Roll	299	6.6
100-2006 Precise Time and Roll	118	7.6
102-2009 Precise Time and Roll	299	6.6
103-1945 Nav Pitch	192	7.0
103-1948 Nav Pitch	192	8.0
103-1951 Pitch	012	6.4
150-1953 Yaw	192	7.8
150-1958 Yaw	012	6.5
151-1954 Yaw	012	6.3
151-1956 Yaw	192	8.0

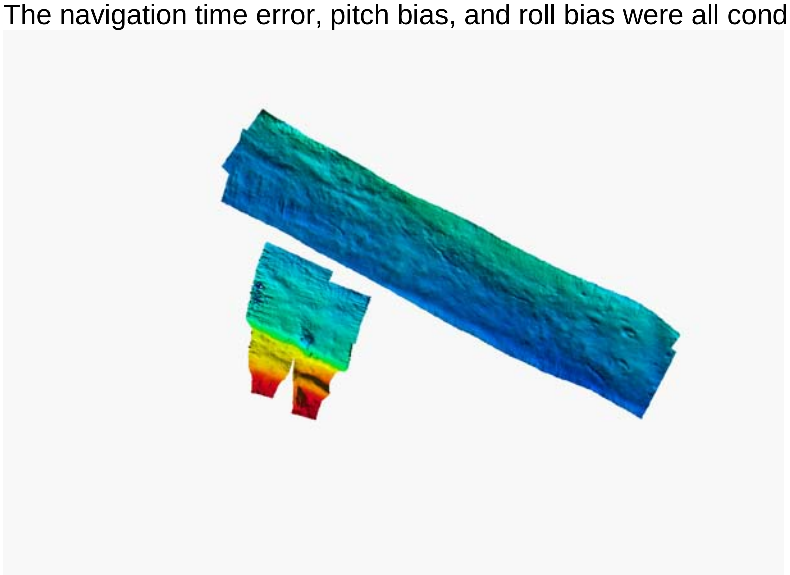
TEST RESULTS

Precise Time (Nav): 0.000
Pitch bias: 0.850
Roll bias: -0.637
Yaw Bias: -0.703

NARRATIVE

Note: 7125sv is roll compensated and in the HVF the Roll is set to apply in merge "NO". Heave and pitch entry's are set to apply "Yes"

The navigation time error, pitch bias, and roll bias were all conducted using the HIPS calibration GUI.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3102
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): LT Davidson

MULTIBEAM SYSTEM INFORMATION

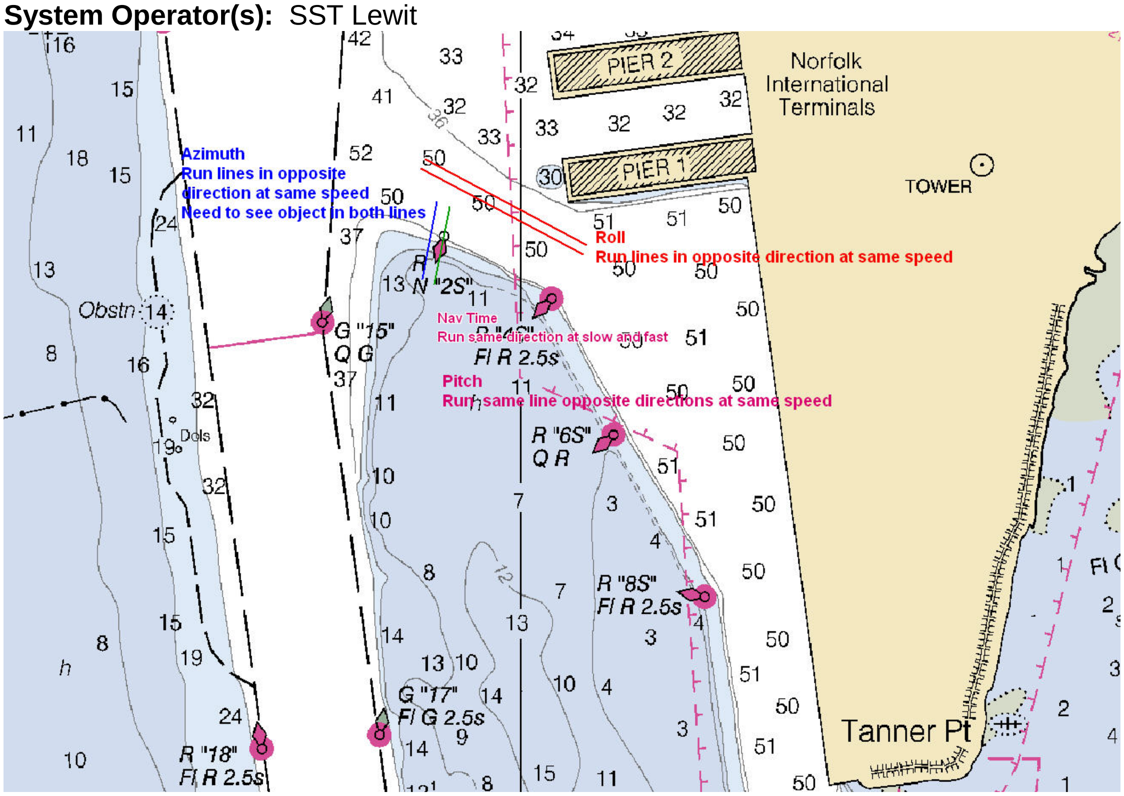
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 200khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: ,
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): SST Lewit



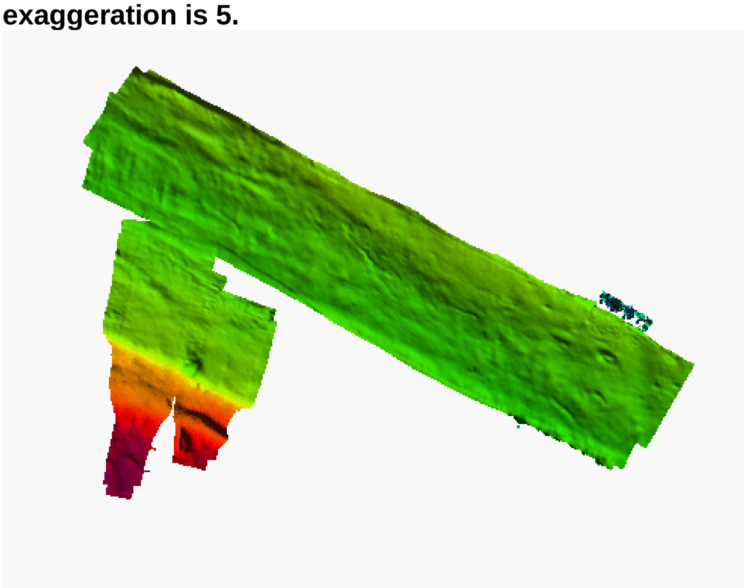
DATA ACQUISITION INFORMATION		
Line Number	**Heading**	**Speed**
102_2006 Precise time	119	3.9 m/s
103-1945 Pitch	192	3.6 m/s
103-1951 Pitch	012	3.3 m/s
100-2000 Roll	117	3.9 m/s
100-2003 Roll	299	3.4 m/s
103-1948 Nav Pitch	192	3.6 m/s
151-1956 Yaw	195	4.1 m/s
150-1953 Yaw	194	4.0 m/s

TEST RESULTS

Precise Time (Nav): 0.000
Pitch bias: 0.890
Roll bias: -0.470
Yaw Bias: -0.890

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3102
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): ST Glomb

MULTIBEAM SYSTEM INFORMATION

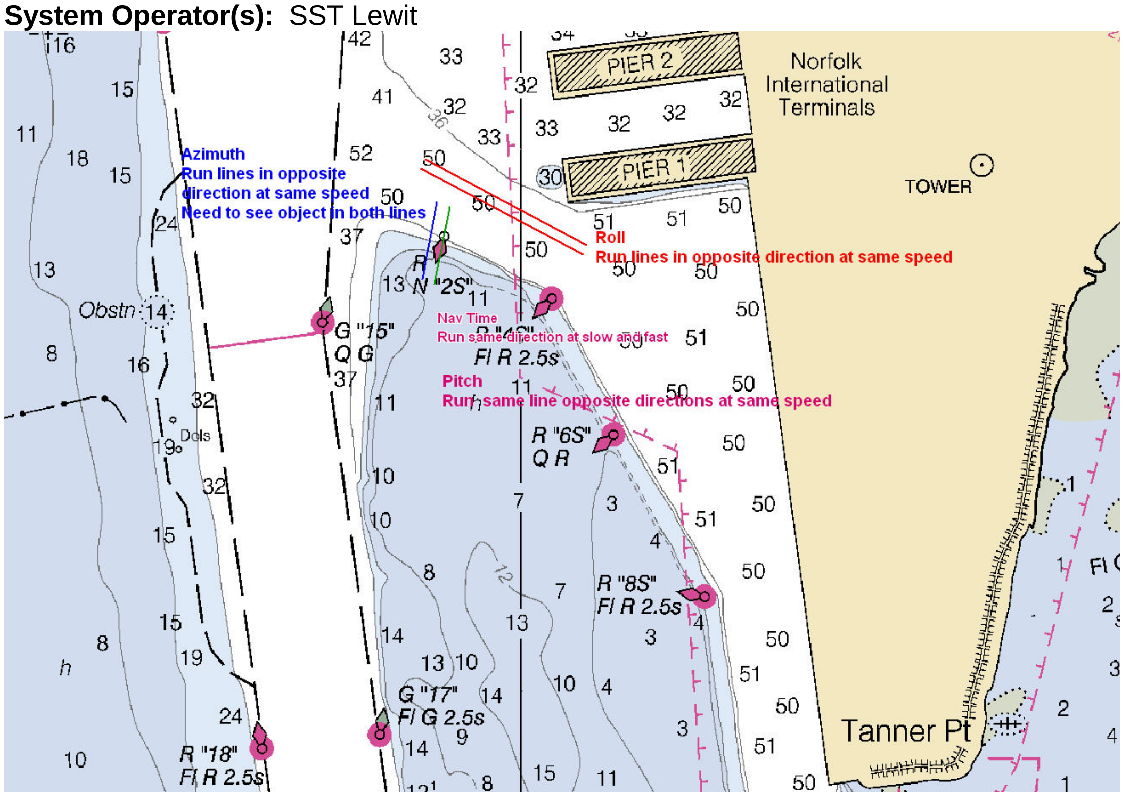
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 200khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: ,
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): SST Lewit



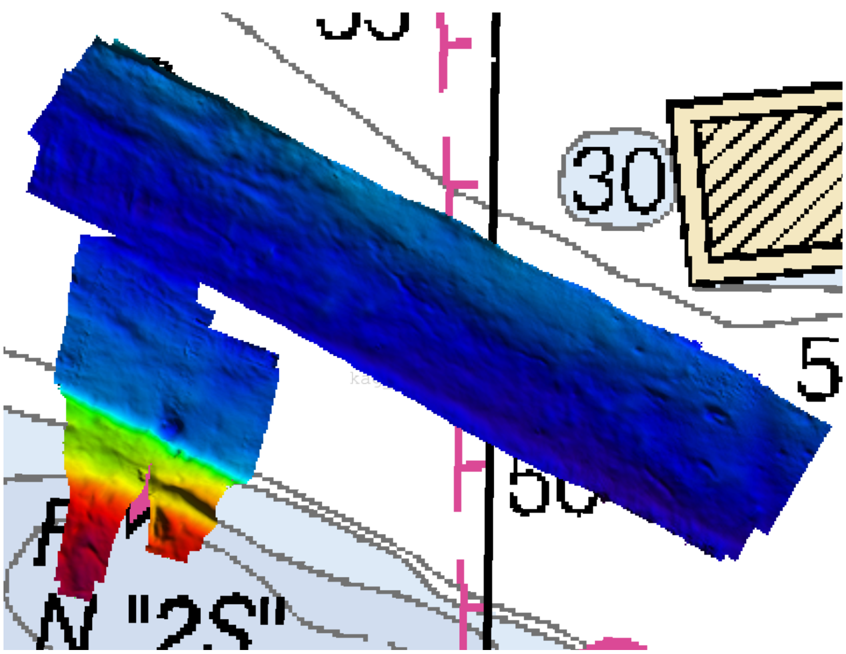
DATA ACQUISITION INFORMATION		
Line Number	Heading	Speed m\s
103_1945 Navigation time	191	3.6
103_1948 Navigation time	191	4.0
103_1948 Pitch	191	4.0
103_1951 Pitch	011	3.3
102_2009 Roll	298	3.4
102_2006 Roll	118	4.0
151_1956 Yaw	192	4.1
150_1953 Yaw	192	4.0

TEST RESULTS

Precise Time (Nav): 0.00
Pitch bias: 0.60
Roll bias: -.60
Yaw Bias: -0.50

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 5.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3102
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): CST Wright

MULTIBEAM SYSTEM INFORMATION

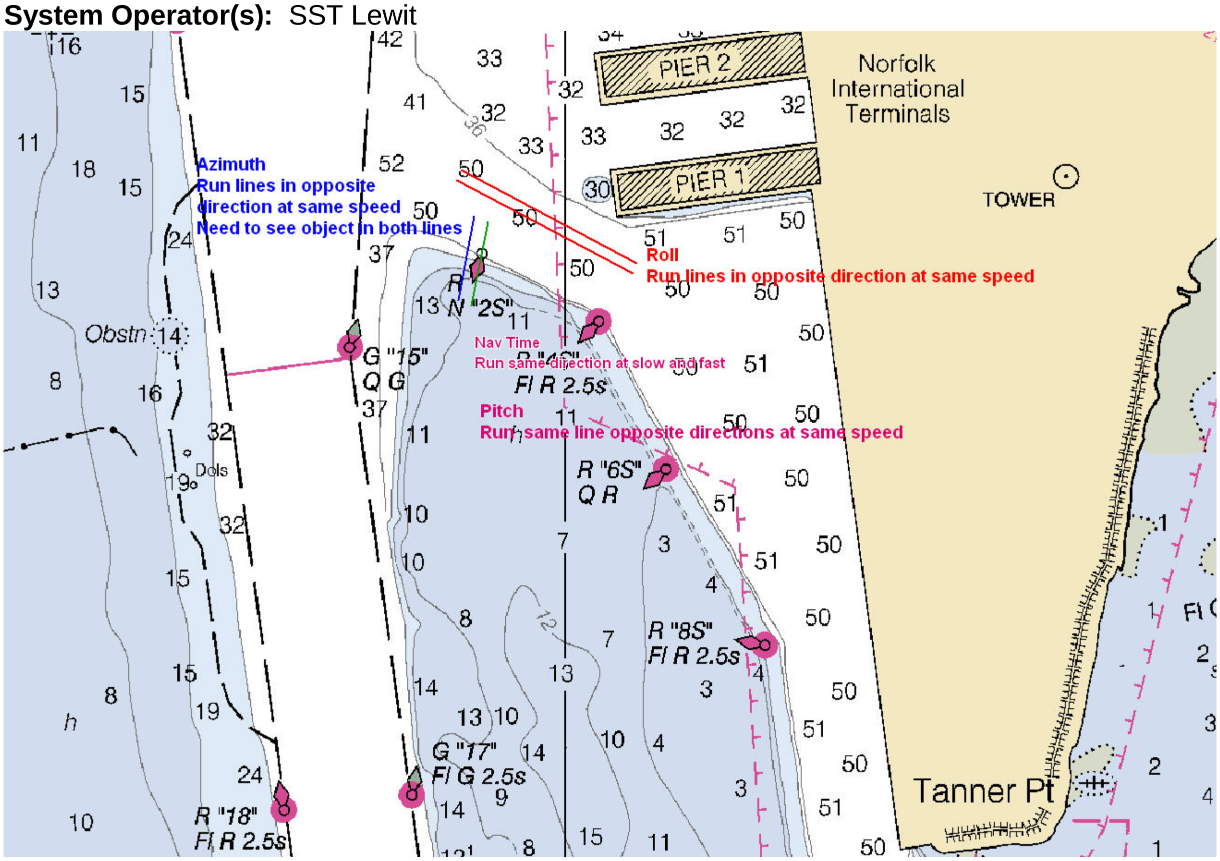
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 200khz Roll Compensated

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: ,
Bottom Type:
Approximate Average Water Depth: 10-15m
System Operator(s): SST Lewit



DATA ACQUISITION INFORMATION

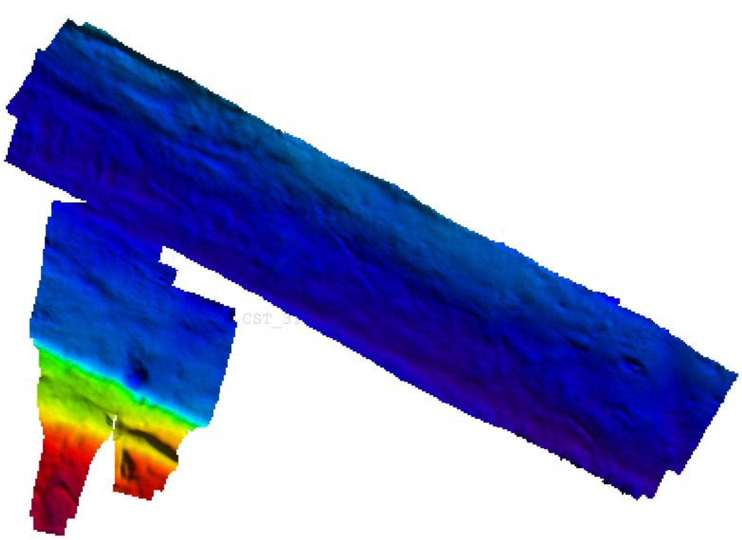
Line Number	Heading	Speed
102_2006 Precise time	119	3.9 m/s
103-1945 Pitch	192	3.6 m/s
103-1951 Pitch	012	3.3 m/s
100-2000 Roll	117	3.9 m/s
100-2003 Roll	299	3.4 m/s
151-1956 Yaw	195	4.1 m/s
150-1953 Yaw	194	4.0 m/s

TEST RESULTS

Precise Time (Nav): 0.00
Pitch bias: 0.81
Roll bias: -0.65
Yaw Bias: -1.30

NARRATIVE

Note: * For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 1.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Field Unit: Thomas Jefferson 3102

Date of Test: 13 March 2010 DN072

Calibrating Hydrographer(s): LT Davidson

MULTIBEAM SYSTEM INFORMATION

Multibeam Echosounder System: Reson 7125-SV Multibeam 400khz
System Location: Port side of launch
Sonar Serial Number:Proj=TC2160 SN1908188 Receiver=
Processing Unit Serial Number:
Date of Most Recent EED / Factory Checkout:

VESSEL INFORMATION

Sonar Mounting Configuration: Port Hull Mount Swing ARM
Date of Current Vessel Offset Measurement / Verification: Jan 2010
Description of Positioning System: POS/MV version 4 w/ Precise Timing
Date of Most Recent Positioning System Calibration: DN0692010

TEST INFORMATION

Test Date(s) / DN(s): DN 072
System Operator(s): SST Lewit
Wind / Seas / Sky: Calm <1
Locality: Approaches to Chesapeake Bay
Sub-Locality: NIT, Tanner Pt, Elizabeth River, VA
Bottom Type: mud and sand
Approximate Average Water Depth:

DATA ACQUISITION INFORMATION

Line Number	Heading	Speed
100-1836	118	7.70
100-1839	298	7.40
102-1843	118	7.70
102-1847	298	7.40
103_1901	191	6.30
103_1909	191	7.60
103_1911	11	7.60

150_1928	**192**	**7.50**
151_1929	**12**	**8.20**
151_1931	**192**	**9.40**
150_1932	**12**	**7.77**

TEST RESULTS

Precise Timing Error: Observed Value=0.00 Entered swath Value= -0.00

Pitch Bias: +1.70

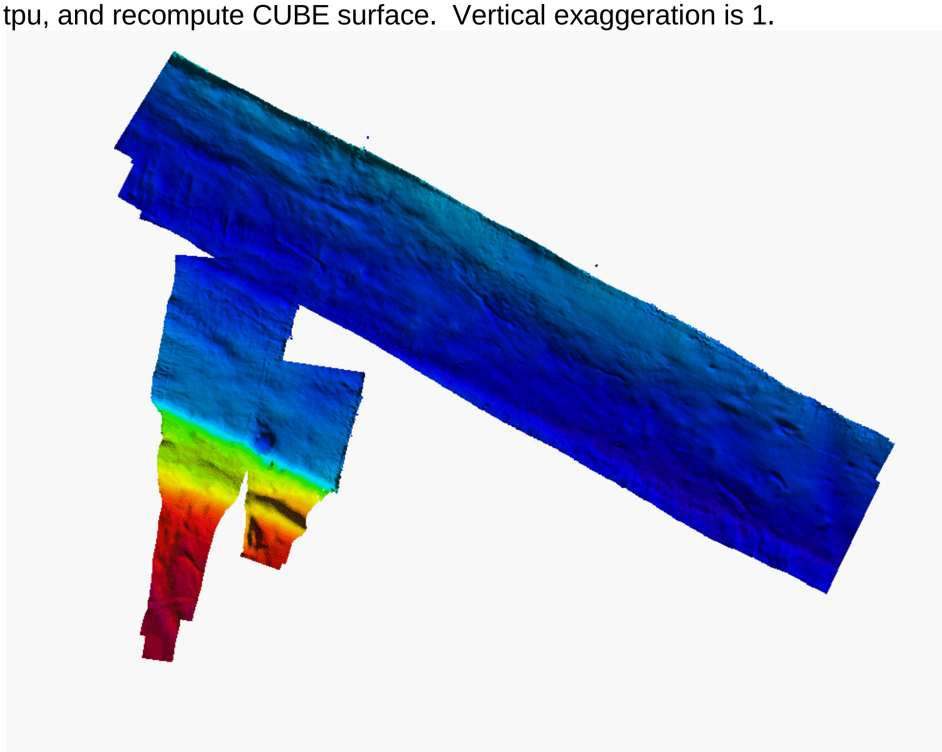
Roll Bias: -0.99

Heading Bias: -0.99

Resulting CARIS HIPS HVF File Name:HSRR_2010_3102_400_mcd

NARRATIVE

* For 7125 precise timing - the determined precise time value will be entered in the swath section with opposite sign. All other motion data will be entered with the same value as derived in the calibration procedure. The image below depicts the patch test area after patch test values were entered in the HVF and the lines re-svp, merged, tpu, and recompute CUBE surface. Vertical exaggeration is 1.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration

Vessel: *Thomas Jefferson* 3102
Date of Test: March 13, 2010, DN 072
Calibrating Hydrographer(s): SST Lewit

MULTIBEAM SYSTEM INFORMATION

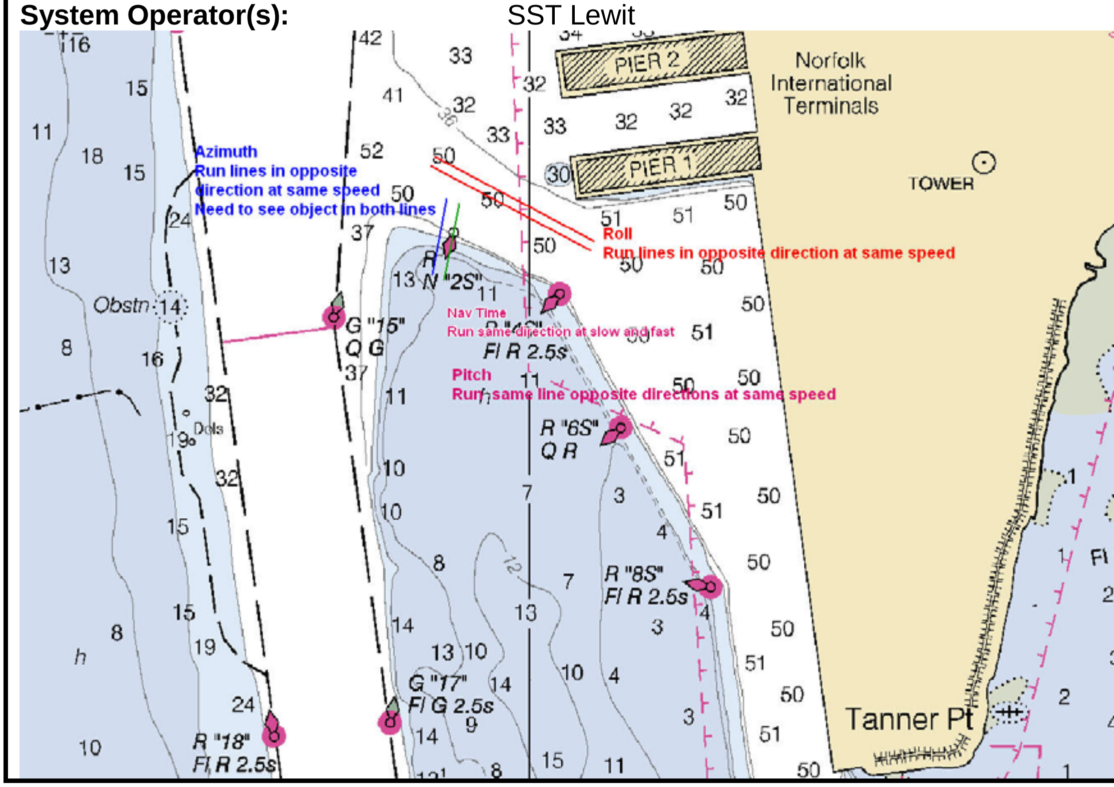
Sonar Serial Number:
Processing Unit Serial Number:
Processor:
System Location: Port Side
Survey Multibeam Echosounder System: Reson 7125SV 400 khz

VESSEL INFORMATION

Sonar Mounting Configuration: Retractable Hull Mount,
Description of Positioning System: POS/MV version 4 w/ Precise Timing,
Date of Most Recent Positioning System Calibration:

TEST INFORMATION

Locality: Approaches to Chesapeake Bay,
Sub-Locality: Elizabeth River,
Bottom Type: Mud
Approximate Average Water Depth: 10-15m
System Operator(s): SST Lewit



DATA ACQUISITION INFORMATION		
Line Number	**Heading**	**Speed**
100-1836	**119**	**8.3**
100-1839	**299**	**6.8**
102-1843	**119**	**6.2**
102-1847	**299**	**7.3**
103-1901	**192**	**7.4**
103-1909	**192**	**7.3**
103-1911	**012**	**7.7**
150-1928	**192**	**8.1**
150-1932	**012**	**8.7**
151-1929	**012**	**7.9**
151-1931	**192**	**7.5**

TEST RESULTS

Precise Time Error: 0.000
Pitch bias: 1.106
Roll bias: -0.955
Yaw Bias: -0.600

NARRATIVE

Note: 7125sv is roll compensated and in the HVF the Roll is set to apply in merge “NO”. Heave and pitch entry’s are set to apply “Yes”

The navigation time error, pitch bias, and roll bias were all conducted using the HIPS calibration GUI.

PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration ***Thomas Jefferson*** **S222 Date of Test: March 11, 2010, DN 070, Calibrating Hydrographer(s): CST Daniel Wright**

MULTIBEAM SYSTEM INFORMATION

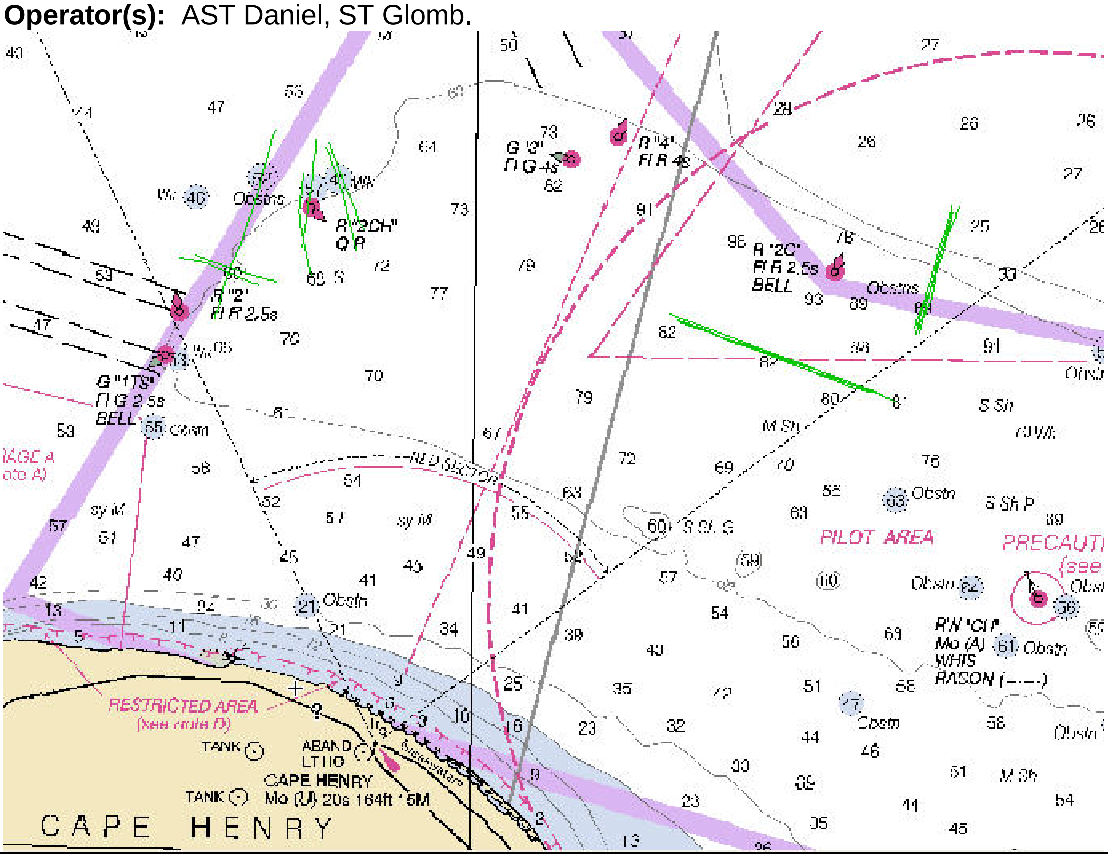
Sonar Serial Number: Processing Unit Serial Number: Processor: 222: System Location: Sonar Void, Survey Multibeam Echosounder System: Reson 7125

VESSEL INFORMATION

Sonar Mounting Configuration: Permanent Hull Mount, **Description of Positioning System:** POS/MV version 4 w/ Precise Timing, **Date of Most Recent Positioning System Calibration:**

TEST INFORMATION

Locality: Approaches to Chesapeake Bay, **Sub-Locality:** 6 Km SE of Chesapeake Light, **Bottom Type:** sandy, **Approximate Average Water Depth:** 20 meters, **System Operator(s):** AST Daniel, ST Glomb.



DATA ACQUISITION INFORMATION		
Line Number	Heading	Speed
004_1833 (Nav timing)	197.481	4.395 m/s
004_1845 (Nav timing)	195.026	2.620 m/s
004_1845 (Pitch)	195.026	2.620 m/s
004_1900 (Pitch)	16.626	2.758 m/s
005_1912 (Roll)	110.801	4.816 m/s
005_2007 (Roll)	290.612	4.209 m/s
011_2250 (Yaw)	343.362	3.739 m/s
012_2304 (Yaw)	338.892	4.195 m/s

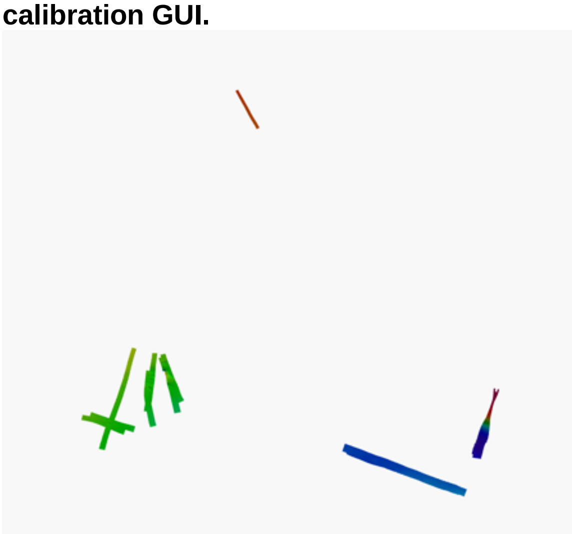
TEST RESULTS

Lines 009_2235/010_2252 used for Pitch & Yaw
Lines 005_1955/005_2007 used for Roll

Navigation Time Error: 0.00 sec
Pitch bias: -1.750 deg
Roll bias: 0.32
Yaw Bias- 0.20

NARRATIVE

Note: The navigation time error, pitch bias, and roll bias were all conducted using the HIPS calibration GUI.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

AHB SELF ONLY

Multibeam Echosounder Calibration ***Thomas Jefferson*** **S222 Date of Test: April 5th, 2009, DN 095, Calibrating Hydrographer(s):** AHB SELF

MULTIBEAM SYSTEM INFORMATION

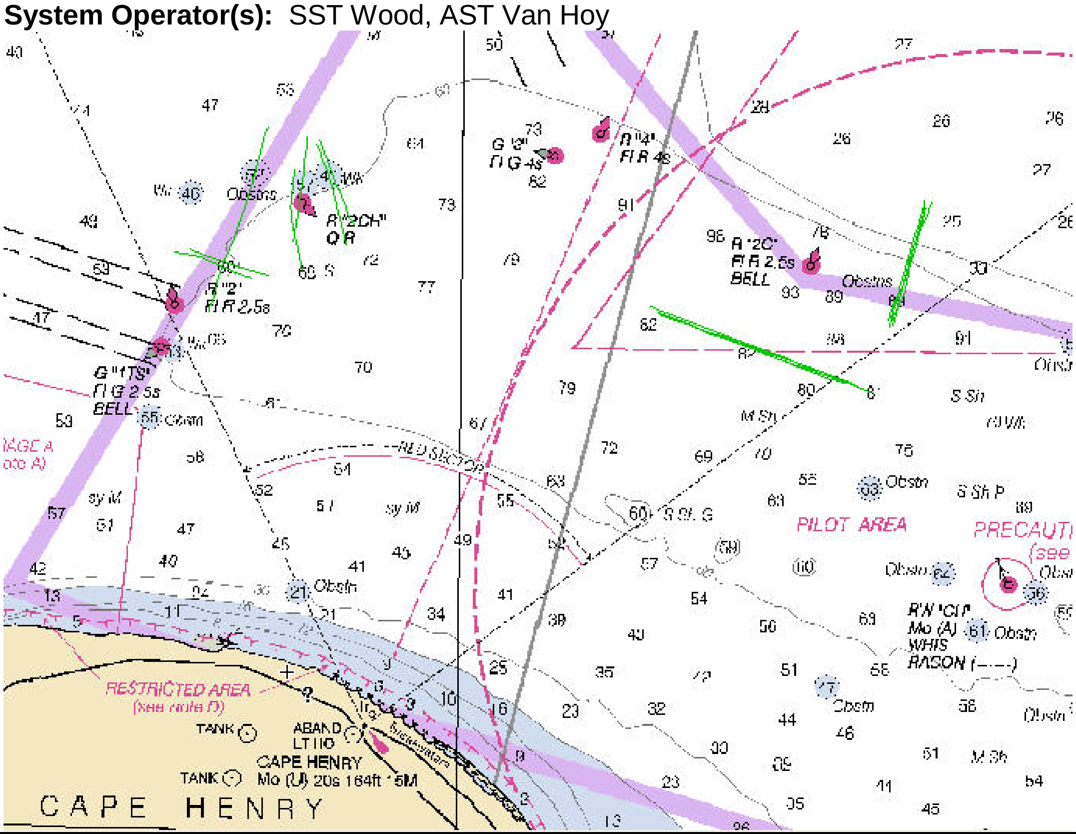
Sonar Serial Number: Processing Unit Serial Number: Processor: 222: System Location: Sonar Void, Survey Multibeam Echosounder System: Reson 7125

VESSEL INFORMATION

Sonar Mounting Configuration: Permanent Hull Mount, **Description of Positioning System:** POS/MV version 4 w/ Precise Timing, **Date of Most Recent Positioning System Calibration:**

TEST INFORMATION

Locality: Approaches to Chesapeake Bay, **Sub-Locality:** 6 Km SE of Chesapeake Light, **Bottom Type:** sandy, **Approximate Average Water Depth:** 20 meters, **System Operator(s):** SST Wood, AST Van Hoy



DATA ACQUISITION INFORMATION		
Line Number	**Heading**	**Speed**
004_1833 (Nav timing)	197.481	4.395 m/s
004_1845 (Nav timing)	195.026	2.620 m/s
004_1845 (Pitch)	195.026	2.620 m/s
004_1900 (Pitch)	16.626	2.758 m/s
005_1912 (Roll)	110.801	4.816 m/s
005_2007 (Roll)	290.612	4.209 m/s
011_2250 (Yaw)	343.362	3.739 m/s
012_2304 (Yaw)	338.892	4.195 m/s

TEST RESULTS

Navigation Time Error: 0.00 sec, Pitch bias: -1.250 deg, Roll bias: 0.28, Yaw Bias 0.003

NARRATIVE

Note: The navigation time error, pitch bias, and roll bias were all conducted using the HIPS calibration GUI. The yaw bias was determined using the alternative subset editor method. The subset editor method was used for the yaw bias test due to the significant amount of noise in the data as the sonar detected the target.

PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

Multibeam Echosounder Calibration ***Thomas Jefferson*** **S222 Date of Test: March 11, 2010, DN 070, Calibrating Hydrographer(s): ST Kimberly Glomb**

MULTIBEAM SYSTEM INFORMATION

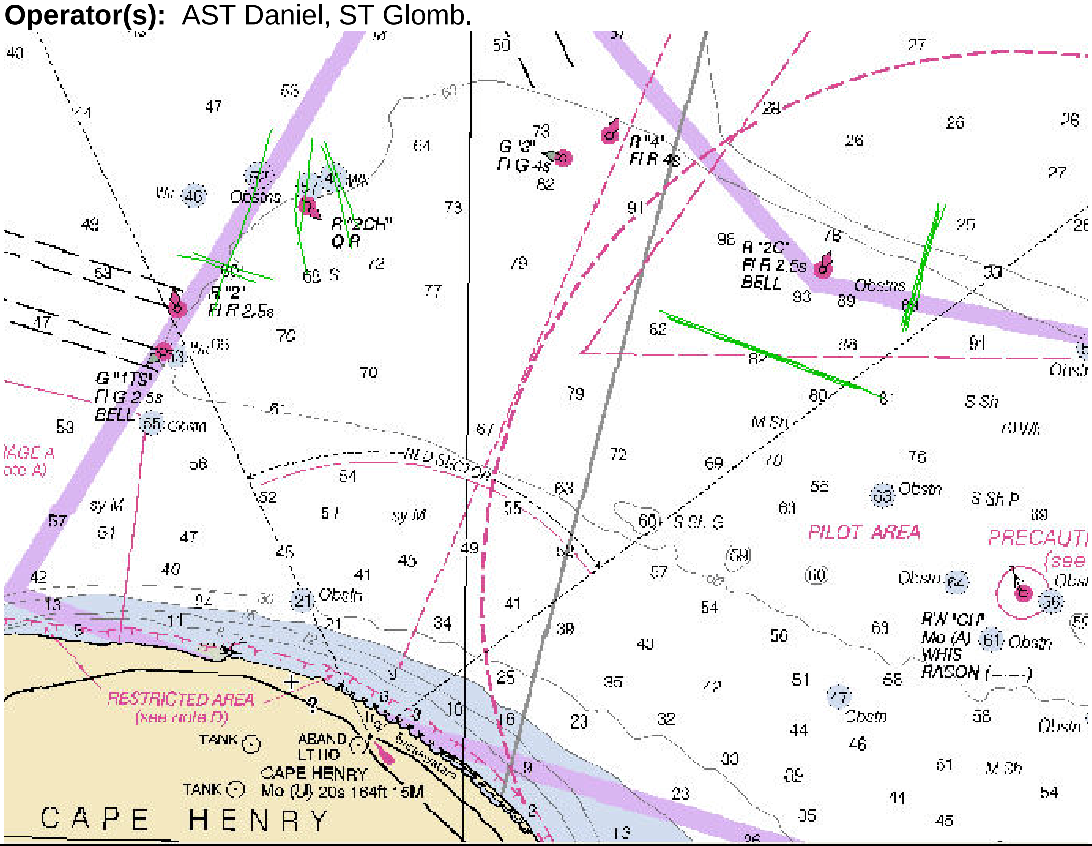
Sonar Serial Number: Processing Unit Serial Number: Processor: 222: System Location: Sonar Void, Survey Multibeam Echosounder System: Reson 7125

VESSEL INFORMATION

Sonar Mounting Configuration: Permanent Hull Mount, **Description of Positioning System:** POS/MV version 4 w/ Precise Timing, **Date of Most Recent Positioning System Calibration:**

TEST INFORMATION

Locality: Approaches to Chesapeake Bay, **Sub-Locality:** 6 Km SE of Chesapeake Light, **Bottom Type:** sandy, **Approximate Average Water Depth:** 20 meters, **System Operator(s):** AST Daniel, ST Glomb.



DATA ACQUISITION INFORMATION		
Line Number	Heading	Speed
004_1833 (Nav timing)	197.481	4.395 m/s
004_1845 (Nav timing)	195.026	2.620 m/s
004_1845 (Pitch)	195.026	2.620 m/s
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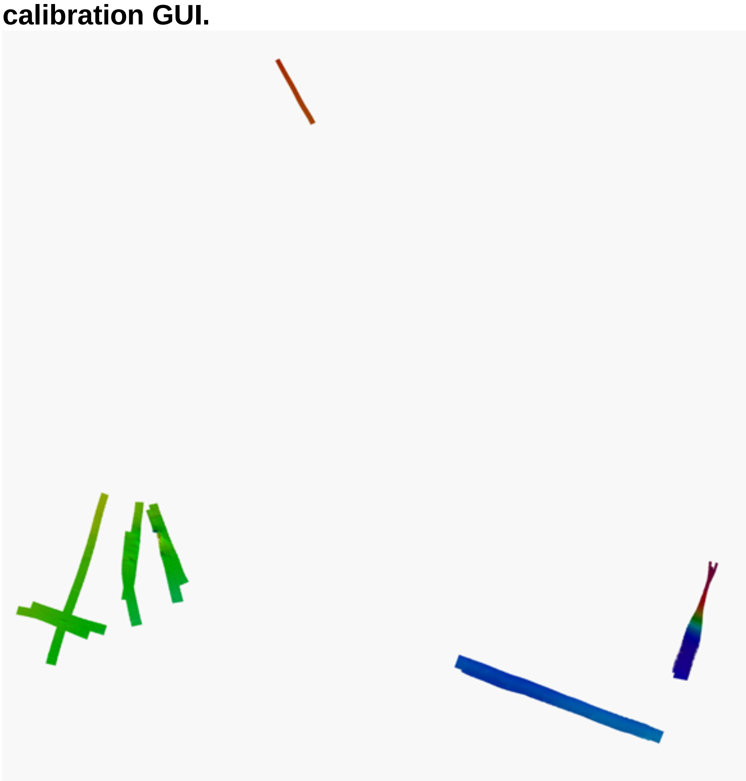
005_2007 (Roll)	290.612	4.209 m/s
011_2250 (Yaw)	343.362	3.739 m/s
012_2304 (Yaw)	338.892	4.195 m/s

TEST RESULTS

Navigation Time Error: 0.00 sec
Pitch bias: -1.730 deg
Roll bias: 0.32
Yaw Bias- 0.07

NARRATIVE

Note: The navigation time error, pitch bias, and roll bias were all conducted using the HIPS calibration GUI.



PURPOSE

Patch tests measure the sensor alignment offsets with respect to the Inertial Measurement Unit (IMU). Sensor alignment offsets must be accurately measured and entered into the processing software to generate an accurate depth sounding and to place it into its correct position on the sea floor. Uncorrected misalignment of a sonar with respect to the IMU results in artifacts in the data associated with heave, pitch, roll, and/or yaw. Alignment issues often have high internal consistencies and are not always readily noticeable within a single line. These issues become noticeable when two or more lines are compared. Patch tests also measure the timing latencies between the navigation/attitude sensor, the sonar, and the acquisition computer. Uncorrected timing latencies can generate positional errors as well as motion artifacts. Timing issues have low internal consistencies and are observable within a single line. A carefully planned and executed patch test can solve for the timing latencies and the sensor misalignments in a survey vessel.

ANALYSIS OF RESULTS

For each vessel, sonar, and frequency, at least three people were assigned to perform a patch test analysis from the raw data. Each analyst started with a CARIS HVF that was only populated with offset values. No values for Navigation, Pitch, Roll, or Yaw were entered prior to performing the calibration procedure. Each analyst converted the raw data using their HVF value and applied correctors for true heave, observed tide, SVP. The corrected depths were then merged and total propagated uncertainty (TPU) was calculated. Each analyst then performed the calibration solving first for Navigation, then Pitch, Roll, and Yaw, respectively. After each variable was solved, the value was entered into the corresponding location in the HVF and the data was re-SVP, Merged, and TPU applied. A surface was generated using each individuals results and the vertical exaggeration of the surface was set to 5 to highlight any deficiencies in the derived patch test values. The results of the patch test have been recorded in a spreadsheet and compared with the patch test results for other individual analysts. Any large discrepancies from the values derived by others for the same sensor and frequency were thrown out as outliers. Next, the values considered to be valid were used to process the raw data collected over a reference surface. Final values were derived by a series of averages, trimmed mean, or in some instances, new figures were derived based solely from iterative adjustments to the HVF value based on examination of the reference surface. The HVF values determined to be the best solution were used to create the official HVF for each vessel, sensor, and frequency. The reference surface area was then regenerated using each of the newly created "official" HVFs to create a 0.5 meter CUBE surfaces. Each CUBE surface was given a vertical exaggeration of 20 and was reviewed by a panel consisting of the Commanding Officer, Chief Survey Tech, Operations Officer, and 4th Officer. Once the values received unanimous approval, each CUBE surface was opened in CARIS Bathy Database - Base Editor. Depth values for each configuration were reviewed to check for overall agreement and were found to be within 15 cm between all vessel configurations within the reference area.

FINAL APPLICATION

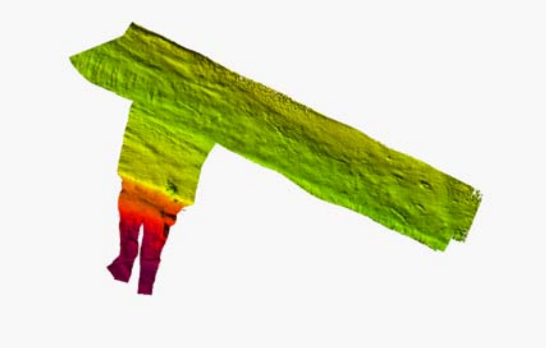
The values listed in ***2010_TJ_patch_test_evaluations_all_platforms.pdf*** have been approved as values to be used in the official HVF for each configuration. These values will be used to start the field season, and will remain in effect until superseded by subsequent path tests.

NOAA Ship *Thomas Jefferson*
2010 Patch Tests Values for all RESON 7125 MB configurations

3101 Patch Test Comparisons

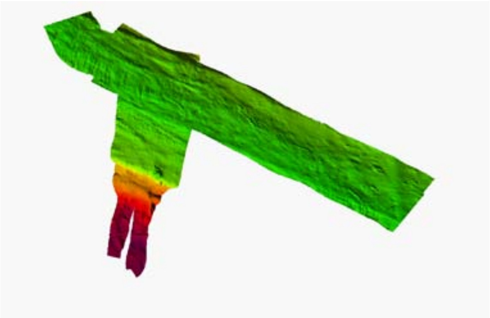
200khz

Analyst	Nav_Time	Pitch	Roll	Yaw	Vert Exag 5	Quality	Comments
CST	0.000	1.500	-0.230	0.800	y	g	slight blurring of linear features
JJM(AHB)	0.000	1.430	-0.230	-0.650	y	g	clear sharp edges to linear features
KAG	0.000	1.400	0.000	0.000	y	g	moderate edges to linear feat.
MCD	0.000	1.560	-0.210	0.000	y	g	moderate edges to linear feat.
AVG	0.000	1.473	-0.168	0.038			
STD DEV	0	-0.07182	-0.11206	-0.59354			
No Hi/Low	0	1.465	-0.115	-0.325			
No Low	0		-0.223				
RefSurf Results	0	1.430	-0.233	-0.650			



3101_200

Analyst	Nav_Time	Pitch	Roll	Yaw	Vert Exag 5	Quality	Comments
CST	0.000	1.200	-0.410	0.900	y	g	mild blurring of edges to linear feat.
JJM(AHB)	0.000	1.640	-0.420	1.680	y	g	mod to crisp edges to linear feat.
KAG	0.000	0.600	-0.400	0.100	y	g	mod edges, minor blurring of pitch
MCD	0.000	1.860	-0.440	0.520	y	g	mod to crisp edges to linear feat.
AVG	0.000	1.325	-0.418	0.800			
STD DEV	0	-0.55579	-0.01708	-0.67152			
No Hi/Low	0	1.420	-0.415	0.710			
No Low	0	1.567		1.033			



3101_400

Reccommendation

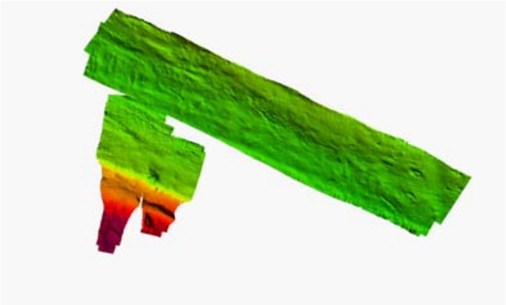
Create new hvf using "No low" pitch, avg roll, "No low" yaw and create a surface at vert exag 5 to compare - MCD

3102 Patch Test Comparisons

200khz

Analyst	Nav_Time	Pitch	Roll	Yaw	Vert Exag 5	Quality	Comments
CST	0.000	0.810	-0.650	-1.300	y	g	none
PGL	0.000	0.850	-0.637	-0.703	y	g	none
KAG	0.000	0.600	-0.600	-0.500	y	g	mild softening around edges of feat.
MCD	0.000	0.890	-0.470	-0.890	y	g	none
AVG	0.000	0.788	-0.589	-0.848			
STD DEV	0	-0.1292	-0.08227	-0.34068			
No Hi/Low	0	0.830	-0.619	-0.797			
No Low	0	0.850	-0.629	-0.964			
Test for fine tuning		1.3	-0.97	-0.9			

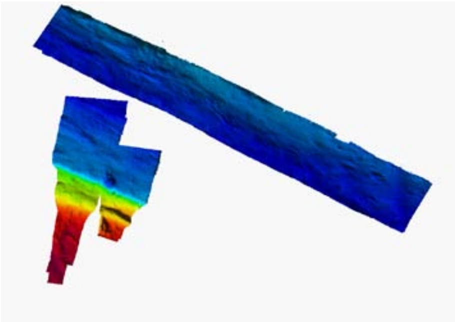
Reccommendation
Create new hvf using "no low" pitch, "no low" roll, and "no low" yaw at vert exag 5 to compare - MCD



3102_200

400khz

Analyst	Nav_Time	Pitch	Roll	Yaw	Vert Exag 5	Quality	Comments
CST	0.000	1.900	-0.920	-0.900	y	g	very mild softening of edges
PGL	0.000	1.106	-0.955	-0.600	y	g	none
KAG	0.200	-1.000	-0.900	-0.800	y	f/g	0.20 nav time is suspicious
MCD	0.000	1.700	-0.990	-0.990	y	g	none
AVG	0.050	0.927	-0.941	-0.823			
STD DEV	-0.1	-1.32786	-0.03966	-0.16741			
No Hi/Low	0	1.403	-0.938	-0.850			
No Low	0	1.569		-0.897			
RefSurf Results		1.8	-0.92	-897			



3102_400

S222 Reson 7125 400kHz

400khz

Analyst	Nav_Time	Pitch	Roll	Yaw	Vert Exag 5
CST	0.000	-1.750	0.320	-0.200	y
KAG	0.000	-1.730	0.320	-0.070	y
AHB	0.000	-1.250	0.280	0.003	n
AVG	0.000	-1.577	0.307	-0.089	
STD DEV	0	0.283078	0.023094	0.102825	
No outlier	0	-1.740	0.320	-0.135	
RefSurf Results	0	-1.7	0.21	-1.1	

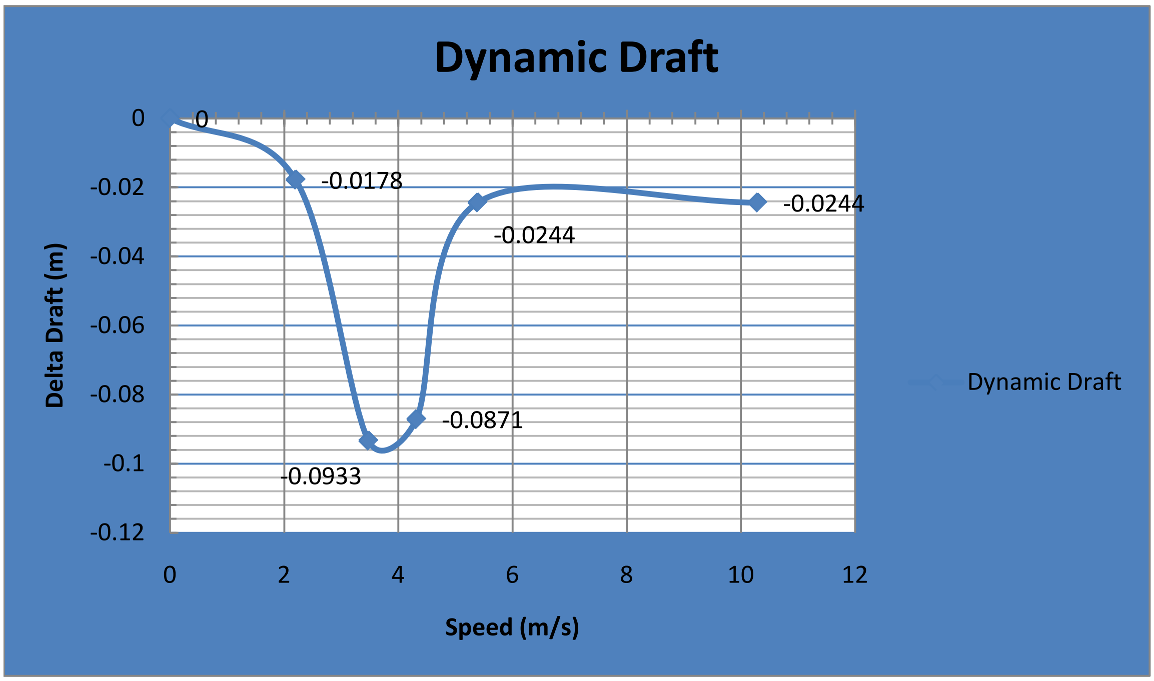
Quality	Comments
	CST Values were already in use - will compare in the Reference Surface and readjust if necessary

Reccommendation
Based on Reference Surface analysis, HVF w/ Pitch, Roll, and Yaw of -1.70, +0.210, -1.10 respectively will be used

3102 Dynamic Draft Calculation Comparisons

Thomas Jefferson - 2010

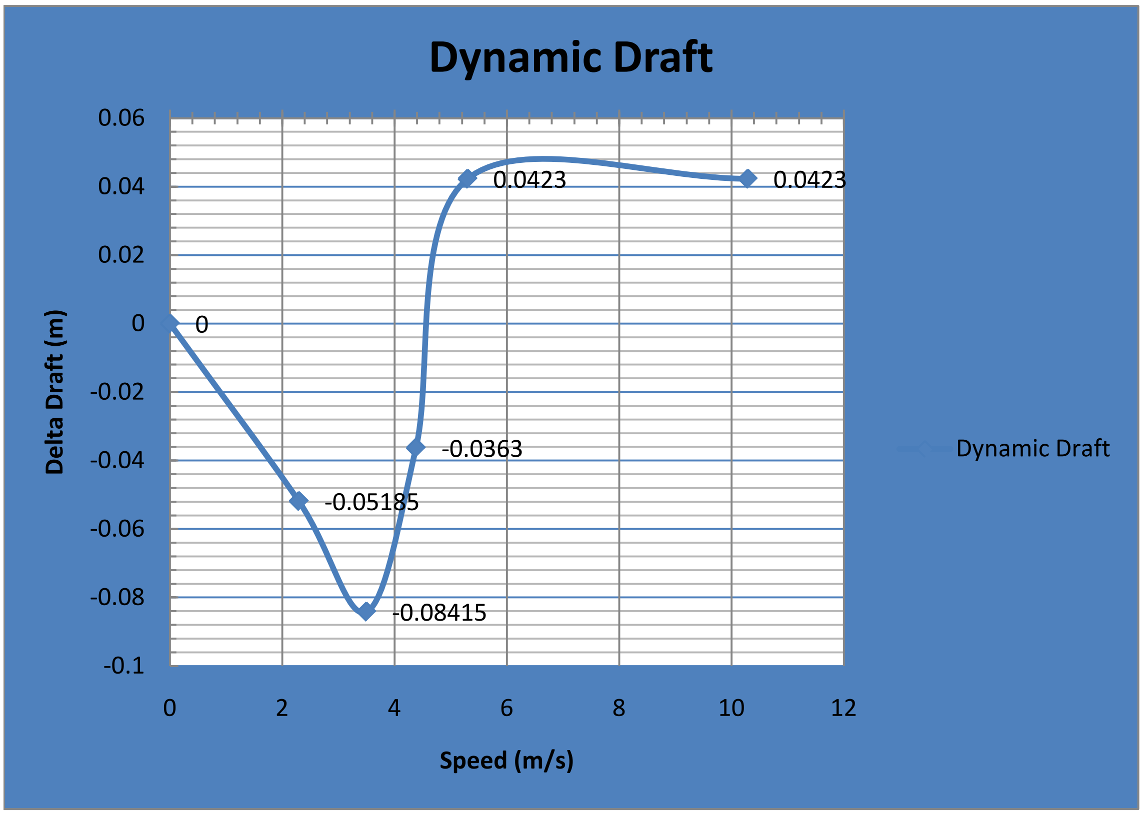
ERS measured Dynamic Draft vs Speed in m/s and kts		
m/s	kts	Dynamic Draft
0	0	0
2.1996454	4.2756294	-0.0178
3.473058459	6.750931033	-0.0933
4.314091805	8.385731651	-0.0871
5.38647388	10.4702279	-0.0244
10.28889	20	-0.0244



3101 Dynamic Draft Calculation Comparisons

Thomas Jefferson - 2010

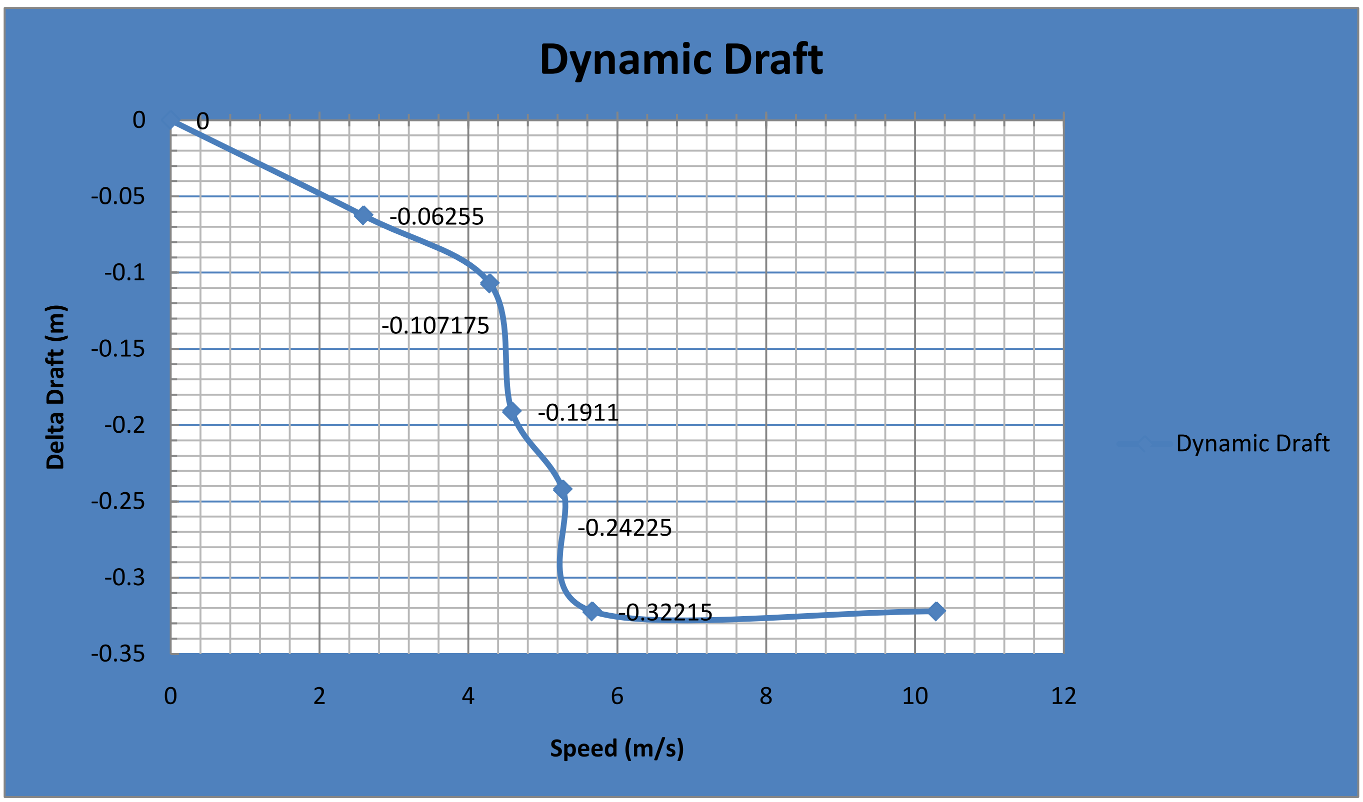
ERS measured Dynamic Draft vs Speed in m/s and kts		
m/s	kts	Dynamic Draft
0	0	0
2.294035	4.45915	-0.05185
3.497052	6.79755	-0.08415
4.379577	8.51295	-0.0363
5.299152	10.30045	0.0423
10.28889	20	0.0423



S222 Dynamic Draft Calculation Comparisons

Thomas Jefferson - 2010

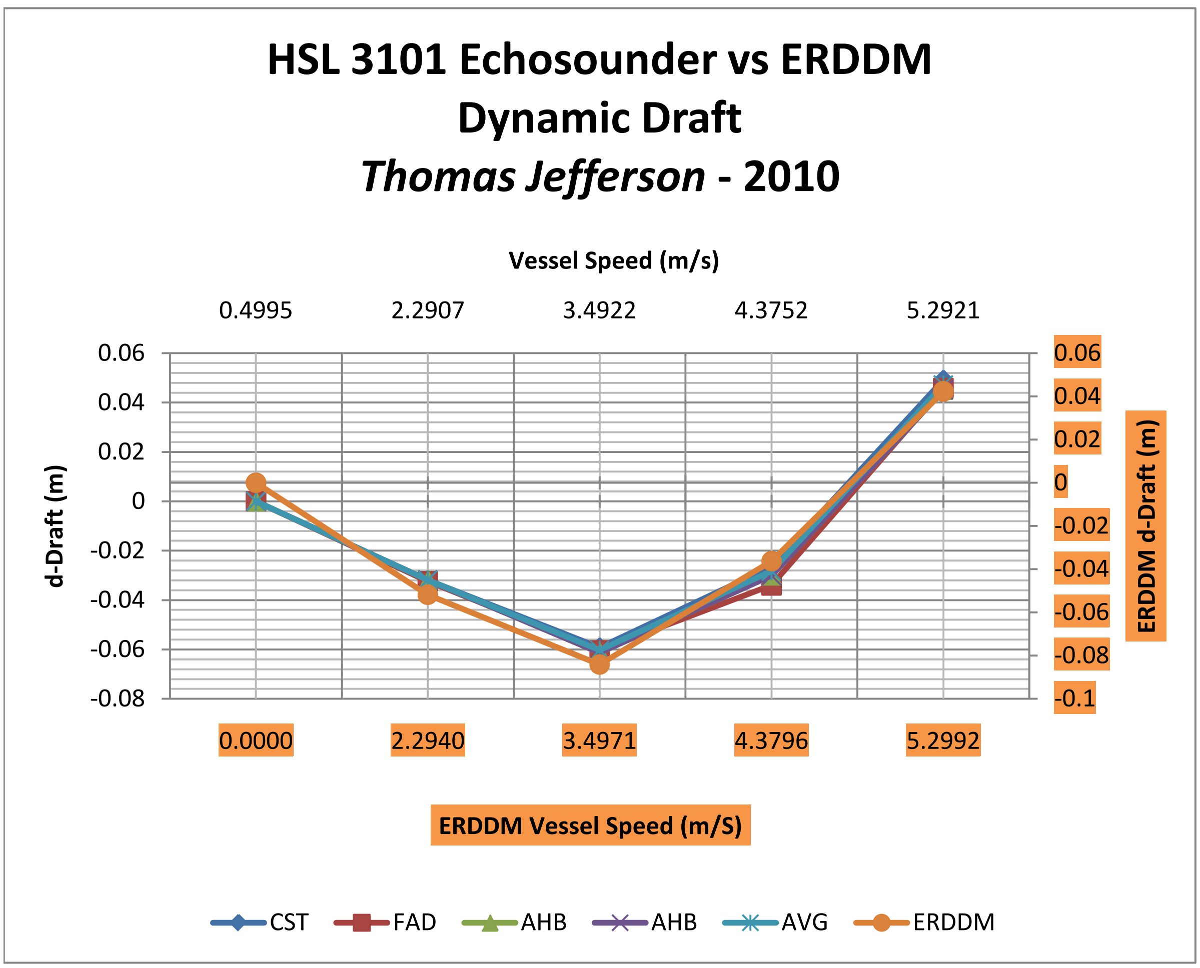
ERS measured Dynamic Draft vs Speed in m/s and kts		
m/s	kts	Dynamic Draft
0	0	0
2.59177684	5.037895822	-0.06255
4.288799446	7.474561006	-0.107175
4.585430285	8.913159387	-0.1911
5.268667581	10.24123604	-0.24225
5.663961234	11.00960785	-0.32215
10.28889	20	-0.32215



Thomas Jefferson - HSRR 2010
Method Comparisons for Dynamic Draft
HSL 3101

		Measured Change in Draft (d-D)				
RPM	Speed (m/s)	CST	FAD	AHB	AVG	ERDDM
Drift	0.499541171	0	0	0	0	0
600	2.290705772	-0.03193	-0.03242	-0.03183	-0.03188	-0.05185
1000	3.492204283	-0.05919	-0.06041	-0.06134	-0.06027	-0.08415
1400	4.375165141	-0.02645	-0.03402	-0.03005	-0.02825	-0.0363
1800	5.292061396	0.049284	0.04589	0.045179	0.047231	0.0423

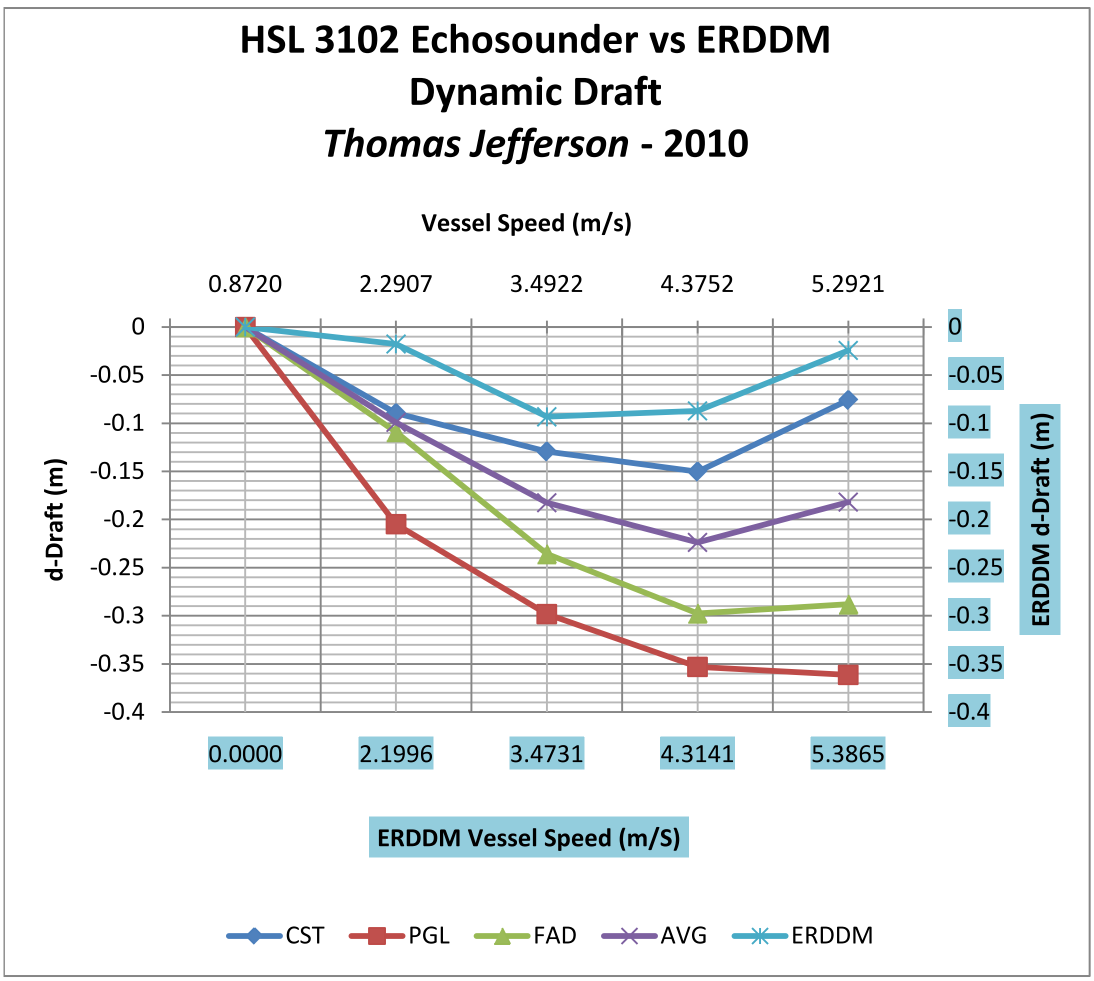
		Standard Deviation of d-D			
RPM	Speed (m/s)	CST	FAD	AHB	AVG
Drift	0.499541171	0	0	0	0
600	2.290705772	0.005438			0.002719
1000	3.492204283	0.00423	0.001558	0.008776	0.006503
1400	4.375165141	0.002015	0.002491	0.004251	0.003133
1800	5.292061396	0.019434	0.010556	0.001861	0.010647



Thomas Jefferson - HSRR 2010
Method Comparisons for Dynamic Draft
HSL 3102

		Measured Change in Draft (d-D)				
RPM	M\S	CST	PGL	FAD	AVG	ERDDM
Drift	0.872023	0	0	0	0	0
600	2.290706	-0.08946	-0.20484	-0.10896	-0.09921	-0.0178
1000	3.492204	-0.12938	-0.29828	-0.23582	-0.1826	-0.0933
1400	4.375165	-0.15023	-0.35309	-0.29747	-0.22385	-0.0871
1800	5.292061	-0.07584	-0.36141	-0.28806	-0.18195	-0.0244

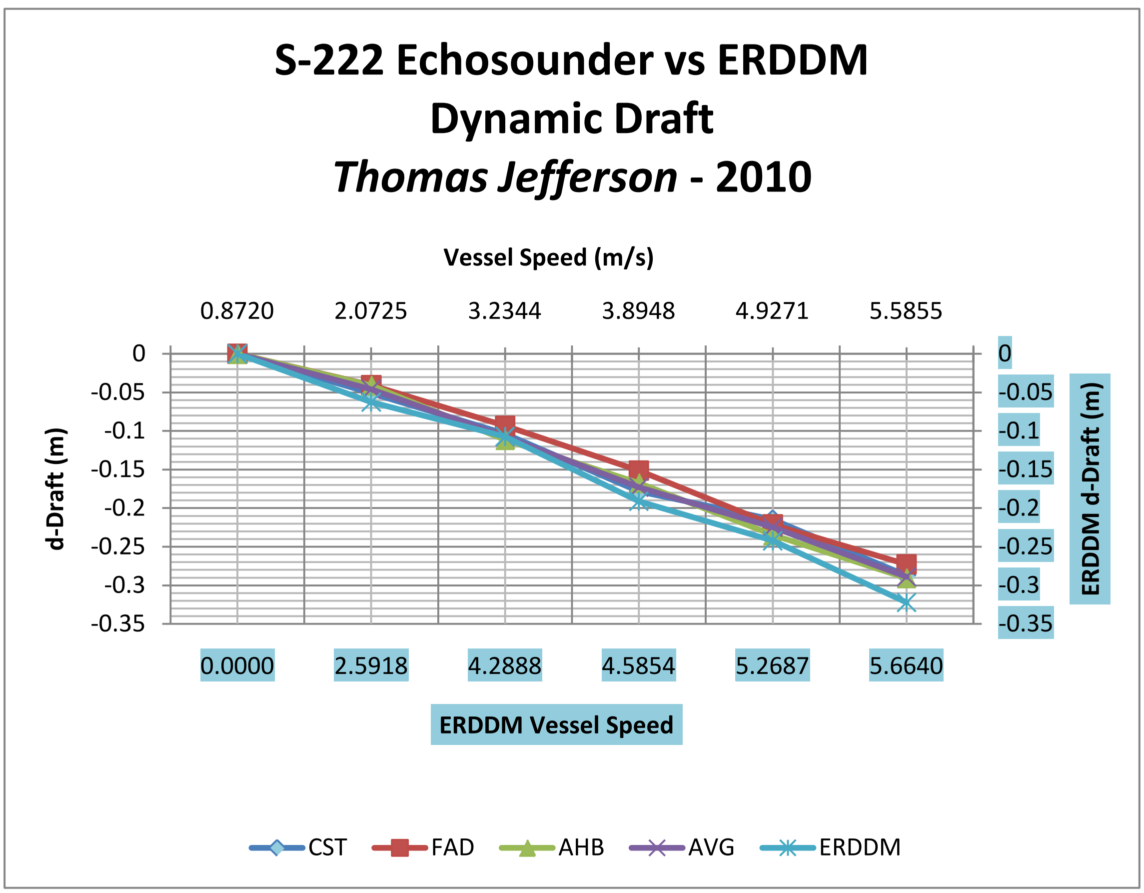
		Standard Deviation of d-D			
RPM	M\S	CST	FAD	FAD	AVG
Drift	0.872023	0	0	0	0
600	2.290706	0.124404	0.091286	0.089908	0.107156
1000	3.492204	0.118947	0.08998	0.117298	0.118122
1400	4.375165	0.121668	0.079852	0.130095	0.125881
1800	5.292061	0.114589	0.094678	0.136142	0.125365



Thomas Jefferson - HSRR 2010
Method Comparisons for Dynamic Draft
S-222

		Measured Change in Draft (d-D)				
RPM	M\S	CST	FAD	AHB	AVG	ERDDM
Drift	0.872023	0	0	0	0	0
ME 350	2.072451	-0.05095	-0.04067	-0.04088	-0.04591	-0.06255
ME 500	3.234435	-0.10354	-0.09342	-0.1114	-0.10747	-0.10718
ME 600	3.894774	-0.17836	-0.15139	-0.16738	-0.17287	-0.1911
ME 700	4.927123	-0.21472	-0.22116	-0.23483	-0.22477	-0.24225
ME 770	5.585466	-0.28747	-0.27265	-0.29045	-0.28896	-0.32215

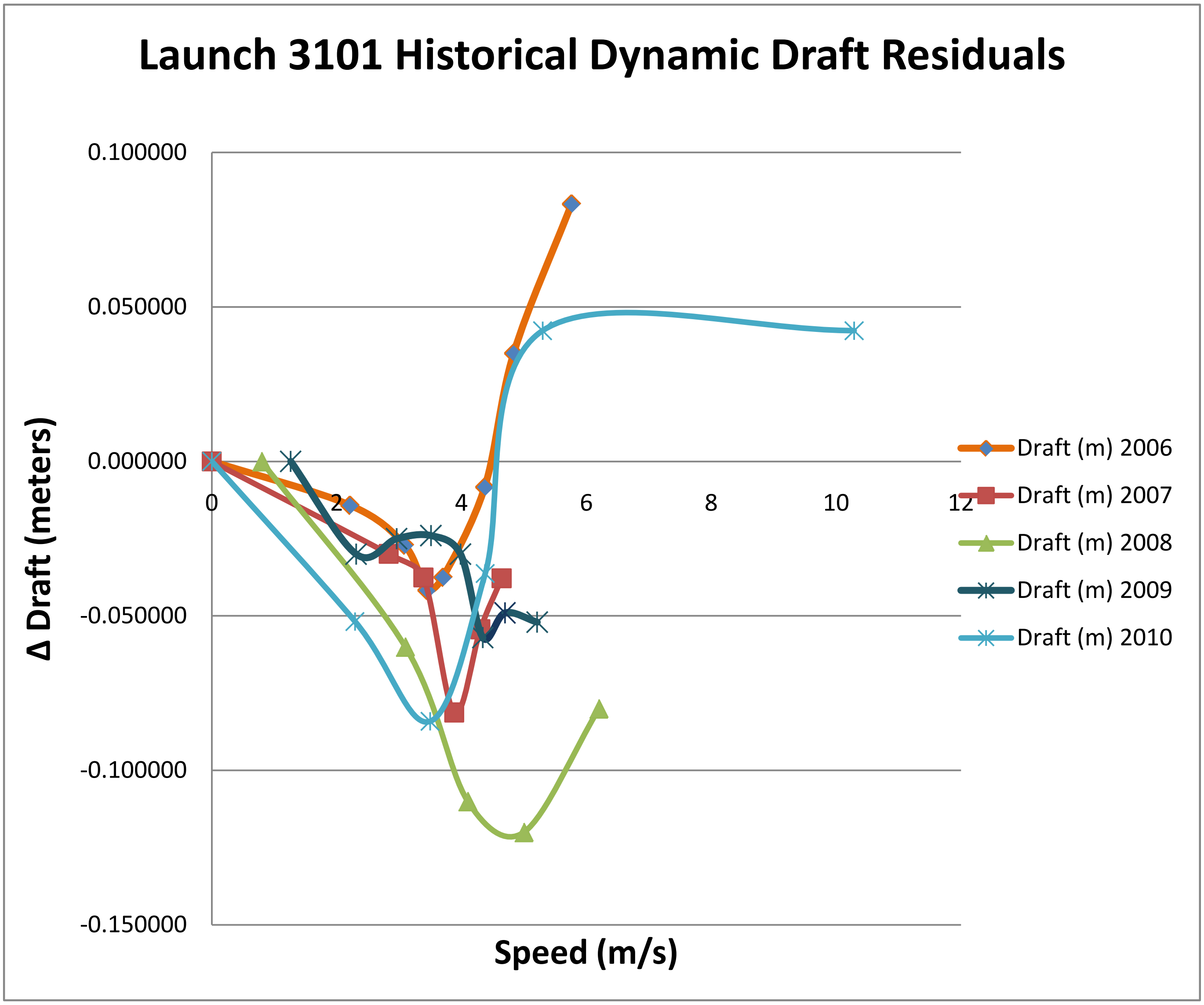
		Standard Deviation of d-D			
RPM	M\S	CST	FAD	AHB	AVG
Drift	0.872023	0	0	0	0
ME 350	2.072451	0.014064	0.013079	0.024949	0.019506
ME 500	3.234435	0.031715	0.02954	0.03546	0.033588
ME 600	3.894774	0.020008	0.011769	0.014098	0.017053
ME 700	4.927123	0.01545	0.024153	0.024564	0.020007
ME 770	5.585466	0.018537	0.022427	0.016424	0.01748

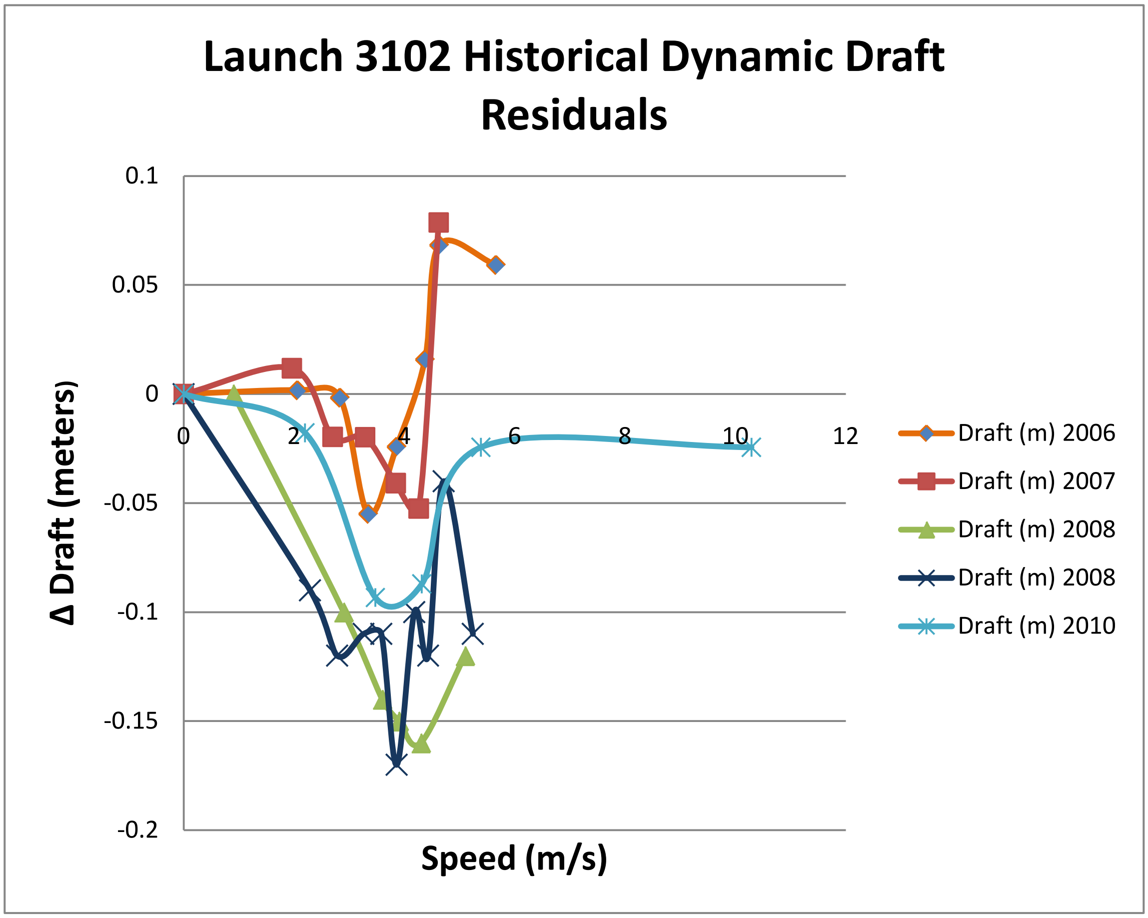


Comparison of Historic Values for Dynamic Draft

Thomas Jefferson HSLs 3101 and 3102

	HSL 3101			HSL 3102	
2006	Speed (m/s)	Draft (m) 2006	3102	Speed (m/s)	Draft (m) 2006
	0	0.000000		0	0
	2.21192	-0.014200		2.0576	0.0017
	3.0864	-0.027100		2.8292	-0.0017
	3.44648	-0.041700		3.3436	-0.055
	3.70368	-0.037500		3.858	-0.0242
	4.3724	-0.008300		4.3724	0.0158
	4.83536	0.035000		4.6296	0.0683
	5.76128	0.083300		5.6584	0.0592
	6.99584	0.266700		6.6872	0.2833
	8.38472	0.397500		7.716	0.3808
2007	Speed (m/s)	Draft (m) 2007	3102	Speed (m/s)	Draft
	0	0.000000		0	0
	2.835	-0.029923		1.961	0.011833333
	3.391	-0.037549		2.7	-0.019666667
	3.884	-0.081249		3.287	-0.019833333
	4.303	-0.054346		3.844	-0.040833333
	4.6435	-0.037824		4.26	-0.0525
				4.622	0.078666667
2008	Speed (m/s)	Draft (m) 2008	3102	Speed (m/s)	Draft
	0.8	0.000000		0.9	0
	3.1	-0.060000		2.9	-0.1
	4.1	-0.110000		3.6	-0.14
	5	-0.120000		3.9	-0.15
	6.2	-0.080000		4.3	-0.16
				5.1	-0.12
2009	Speed (m/s)	Draft (m) 2009	3102	Speed (m/s)	Draft
	1.264	0.000000		0	0
	2.312	-0.030000		2.29	-0.09
	2.961	-0.025000		2.78	-0.12
	3.51	-0.024000		3.26	-0.11
	3.984	-0.030000		3.58	-0.11
	4.341	-0.057000		3.86	-0.17
	4.698	-0.049000		4.18	-0.1
	5.212	-0.052000		4.43	-0.12
				4.71	-0.04
				5.24	-0.11
2010	Speed (m/s)	Draft (m) 2010	3102	Speed (m/s)	Draft
ERDDM	0	0	ERDDM	0	0
	2.294035	-0.05185		2.1996454	-0.0178
	3.497052	-0.08415		3.473058459	-0.0933
	4.379577	-0.0363		4.314091805	-0.0871
	5.299152	0.0423		5.38647388	-0.0244
	10.28889	0.0423		10.28889	-0.0244


Launch 3101 Historical Dynamic Draft Residuals
0.100000
0.050000
0.000000
-0.050000
-0.100000
-0.150000
0
2
4
6
8
10
12
Δ Draft (meters)
Speed (m/s)
Draft (m) 2006
Draft (m) 2007
Draft (m) 2008
Draft (m) 2009
Draft (m) 2010



Launch 3102 Historical Dynamic Draft Residuals
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
0
2
4
6
8
10
12
Δ Draft (meters)
Speed (m/s)
Draft (m) 2006
Draft (m) 2007
Draft (m) 2008
Draft (m) 2008
Draft (m) 2010

2010 HSRR Reference Surface Summary of Difference Surfaces

During the 2010 Hydrographic Systems Readiness Review (HSRR) a reference area was established in the Hampton Roads anchorages at the confluence of the Elizabeth River and the James River. On DN 073, NOAA Ship Thomas Jefferson surveyed the area with its 400kHz Reson 7125. Also on DN 073, launches 3101 and 3102 acquired data with their Reson 7125SV multibeam sonars on the 200kHz and 400kHz frequencies. Raw data was converted using the officially approved HVF values for all vessels and correctors for true heave, tide, and svp were applied. The data was then merged and TPU was applied based on the best estimates available at the time. CUBE Surfaces were created from the processed depths and the surfaces were cleaned for major fliers (some surfaces were cleaned more diligently than others as evidenced by the statistics below). Difference surfaces were created to compare different frequencies on the same vessel and the same frequencies between different vessels. Each difference surface was exported to ASCII format and imported into Excel where the data was analyzed to determine the percentage of difference surface nodes with a value between -0.151 and 0.151. The maximum positive and negative differences (measured in meters) were calculated to demonstrate the level of data cleaning. Finally, standard deviation for the difference surfaces were calculated.

Despite the differences in sonar frequency and the disparity in the level of cleaning on the CUBE surfaces, all configurations of Thomas Jefferson's Reson sonars achieved less than 15cm of standard deviation at the 95% confidence internval.

Difference Surface for 3101 200kHz and 400kHz Reson 7125 SV*

Percentage of Nodes +/0.15m	Maximum Negative Difference (m)	Maximum Positive Difference (m)	Standard Deviation (m)
94.951	-15.670	9.970	0.082

Difference Surface for 3102 200kHz 400kHz Reson 7125 SV*

Percentage of Nodes +/0.15m	Maximum Negative Difference	Maximum Positive Difference (m)	Standard Deviation (m)
95.030	-8.820	10.470	0.145

Difference Surface for 3101 and 3102 Reson 7125 SV 200kHz

Percentage of Nodes +/0.15m	Maximum Negative Difference	Maximum Positive Difference (m)	Standard Deviation (m)
98.395	-8.830	8.920	0.107

Difference Surface for 3101 and 3102 Reson 7125 SV 400kHz

Percentage of Nodes +/0.15m	Maximum Negative Difference	Maximum Positive Difference (m)	Standard Deviation (m)
99.527	-9.900	15.710	0.075

Difference Surface for S222 Reson 7125 400kHz and 3102 Reson7125 SV 400kHz

Percentage of Nodes +/0.15m	Maximum Negative Difference	Maximum Positive Difference (m)	Standard Deviation (m)
99.214	-8.280	1.170	0.092

*Difference surfaces between different frequencies have a lower confidence interval due to the signal response of the soft sediment (Mud) in the reference surface area.

Analysis by LT Davidson

D. APPROVAL SHEET

This Data Acquisition and Processing Report for project **OPR-E350-TJ-10, Approaches to Chesapeake Bay, VA** is respectfully submitted.

This project began in March, 2010 and was acquired and processed in accordance with the Hydrographic Specification and Deliverables, Hydrographic Survey Technical Directives, and the Field Procedures Manual for Hydrographic Surveying that were in effect at the date the project was began. As Chief of Party, I have ensured that standard field surveying and processing procedures were adhered to during these projects in accordance with the Hydrographic Surveys Specifications and Deliverables (**4/2009**), Hydrographic Survey Technical Directives **HTD 2010-01**, and the Field Procedures Manual for Hydrographic Surveying (**4/2009**,).

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

This DAPR applies to all surveys completed in 2010 for Project OPR-E350-TJ-10.

Approved and Forwarded:

Mark Blankenship
2010.07.26
17:31:10 -04'00'

LT Mark A. Blankenship, NOAA
Field Operations Officer

Digitally signed by
Shepard Smith
Date: 2010.07.26 18:15:08
-04'00'

CDR Shepard M. Smith, NOAA
Commanding Officer