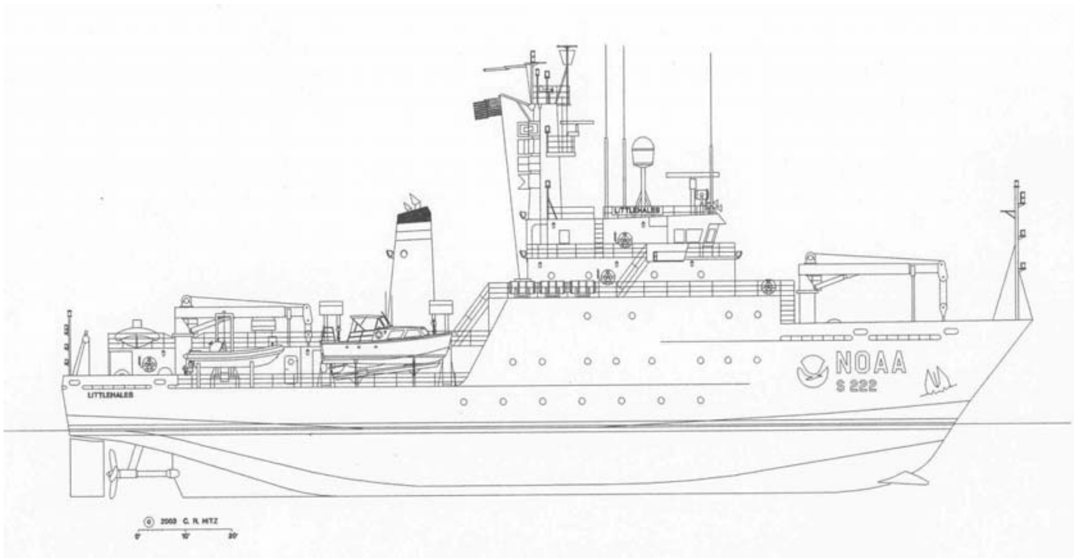
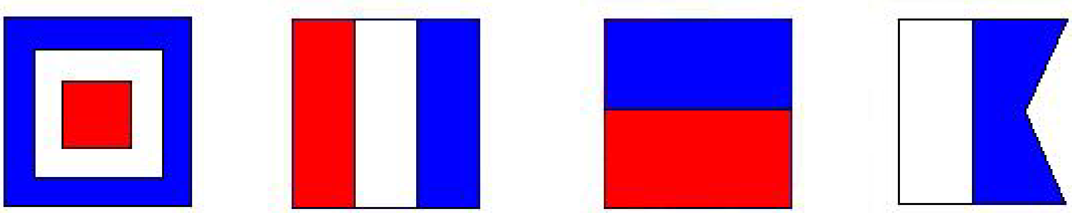
2005 FALL DAPR

***D**ata*
***A**cquisition and*
***P**rocessing*
***R**eport*



NOAA SHIP THOMAS JEFFERSON



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DATA ACQUISITION AND PROCESSING REPORT

to accompany

PROJECTS OPR-J323-TJ-05, S-K921-TJ-05, S-K922-TJ-05, S-A902-TJ-05,

OPR-J376-TJ-05, OPR-D304-TJ-05

NOAA Ship THOMAS JEFFERSON
CAPT Emily B. Christman, Commanding Officer

A. EQUIPMENT

All survey data for August - November 2005 were acquired by NOAA Ship THOMAS JEFFERSON and Survey Launches 3101 and 3102. THOMAS JEFFERSON acquired side scan sonar (SSS) data, multibeam echosounder (MBES) data, vertical beam echosounder (VBES) data, and sound velocity profile (SVP) data. Survey Launch 3101 acquired SSS data, MBES data, and SVP data. Survey Launch 3102 acquired SSS data, MBES data, and SVP data.

The methods and systems described in this report are used to meet full-coverage requirements are in accordance with the National Ocean Service Standing Instructions for Hydrographic Surveys (3/2004), the Hydrographic Surveys Specifications and Deliverables Manual (3/2003), Hydrographic Survey Directives, and the Field Procedures Manual for Hydrographic Surveying (1/2005, v 1.0).

A.1. ECHOSOUNDING EQUIPMENT

ODOM ECHOTRAC DF3200 MK II VERTICAL-BEAM ECHOSOUNDER

The Odom Echotrac DF3200 MKII is a dual-frequency digital recording echosounder system with an analog paper recorder. The high frequency setting may range from 100 kHz to 1 MHz. The low frequency setting may range from 12 kHz to 50 kHz.

The high frequency transducer on THOMAS JEFFERSON operates at 200 kHz. The high frequency pulse forms a circular beam with a main-lobe beam footprint of 7.5° at the -6dB point. The low-frequency transducer on all platforms operates at 24 kHz with a rectangular main-lobe beam footprint of 27° (along-track direction) by 47° (across-track direction) at the -6 dB point. Soundings are acquired in meters on both frequencies, with the high frequency selected for all sounding data.

On THOMAS JEFFERSON, the transducer is installed in an acoustically transparent fiberglass blister on the port side, adjacent to the SIMRAD EM1002 multibeam transducer.

For the purposes of calculating total propagated error (TPE), the ODOM Echotrac MK II 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. As the primary bathymetry source for THOMAS JEFFERSON is almost exclusively the SIMRAD EM1002, the vertical-beam echosounder data for THOMAS JEFFERSON is archived in raw format

The ODOM Echotrac is inappropriate for sole use in situations requiring full bottom bathymetry coverage. The ODOM Echotrac does not meet NOAA object detection specifications. Combined ODOM Echotrac bathymetric acquisition and KLEIN 5500 side-scan sonar acquisition meets NOAA specifications for full bottom coverage and 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 was taken to avoid using the ODOM as the primary source of bathymetry in situations where the pitch or roll will cause attitude artifacts or side-lobe hits.

The ODOM Echotrac MKII was used for limited bathymetry data acquisition for projects S-A902-TJ-05 and OPR-J323-TJ-05. It is also used to provide a depth input to the Brooke Ocean MVP System. Hypack was used as the acquisition software package.

Kongsberg SIMRAD EM 1002 Multibeam Echosounder

The Kongsberg SIMRAD EM1002 system is a single-frequency, digital recording multibeam echosounder with an operating frequency of about 95 kHz. The SIMRAD 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 SIMRAD 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 SIMRAD 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. The SIMRAD EM1002 is capable of bottom detection in depths from 5-1000m. Aboard the THOMAS JEFFERSON the SIMRAD EM1002 is used in depths from 10m-1000m.

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 outerbeam roll calibration coefficient is determined before starting acquisition for a project. This value is entered into the acquisition software and cannot be post processed.

Acoustic backscatter data is acquired concurrently with bathymetry information. The SIMRAD acoustic backscatter data is automatically slant-range corrected by the SIMRAD operating system. Acoustic backscatter data is not used for generating hydrographic products; it is usually archived or used to generate third party and scientific data products.

The SIMRAD EM1002 does not meet NOAA specifications for object detection in shallow water (<20m). EM1002 data must be acquired with either side-scan sonar or high-resolution multibeam echosounder data (e.g. RESON 8125) to meet NOAA object detection specifications in shallow water.

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

The best expected performance of the SIMRAD 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, swell, tide zoning error, and sound velocity spatial and temporal distribution.

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 windows based Kongsberg seafloor Information System (SIS) is used to acquire these data.

RESON SeaBat 8101 Multibeam Echosounder

The RESON SeaBat 8101 multibeam echosounder system is a single-frequency, digital-recording multibeam echosounder with an operating frequency of 240 kHz. The RESON 8101 transducer consists of a curved transmitter array and solid cylindrical receiver array deployed on a retractable arm from the hull of Survey Launch 3102. The RESON 8101 forms 101 beams each of which has a 1.5° across-track beam footprint for a maximum total swath width of 150°. Each beam has an along-track resolution of 1.5°. The ping rate is nominally 20-30 Hz, but may vary according to user specification. The RESON 8101 sonar is capable of bottom detection in depths from 3-300m. Aboard Survey Launch 3102 the RESON 8101 is used in depths from 3-60m.

The RESON 8101 does not perform active beam steering. The curved faces of the transducer transmit and receive arrays are designed to mechanically steer acoustic energy.

While the primary use of the RESON 8101 is determining bathymetry, acoustic backscatter data from this sonar is recorded and archived. This data is recorded in “snippet” format, where the acoustic backscatter strength for each ping/beam is measured over time (on the order of hundreds of microseconds). Snippets backscatter data is not used to generate hydrographic products; it is usually archived or used to generate end-user scientific products.

The error model of the RESON 8101 has not been released to the public. For the purposes of calculating total propagated error, the RESON 8101 is assumed to have an operational frequency of 240 kHz, pulse length of 0.15ms, and a typical ping rate of 30Hz.

The outer beams of the RESON 8101 (45°-75° off nadir) do not meet NOAA specifications for object detection in water deeper than 10m. 200% bottom coverage data from the RESON 8101, under most conditions, will meet NOAA object detection specifications. RESON 8101 data acquired concurrently with side-scan sonar data meets NOAA object detection specifications.

The best expected performance of the RESON 8101, as installed on Survey Launch 3102, is to the IHO Special Order from 0-8m water depth for all beams, to IHO Special Order from 0-45° off nadir in depths from 8-20m, and to IHO Order I for the full swath in depths greater than 8m. Actual performance will vary according to sea state, swell, tide zoning error, and sound velocity spatial and temporal distribution.

The RESON 8101 was used simultaneously with the hull mounted KLEIN 5000 Side Scan Sonar on Launch 3102. Initially this configuration led to significant electronic interference for the RESON 8101 data. Grounding the RESON 8101, RESON 8101 power supply, and the KLEIN 5000 mitigated this problem. Although there is still some interference with the RESON 8101 data when both systems are operating, the RESON 8101 data were acceptable for general bathymetry.

The software acquisition package TEI ISIS is used to acquire data with the RESON 8101.

RESON SeaBat 8125 Multibeam Echosounder

The RESON SeaBat 8125 multibeam echosounder is a single-frequency, digital-recording multibeam echosounder with an operating frequency of 455 kHz. The RESON 8125 transducer consists of a flat transmitter array and solid cylindrical receiver array deployed on a retractable arm from the hull of Survey Launch 3101.

The RESON 8125 forms 240 beams each of which has a 0.5° across-track beam footprint for a maximum total swath width of 120°. Each beam has an along-track resolution of 1°. The ping rate is nominally 20-40 Hz, but may vary according to user specification. The RESON 8125 sonar is capable of bottom detection in depths from 3-120m. Aboard Survey Launch 3101 the RESON 8125 is used in depths from 4-40m.

The RESON 8125 performs active beam steering to correct for sound velocity at the transducer head using an ODOM Hydrographic Systems Digibar Pro sea surface sound velocity sensor. This sensor will be discussed in more detail in the Sound Velocity Equipment section.

While the primary use of the RESON 8125 is determining bathymetry, acoustic backscatter data from this sonar is recorded and archived. This data is recorded in "snippet" format, where the acoustic backscatter strength for each ping/beam is measured over time (on the order of hundreds of microseconds). Backscatter snippet data is not used to generate hydrographic products; it is usually archived or used to generate end-user scientific products.

The error model of the RESON 8125 has not been released to the public. For the purposes of calculating total propagated error, the RESON 8125 is assumed to have an operational frequency of 455 kHz, a pulse length of 0.15ms, and a typical ping rate of 40Hz. The RESON 8125 meets NOAA specifications for object detection in shallow water.

The best expected performance of the RESON 8125, as installed on Survey Launch 3101, is to the IHO Special Order standard. Actual performance will vary according to sea state, swell, tide zoning error, and sound velocity spatial and temporal distribution.

A minor "wobble" was observed with the RESON 8125 data during this reporting period. Although this wobble did not exceed the error budget, it is noticeable in the data. Currently the cause of the wobble is believed to be mounting bolts not completely tightened.

A.2. Acoustic Imaging Equipment

KLEIN 5500 High-speed Side Scan Sonar

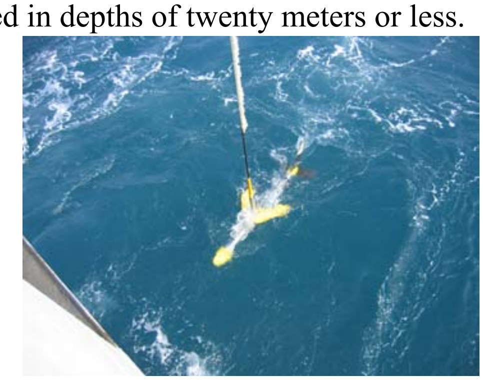
The KLEIN 5500 high-resolution side-scan sonar system is a digital-recording, beam-forming acoustic imagery device with an operating frequency of 455 kHz and vertical beam angle of 40°. The KLEIN 5500 system consists of a KLEIN towfish, a Transceiver/Processing Unit (TPU), and a computer for user interface. Stern-towed units also include a tow cable telemetry assembly. There are two configurations for data acquisition using the KLEIN 5500 system: stern-towed and hull-mounted.

The KLEIN 5500 system is distinct from other commercially-available side scan sonars in that it forms 5 simultaneous, dynamically-focused receiver beams per transducer face to improve along-track resolution. This improves along-track resolution to approximately 30cm 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 0.3m resolution meets the NOAA Hydrographic Surveys Specifications and Deliverables Manual (HSSDM) for object detection. TEI ISIS is used to acquire data with the KLEIN 5000 side scan sonar.

Stern-Towed Configuration
Aboard THOMAS JEFFERSON, side-scan sonar acquisition is performed with a stern tow. The towfish is deployed from DT Marine electric-hydraulic winch spooled with approximately 300m of armored steel coaxial cable encased in a green haired fairing. The cable is run through a block attached to a C-frame on the starboard side of the fantail. A yellow metal depressor wing is mounted to the body of the towfish at the cable connection point. Vertical and lateral stabilizing fins are attached to the tail end of the towfish. A Todco cable counter monitors the amount of cable out, which is logged in the acquisition software.

Hull-Mounted Configuration
Aboard Survey Launch 3102, the towfish is mounted to an aluminum sled using omega brackets. The hull-mounted configurations are used in depths of twenty meters or less.

Hull-Mount Configuration



Towed Configuration

A.3. MANUAL SOUNDING EQUIPMENT

DIVERS LEAST DEPTH GAUGE

The divers least depth gauge is a hand-held device that uses pressure to determine depth of water over a discrete point (e.g. mast of a shipwreck). A raw sounding obtained during a dive is corrected with verified tides and a sound velocity profile acquired in the vicinity of the object. The sound velocity profile is acquired from THOMAS JEFFERSON or one of the launches.

LEAD LINES

Lead lines are composed of brass or bronze wire that is encased in dark red cotton tiller rope and marked at predetermined intervals. Lead lines are used for acquiring soundings in very shallow or restricted waters, areas where an echosounder will have extreme difficulty in resolving the water bottom (e.g. kelp or eelgrass), and to perform confidence checks against acoustic echosounders and/or divers least depth gauges. Leadlines aboard THOMAS JEFFERSON and Survey Launches 3101 and 3102 are marked in whole meters and decimeters. An alternative method of determining manual depths is to use a steel engineering tape with a lead attached. Lead lines were calibrated in January 2005. Calibration documents are located in Appendix II of the 2005 Hydrographic Systems Certification Report, 17 May 2005.

A.4. POSITIONING AND ORIENTATION EQUIPMENT

A basic requirement of multibeam hydrography is accurate ships position and attitude data during data acquisition. THOMAS JEFFERSON uses inertial positioning/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 system outputs position information one time per second. Best expected position accuracy with the DSM212L system is less than one meter with 5 or more space vehicle vectors in the solution. This system is very accurate in the long term (>5 min) but subject to short period noise.

Inertial position calculations on THOMAS JEFFERSON, Survey Launch 3101, and Survey Launch 3102 are provided by an Applanix POS/MV Model 320 v. 3. 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. The POS/MV position solution is not sensitive to short period noise, but its accuracy decays rapidly over time.

The blended DGPS and 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 ms^{-1} velocity accuracy. These parameters are monitored in real time during acquisition using the POS/MV user interface software.

Survey Launches 3101 and 3102 are equipped with Precise Timing, a multibeam sonar acquisition configuration which applies a time stamp *at the point of acquisition* to all incoming sonar, attitude, and positioning data. The timing message is generated by the POS/MV and synchronizes the launch RESON system time with the POS/MV UTC time. Although Precise Time reduces the effect of time latency on multibeam data, corrections for residual time latency biases must still be made via a patch test.

The Heave Bandwidth Settings were changed frequently depending on the long-period motion expected from Survey Launch 3101 and 3102.

Both launch POS/MV systems utilized true heave for a post processed heave solution.

Further documentation on Precise Timing may be found in Appendix V of the 2005 Hydrographic Systems Certification Report, 17 May 2005.

A.5. Sound Velocity Profilers

Sea-Bird SBE19/19+ CTD Profilers

Sound velocity correction is essential for multibeam hydrography. THOMAS JEFFERSON and SURVEY LAUNCH 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 DeepCat CTD profiler with strain gauge pressure sensor. The DeepCat is capable of CTD profiling at depths from 0-3400m. Post-calibration initial accuracy specifications were not available. 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 DeepCat is deployed using an electric-hydraulic winch with approximately 500m steel cable.

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 0.005 °C, conductivity 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 2004-2005 winter in-port period. Calibration documents are contained in Appendix II of the 2005 Hydrographic Systems Certification Report (HSCR), 17 May 2005.

Brooke Ocean Moving Vessel Profiler

The MVP100 system is a self-contained profiling system capable of sampling water column profiles to 100m depth from a vessel moving up to 12 knots, and deeper depths at slower speeds. The system provides vertical profiles of oceanographic data such as sound velocity and depth for various operations including the calibration of multi-beam sounder system for hydrographic operations. The MVP100 is completely autonomous and can be controlled by computer without the requirement for personnel on deck. The system consists of a single or multi-sensor free fall fish, and integrated winch and hydraulic power unit, towing boom and a remotely located user interface controller.

The Brooke Ocean MVP is taking constant measurements and importing real time data of the water column into the Kongsberg SIS computer aboard the THOMAS JEFFERSON. The MVP unit is also used to take CTD casts for data processing. Having the MVP has increased productivity simply because the ship does not have to stop operations and set up to take a CTD cast off the port side of the ship. While acquiring data underway, the fish is deployed and recovered without having to slow operations, thus multi-beam data acquisition still continues. As well as being imported real-time, the CTD cast data is also post processed using the *Velocwin* computer program, which is discussed further in section B.2 of this report.

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 Kongsberg SIMRAD EM1002 and RESON 8125 systems both require SSVS data.

Applied Microsystems Smart SV & T Probe

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 0.05 ms^{-1} and temperature accuracy is 0.05 °C. Empirical observations of drift show a sound velocity drift of approximately 0.5 ms^{-1} $yr^{-1}$and temperature drift of approximately 0.05 °C yr^{-1}. 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 to the SIMRAD EM1002 system at a rate of 10 Hz. Data are sent in real time to the Kongsberg EM1002 transducer.

The AML Smart SV&T Probe was returned to the manufacturer for calibration during the 2004-2005 winter in-port period. Estimated error of the Calibration documents are contained in Appendix II of the 2005 HSCR, 17 May 2005.

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^{-1}. Aboard Survey Launch 3101, the Digibar Pro is mounted to an aluminum sled, aft of the RESON 8125 transducer. Sea surface temperature and sound velocity values are output to the RESON 8125 system at a rate of 10 Hz. Data are sent in real time to the RESOM 8125 processor unit.

The Digibar Pro was returned to the manufacturer for calibration during the 2004-2005 winter in-port period. Calibration documents are contained in Appendix II of the 2005 HSCR, 17 May 2005.

B. Software Systems

B.1 Acquisition Software

Coastal Oceanographics *Hypack Max*

Coastal Oceanographics *Hypack Max* is a multi-function marine survey software package. *Hypack Max* is used for vessel navigation during sidescan and multibeam acquisition, and acquisition of vertical-beam echosounder data. Survey lines, vessel position with respect to lines, and various navigation parameters are displayed on a screen both at the acquisition station and on a repeater screen for the helmsman or coxswain. Hypack Max is also used to acquire ODOM vertical beam data on THOMAS JEFFERSON as well as detached positions from all three platforms

Kongsberg Simrad *SIS*

Kongsberg Seafloor Information System (SIS) is a windows based acquisition software package providing real time coverage, sensor control and monitoring for the EM 1002 multibeam echosounder. SIS was installed July 2005.

Triton Elics International Imaging *ISIS*

TE *Isis* is an acquisition software package providing imagery displays, area coverage displays, and real-time ping strength displays. *Isis* is used for acquisition of side-scan sonar imagery on THOMAS JEFFERSON and for RESON 8125 and 8101 multibeam and side-scan sonar acquisition aboard Survey Launches 3101 and 3102.

B.2. Processing Software

CARIS *HIPS v5.4*

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* 5.4 uses statistical modeling to create uncertainty-weighted Bathymetry with Associated Statistical Error (BASE) surfaces to assist the hydrographer in data cleaning and hydrographic product generation.

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, and mosaic generation. The towpoint entry for the hull mounted side scan sonar HVF was eliminated from the launch HVF's due to problems with processing software CARIS. The reference point was changed from the IMU to towfish for this change.

CARIS *HIPS AND SIPS v6.1*

CARIS HIPS and SIPS v6.1 is used for CUBE (Combined Uncertainty Bathymetry Estimator) surface generation and surface directed editing. Surface directed editing allows the user to utilize the different layers created for the surface to clean and define just those areas in need. User Hypothesis selection was not done for the time period covered by the DAPR.

As errors in the software are resolved, some basic processing steps are done using the software including: tide, sound velocity, vessel offset correction, data cleaning, and data conversion.

CUBE surfaces and finalized CUBE surfaces are the bathymetry product provided.

ERROR MODELING IN CARIS HIPS

A table describing values used to compute TPE of soundings acquired by THOMAS JEFFERSON and her launches is contained in Appendix I of the 2005 Hydrographic Systems Certification Report, 17 May 2005.

HSTP PYDRO

HSTP *PYDRO* is a proprietary 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 granted 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 (PSS), which is delivered to the Atlantic Hydrographic Branch as part of the final submission package.

HSTP *VELOCWIN*

HSTP *Velocwin* is a proprietary 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. These sound velocity files are applied to the data in CARIS *HIPS*. *Velocwin* is also used to check the accuracy of sound velocity casts, to calculate least depth from a Divers Least Depth Gauge, and to archive sound velocity information for the National Oceanographic Data Center.

MAPINFO PROFESSIONAL

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.

B.3. VISUALIZATION SOFTWARE

INTERACTIVE VISUALIZATION SYSTEMS *FLEDERMAUS*

IVS *Fledermaus* is an interactive digital terrain model visualization software package. Digital terrain models, side-scan mosaics, and ancillary data are imported into *Fledermaus* for the creation of scenes (user-specified zooming interface) and fly-through (movies). *Fledermaus* is not used for hydrographic product generation, but is frequently used for scientific end user product generation.

UNIVERSITY OF NEW HAMPSHIRE *GEOZUI 3D*

UNH *GeoZui 3D* is an interactive, zooming visualization software package. Data is imported and converted to gridded universal terrain models (GUTMs), which the user may then zoom through, rotate, and view the data in various ways. *GeoZui 3D* is not used for hydrographic product generation, but is frequently used for detailed inspection of BASE surface data, presentation, and scientific end user product generation.

C. Acquisition Methods

THOMAS JEFFERSON and her launches acquire hydrographic data according to the Letter Instructions for each survey. The Letter Instructions for a given survey typically call for 200% bottom coverage of the survey area, and generally gives the field party discretion as to how that 200% bottom coverage is achieved. Under certain conditions, e.g. a desired IHO Special Order survey, the Letter Instructions will specify acquisition method.

The two most commonly-used methods to achieve 200% bottom coverage are 200% side-scan sonar with vertical beam bathymetry, and 100% side scan sonar + 100% multibeam bathymetry coverage.

200% Side Scan Sonar + VBES

Two line plans (100% coverage and 200% coverage) are developed for the desired range scale. Line spacing for the first 100% coverage is 120m at the 75 meter range scale and 160m at the 100 meter range scale. The line spacing for the second 100% coverage is identical to the spacing for the first 100%, and the first line of the second 100% coverage is offset by half the line spacing.

As VBES is the primary source of bathymetry for this type of survey, lines are run perpendicular or near perpendicular to the expected bathymetry contour. VBES data is logged both digitally and in analog paper record format. Least depths of features located by the side scan sonar must be developed by MBES, closely-spaced VBES, or Divers Least Depth Gauge.

In very shallow water (<10m), flat sandy bottoms, and areas with a low probability of anthropogenic artifacts, 200% SSS is often more efficient than attempting 100% MBES + 100% SSS coverage.

100% Side Scan Sonar + 100% MBES

Two line plans are developed: one 100% SSS line plan and one 100% MBES line plan. Line spacing for the SSS line plan is identical to the spacing discussed above. Line spacing for the MBES line plan varies from three to five times water depth. Data acquired at wide line spacings are examined frequently in CARIS HIPS to determine if outer beam data is acceptable. If necessary, outer beam data is rejected and data is acquired at a more conservative line spacing.

As MBES is the primary source of bathymetry for this type of survey, lines are run parallel or near parallel to the expected bathymetry contour. Running perpendicular to the contour causes rapid changes in the swath width, and is inefficient compared to running parallel to the depth contour. Least depths of features located by side scan sonar or multibeam echosounder may be developed by RESON 8125 MBES or Divers Least Depth Gauge should the basic bathymetry coverage be insufficient or undesirable for that purpose.

100% MBES + 100% SSS surveys are most desirable in areas of rapidly changing bottom type, rapidly changing bathymetry, areas of prior glaciations, ports and harbors, and areas with a high probability of anthropogenic artifacts.

100% MBES

While uncommon for near-shore or shallow-water navigable area surveys, this type of survey is typically used for offshore/deep-water navigable area surveys and for special-purpose surveys. Examples of special-purpose surveys include surveys of marine protected areas or surveys of geologically important areas. Lines are run parallel to depth contours where feasible. For these surveys, the NOAA multibeam bathymetry coverage specification of 3.3 pings per 3 meters of water bottom may be waived. Backscatter data (both SIMRAD backscatter and RESON Snippets) are recorded.

Crosslines

Crosslines are acquired as an additional confidence check to the performance of echosounder data. According to the 2005 Field Procedures Manual, a VBES survey requires crossline mileage equal in length to 8% of the total linear nautical mileage of mainscheme data, and an MBES survey requires crossline mileage equal in length to 5% of the total linear nautical mileage of mainscheme 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.

Coverage Determination

THOMAS JEFFERSON tested different coverage requirements including object detection and coverage. All MBES coverage exceeded previous NOS coverage requirements.

Side Scan Sonar coverage was determined using one meter resolution mosaics overlaid on the survey area.

D. Corrections to Echo Sounding

D.1. SOUND VELOCITY

SBE19 Conductivity, Temperature and Depth (CTD) Profilers

Sound velocity profiles for the THOMAS JEFFERSON are acquired with a Sea-Bird Electronics SeaCat SBE19 CTD profiler. Sound velocity profiles for Launch 3101 and 3102 are acquired with Sea-Bird Electronics SeaCat SBE19+ CTD profilers. Raw conductivity, temperature and pressure data are processed using the program **Velocwin** which generates sound velocity profiles for CARIS **HIPS and SIPS 5.4**. Sound velocity correctors are applied to MBES and VBES soundings in CARIS **HIPS and SIPS 5.4** during post processing only. Calibration reports for the SBE19/19+ CTD profilers are included in Appendix II of this report.

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

The sound velocity casts are extended in **Velocwin** and applied to the Simrad MBES and RESON MBES data in CARIS **HIPS and SIPS 5.4** during post processing.

Kongsberg SIMRAD Surface Sound Velocity System

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

RESON 8125 Surface Sound Velocity System

Survey Launch 3101 is equipped with an Odom Hydrographic Systems Digibar Pro sea surface sound velocity sensor. The sensor is used to measure sound velocity at the depth of the RESON 8125 transducer. This data is used for real-time beam-steering at the transducer head. The sensor is mounted just aft of the transducer on the hull mounted equipment sled.

D.2. WATER LEVEL CORRECTORS

Soundings are initially reduced to Mean Lower-Low Water (MLLW) using predicted tides or preliminary water level data from the local, primary tide gauge obtained from the Center for Operational Oceanographic Products and Services (CO-OPS) web site. For all projects, a simple predicted tide table is applied to MBES data in CARIS HIPS and SIPS during the Merge process. A zone-corrected verified water level or approved water level tide file is supplied by CO-OPS, which is then reapplied during data processing in CARIS **HIPS and SIPS 5.4**.

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

Heave, pitch, roll, and navigation latency bias 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 Configuration Files (VCFs and HVFs). These offsets and biases are applied to the sounding data during processing in CARIS HIPS and SIPS 5.4. The VCFs, HVFs and Patch Test data are included with the digital data. A Patch Test or verification of certain biases is also performed at the start of each project before acquiring MBES data in the new survey area. The Patch Test Report for each vessel can be found in Appendix A of the CARIS Documentation for Launch 3101 Report and Appendix A of the CARIS Documentation for Launch 3102 Report, both dated August 2005.

D.4. VESSEL OFFSETS AND DYNAMIC DRAFT CORRECTORS

THOMAS JEFFERSON OFFSETS AND DYNAMIC DRAFT

A partial re-survey of THOMAS JEFFERSON vessel offsets was conducted on March 10, 2005 by NGS personnel. This resurvey was in response to a change in POS/MV antenna configuration following mast work during the 2004-2005 winter inport period. The procedure and results are in the Offset Confirmation Report contained in Appendix III of the 2005 Hydrographic System Certification Report.

Preliminary static draft measurements are made at the beginning of each leg. Static draft for THOMAS JEFFERSON is measured using a bubble tube located in lower survey stores. Additional static draft measurements will be made as needed with changing conditions, such as engineers switching ballast, or if on a particularly long leg where a large amount of fuel consumption occurs.

Dynamic draft measurements were made on THOMAS JEFFERSON on March 24-25, 2005. Refer to Appendix I of the 2005 Hydrographic System Certification Report for detailed results.

LAUNCH 3101 OFFSETS AND DYNAMIC DRAFT

Vessel offset measurements were made on Launch 3101 on August 19, 2005 by NGS personnel. Static draft measurements for Launch 3101 were determined using a sight tube. Site tube measurements were made from a reference point with respect to the IMU. These measurements were made at the beginning and end of each working day while the vessel is dead in the water. Dynamic draft measurements were made on August 24, 2005. Refer the CARIS Documentation for Launch 3101 Report, August 2005 for detailed results.

LAUNCH 3102 OFFSETS AND DYNAMIC DRAFT

Vessel offset measurements were made on Launch 3102 on August 25, 2005 by NGS personnel. Static draft measurements for Launch 3102 are determined using a sight tube. Site tube measurements were made from a reference point with respect to the IMU. These measurements were made at the beginning and end of each working day while the vessel is dead in the water. Dynamic draft measurements were made on August 29, 2005. Refer to the CARIS Documentation for Launch 3102 Report, August 2005 for detailed results.

E. Data Processing and Quality Control

E.1. Bathymetry

Raw bathymetry data (XTF, SIMRAD, and HYPACK VBES) 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, water level, sound velocity, attitude, and navigation data are applied as described in sections D.1. – D.4. Bathymetry lines are then merged. Following merge, Total Propagated Error (TPE) is calculated for each sounding. For a more detailed explanation of TPE calculation of multibeam and vertical beam echosounder data, refer to NOAA Ship THOMAS JEFFERSON BASE Surface SOP v 1.3 (26 October 2004).

Vertical Beam Bathymetry

When vertical beam echosounder is the sole source of bathymetry (e.g. 200% SSS + VBES survey), vertical beam echosounder data is loaded into CARIS HIPS as described above. The data is then examined and cleaned in CARIS Singlebeam Editor. Analog paper records are used to provide extra information to the hydrographers during data cleaning.

If the survey includes both VBES and MBES as the primary source of bathymetry (e.g. ship acquire VBES and launches acquire MBES), then VBES data will be included into a BASE Surface with the MBES bathymetry. Total propagated error for the VBES system assumes that a vertical-beam echosounder is equivalent to a multibeam echosounder with one beam. Resolution of the VBES BASE Surface will be equal to the resolution of the adjacent MBES BASE Surface.

If the primary source of bathymetry for a survey is MBES, VBES data is acquired but not processed, and is immediately archived in raw format. This data should not be used for creation of any hydrographic or scientific product.

Multibeam Bathymetry

After computation of TPE, multibeam lines are either used to create a new CUBE Surface or are added to an existing CUBE Surface. The resulting layers are analyzed by the data processor to identify blunders, systematic errors, where the CUBE surface failed, and to identify significant waterbottom features. Blunders are rejected by the data processor in CARIS Subset Editor (multi-line spatial view). Systematic errors are identified and documented by the data processor. If the systematic error can be corrected it is done at this time.

To obtain optimal resolution of bathymetry data, several different CUBE Surfaces of various resolutions are created. Guidelines for surface resolutions specified in either the Letter Instructions of Field Procedures Manual are followed except where either higher resolution is desired or where a particular system doesn't support the specified resolution.

Traditional CARIS crossline certifications are no longer performed. The error modeling inherent in the CUBE Surface concept allows the hydrographer to examine the surface and determine whether the data of which the surface is created is acceptable or not.

GEOZUI and Fledermaus are used to assist the data processor in identifying data outliers and systematic errors harder to detect with other methods.

Hypothesis selection available in CARIS 6.0 are not currently used for CUBE surfaces.

E.2. Imagery

Side scan sonar data are converted from *.xtf (TEI ISIS raw format) to HDCS**.** Side scan data are processed using CARIS SIPS 5.4.

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 5.4. 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, selecting contact position, and creating a contact snapshot (*.tif) image.

Side scan sonar coverage is determined by using mosaics generated in CARIS SIPS 5.4 and imported into MapInfo. 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, in order to meet the requirements set forth in the Hydrographic Survey Letter Instructions.

E.3. Bathymetry Analysis and Feature Classification

Following data cleaning in CARIS HIPS and SIPS, uncertainty-weighted bathymetry grids and CARIS contacts are inserted into a PYDRO Preliminary Smooth Sheet (PSS). Side Scan Sonar (SSS), Multi Beam Echo Sounding (MBES) and Vertical Beam Echo Sounding (VBES) data are imported into PYDRO using the "Insert CARIS Line

Features" 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 position, AWOIS item positions, surrounding depths, contact cross references, and charting recommendations. Each contact is reviewed, and information flags are set accordingly. The available flags are "Resolved", "Rejected", "Primary Hit", "Significant", "Chart", and "DTON" (see Figure 14).

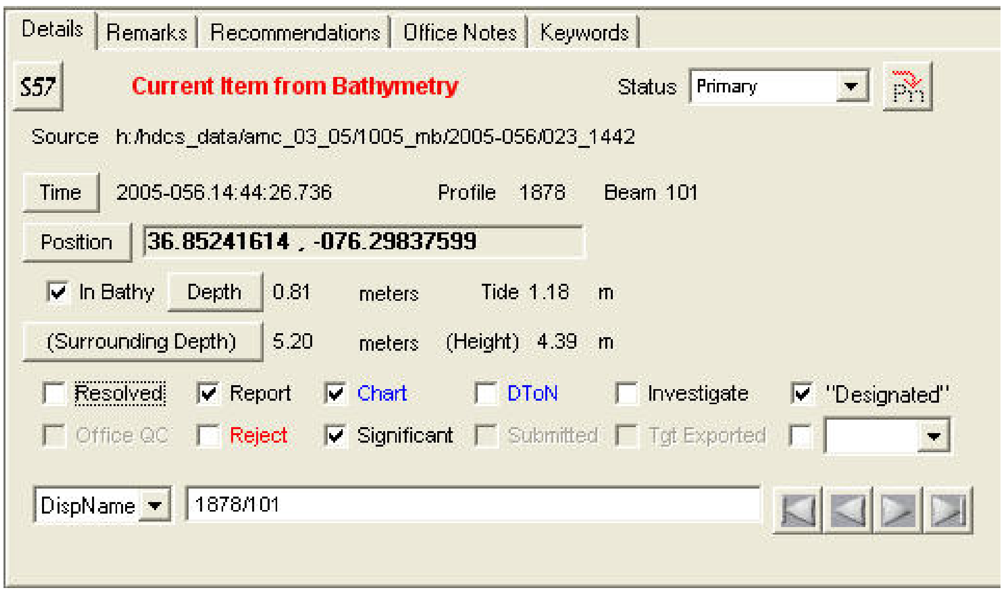


Figure 14

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 by multibeam. 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, divers least depth gauge, or vertical beam echosounder.

Any items that are to be addressed in the Item Investigation section of the Descriptive Report are flagged as “Chart”. Examples of Chart 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 bedforms which have not been previously noted on the chart. Items which have the “Chart” 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.

E.4. Product Generation

The ship’s bathymetry product is a collection of finalized CUBE surfaces, which maintains the optimal resolution for a given depth range and allows for more efficient and objective cartographic representations. Although OCS is still the primary “ship’s customer”, there are a number of other users who have a great interest in bathymetric models produced by NOAA’s hydrographic survey platforms.

Side scan sonar data is used to create high-resolution mosaics of the seafloor. These mosaics are used to identify contacts on the sea floor, as well as general bottom type. When permitted by Letter Instructions these mosaics are used to determine where to acquire full multibeam coverage and developments. In areas without full multibeam coverage, side scan sonar data are analyzed for significant individual contacts and subsequent development.

The Pydro Preliminary Smooth Sheet (PSS) is the ship's record of the survey, from which the final survey is created at the Atlantic Hydrographic Branch. The PSS consists of the final CUBE surface collection and S-57 classified features.

Data visualization products, including Gridded Universal Terrain Models (GUTMs) and IVF Fledermaus Scene and Movie files, are generated as end user scientific products and as media relations products. These products are not submitted for cartographic purposes, and should not be used for navigation.

RESON Snippets data and SIMRAD acoustic backscatter data are collected during multibeam data acquisition, but are not used for bathymetric processing. Backscatter mosaics are generated for end user scientific products.

The ship will occasionally produce high-resolution digital terrain models, multibeam echosounder backscatter mosaics and XYZ bathymetry grids for third party scientific users. These are special request products.

APPROVAL

As Chief of Party, I have ensured that standard field surveying and processing procedures were adhered to during these projects in accordance with the National Ocean Service Standing Instructions for Hydrographic Surveys (3/2004), the Hydrographic Surveys Specifications and Deliverables Manual (3/2003), Hydrographic Survey Directives, and the Field Procedures Manual for Hydrographic Surveying (1/2005, v 1.0).

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

Submitted:

/S/

ENS Stephen Kuzirian
Junior Officer/Hydrographer

Approved and Forwarded:

LT NOAA

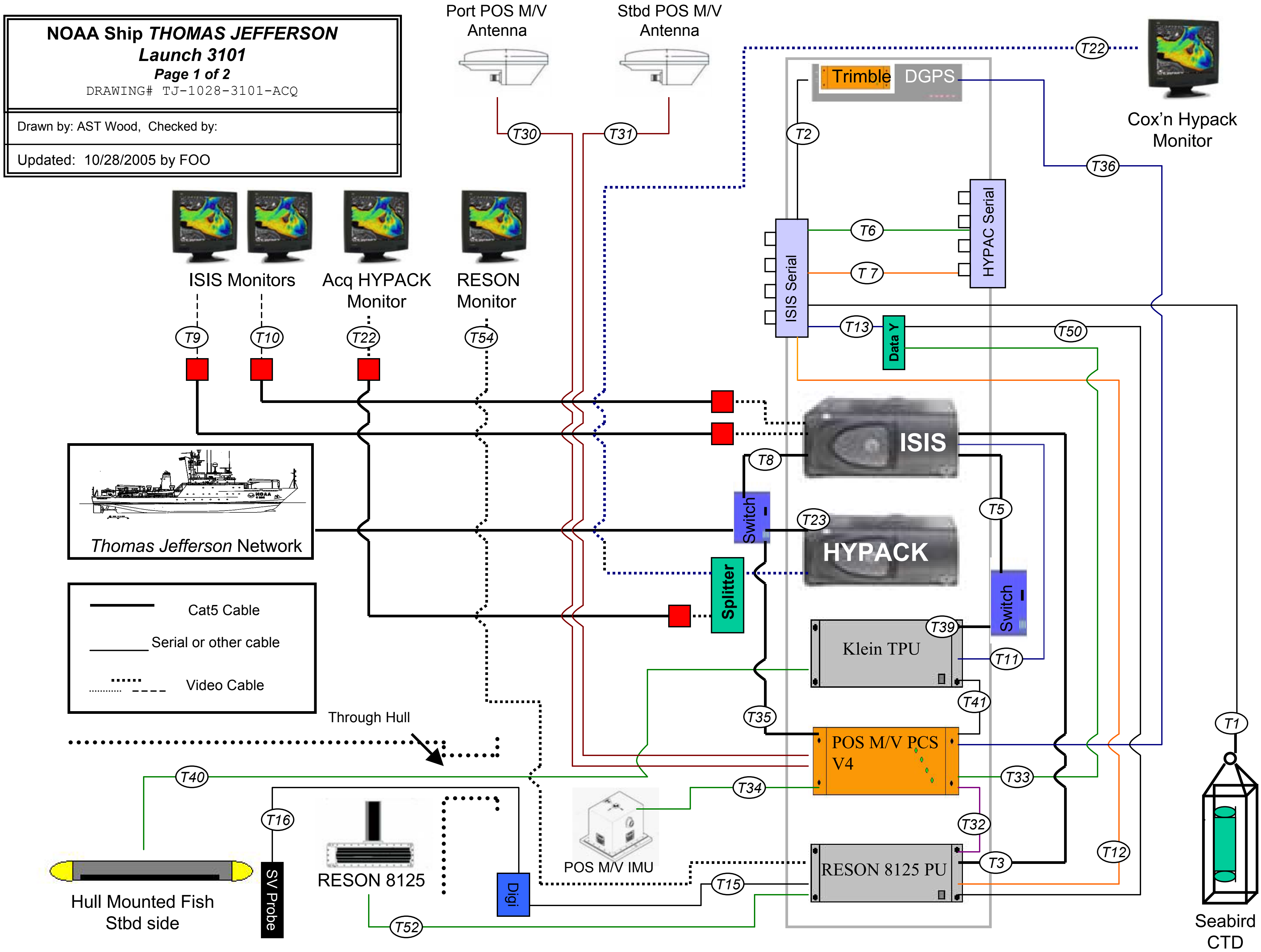
LT Marc Moser, NOAA
Field Operations Officer

CAPT Emily B. Christman, NOAA
Commanding Officer

APPENDIX I – EQUIPMENT and SOFTWARE

Equipment	Serial Number(s)	Vendor Calibration	Firmware Updated	Remarks
Reson 8101 Multibeam Echosounder	Processor 13976		12/20/2005	3102
	Transducer 089704	12/20/2005		
Reson 8125 Multibeam Echosounder	Processor 31381		5/10/2004 and 12/20/2005	3101
	Transducer 1501014	12/20/2005		
Simrad EM 1002 Echosounder	Processor 222		7/10/2005 and 3/3/2006	TJ
	Transducer 267			TJ
Klein 5500 high speed, high resolution, side scan sonar towfish	278			Hull mounted 3102
	279			Stern towed from TJ
	Klein TPU – 166			3101
	Klein TPU – 137			3102
	Klein TPU – 135			TJ
Trimble DSM212L	Launch 3102 - 0220168291			
	Launch 3101 - 0220157923			
TSS Position & Orientation System POS/MV	Launch 3102 PCS - 402	5/15/2005	9/15/2004	FW 2.16
	Launch 3102 IMU - 146		N/A	
	Launch 3101 PCS - 2207		06/2005	FW 3.0
	Launch 3101 IMU - 30		N/A	
	TJ PCS - 780			
	TJ IMU - 007			
Trimble GPS Pathfinder Pro XRS Receiver	224025052			
Diver Least Depth Gauge	68334	1/24/2005		
Seabird SBE 19 Plus SVP	4486	12/4/2004	3/22/2005	3102
Seabird SBE 19 Plus SVP	4281			LOANER
Seabird SBE 19 Plus SVP	4487	12/4/2004	3/22/2005	3101
Odom DIGIBAR-Pro Profiling Sound Velocimeter	98130-0124403	12/8/2004	N/A	3101
AML Smart SV+T SSVS	4823	11/23/2004	11/23/2004	TJ
Brooke Ocean Moving Vessel Profiler	Deck Unit (winch): 10332 AML SSVS: 4988 MVP PC: 0127560 MVP PU: 10334	11/30/2004	11/30/2004	TJ

Software	Version	Intalled
Acquisition		
Hypack Max	4.3.5.8	03/05
Isis	6.6.136.0	03/05
TEI Suite	v297	03/05
ISIS	2.5 Build 60 a1	07/05
SIS	3.0.2	03/06
Horizantal Control		
TSIP Talker	2.0	
POS/MV Controller (3102)	2.1	01/05
POS/MV Controller (3101)	3.2	08/05
Sound Velocity		
Velocwin	8.7.6	01/05
Processing		
Pydro	v5.94	07/06
MapInfo	6.5	02/04
MapBasic	5.0	
Vertical Mapper	3.0	05/05
Fledermaus	6.2	08/05
GeoZui	3.4	08/05
Grid Manipulator	Shepware	08/05
CARIS GIS	4.4a 3.0	07/05
CARIS HIPS & SIPS	5.4 HF 1-27	07/05
CARIS HIPS & SIPS	6.1 HF 1-5	11/06
Utilities		
KapConv	3.4.1	07/05
HydroMI	v5.94	
Tides and Currents	2.6	
Cygwin		10/31/2005
WorldReg	1.0	
NOAA Chart Reprojector	2.0.4	02/05


NOAA Ship THOMAS JEFFERSON
Launch 3101
Page 1 of 2
DRAWING# TJ-1028-3101-ACQ
Drawn by: AST Wood, Checked by:
Updated: 10/28/2005 by FOO
Port POS M/V Antenna
Stbd POS M/V Antenna
Trimble DGPS
Cox'n Hypack Monitor
ISIS Monitors
Acq HYPACK Monitor
RESON Monitor
ISIS Serial
HYPAC Serial
Data Y
ISIS
HYPACK
Switch
Splitter
Klein TPU
POS M/V PCS V4
RESON 8125 PU
POS M/V IMU
Thomas Jefferson Network
Cat5 Cable
Serial or other cable
Video Cable
Through Hull
Hull Mounted Fish Stbd side
SV Probe
RESON 8125
Digi
Seabird CTD
T1
T2
T3
T5
T6
T 7
T8
T9
T10
T11
T12
T13
T15
T16
T22
T23
T30
T31
T32
T33
T34
T35
T36
T39
T40
T41
T50
T52
T54

T1 Serial download/control	ISIS COM 10; 9600,8,n,1	CTD; 9600,8,n,1
T2 Serial control, TSIP	ISIS COM 4; 9600,8,o,1	TRIMBLE; 9600,8,o,1
T3 Ethernet (X) data	ISIS IP: 192.168.0.82 input	RESON PU IP: 192.168.0.83 output
T5 Ethernet data	ISIS IP: 192.168.0.83 input	LAUNCH SWITCH- **TPU Network**
T6 Serial (X)output, TELEMOUT	ISIS COM 9 output; 9600,8,n,1	HYPACK COM 8 Input; 9600,8,n,1
T7 Serial (X) output, DELPH	ISIS COM 7 input;9600,8,n,1	HYPACK COM 7 output; 9600,8,n,1
T8 Ethernet	ISIS IP: 10.48.16.25	LAUNCH SWITCH- **THOMAS JEFFERSON network**
T9 Video	ISIS Analog video output	Analog video input
T10 Video	ISIS Analog video output	Analog video input
T11 Serial (X) control	ISIS COM 1; 9600,8,n,1	KLEIN TPU COM 1; 9600,8,n,1
T12 Serial (X) control	ISIS COM 6; 19200,8,n,1	RESON PU COM 2; 19200,8,n,1
T13 Serial TIME	ISIS COM 3 input; 19200,8,n,1	Y output; 19200,8,n,1
T15 Serial SV	Digibar Pro output; 9600,8,n,1	RESON PU input; 9600,8,n,1
T16 Data cable to SV probe	Digibar Pro PU	Digibar Pro SV probe
T22 Video	HYPACK Analog video output	Analog video input
T23 Ethernet	HYPACK IP: 10.48.16.24	LAUNCH SWITCH- **THOMAS JEFFERSON network**
T30 Port GPS antenna	POS PCS antenna cable	POS PCS antenna cable
T31 Stbd GPS antenna	POS PCS antenna cable	POS PCS antenna cable
T32 Serial (X) ATTITUDE	POS PCS COM 2 output; 38400,8,n,1	RESON PU COM 3 input; 38400,8,n,1
T33 Serial (X) TIME	POS PCS COM 1 output; 19200,8,n,1	Y input; 19200,8,n,1
T34 Data cable to IMU	POS PCS Data cable	IMU Data cable
T35 Ethernet	POS PCS IP: 10.48.16.26	LAUNCH SWITCH- **THOMAS JEFFERSON network**
T36 Serial DIFF	POS PCS RTCM input	TRIMBLE DIFF output
T39 Ethernet	KLEIN TPU IP:192.168.0.91	LAUNCH SWITCH- **TPU Network**
T40 Data cable	KLEIN TPU	KLIEN TOWFISH data cable
T41 Serial POSITION	KLEIN TPU COM 2 input; 19200,8,n,1	POC PCS COM Z output; 19200,8,n,1
T50 Serial TIME	RESON PU COM 1 input; 19200,8,n,1	Y output; 19200,8,n,1
T52 Data cable	RESON PU data cable	RESON TRANSDUCER data cable
T54 Video	RESON PU Analog video output	Analog video input

POS MV v4 OUTPUTS

COM 1 TIME: $UTC; 5Hz,
COM 2 ATTITUDE: TSS Format 1; 25Hz
COM Z POSITION: $VTG; 1Hz

Ethernet Logging: *Group* 10, 102, 111, 113; 25 Hz(True Heave)
Ethernet Realtime: *Group* 3, 7, 10, 102, 111, 112, 113; 50 Hz
To SSS ISIS, MBES ISIS, and Hypack

NOAA Ship THOMAS JEFFERSON Launch 3101
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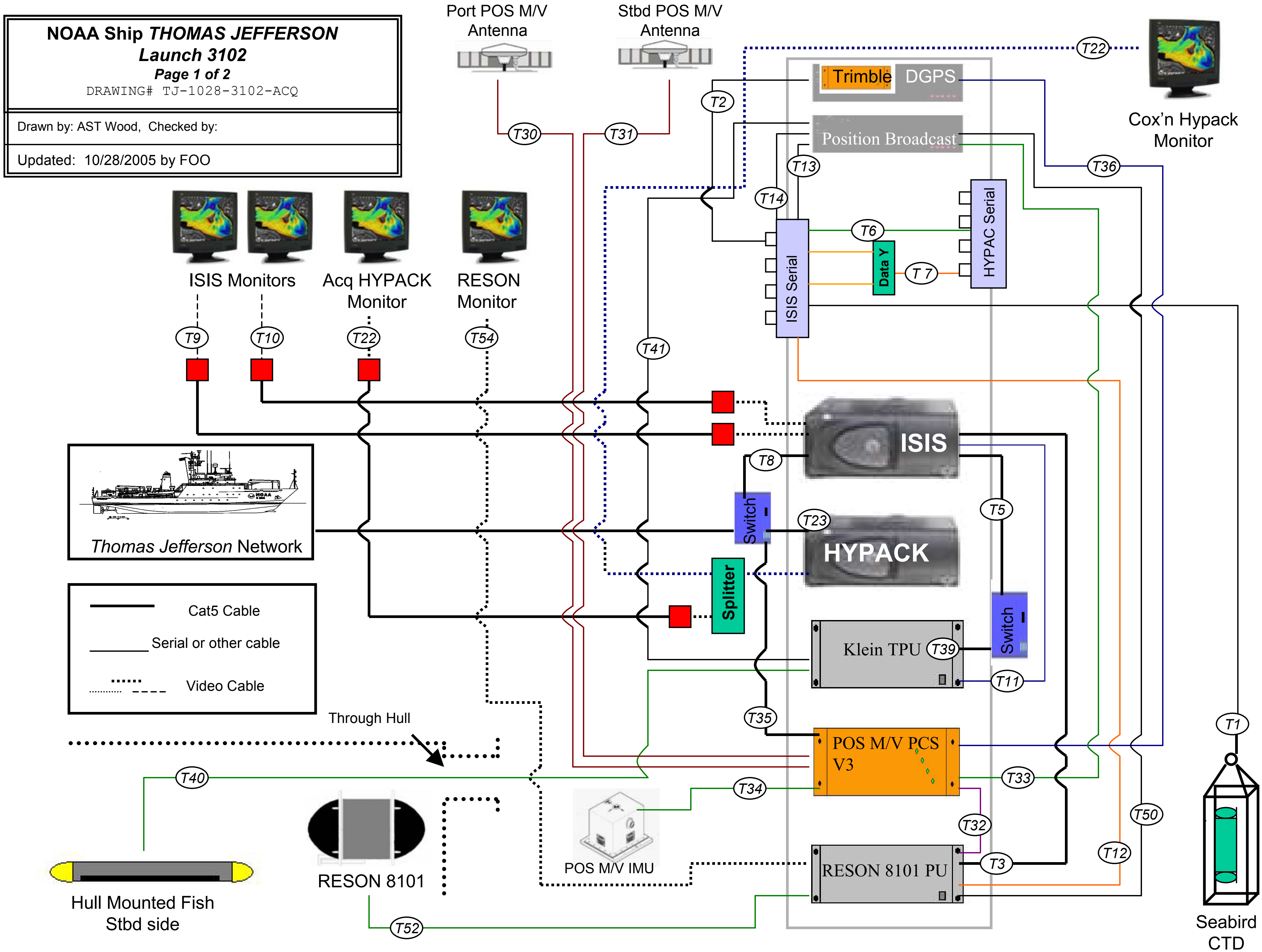
NOAA Ship THOMAS JEFFERSON
Launch 3102
Page 1 of 2
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Updated: 10/28/2005 by FOO
Port POS M/V Antenna
Stbd POS M/V Antenna
Trimble DGPS
Position Broadcast
Cox'n Hypack Monitor
ISIS Monitors
Acq HYPACK Monitor
RESON Monitor
ISIS Serial
HYPAC Serial
Data Y
ISIS
HYPACK
Switch
Splitter
Klein TPU
POS M/V PCS V3
RESON 8101 PU
Thomas Jefferson Network
Cat5 Cable
Serial or other cable
Video Cable
Through Hull
Hull Mounted Fish Stbd side
RESON 8101
POS M/V IMU
Seabird CTD
T1
T2
T3
T5
T6
T 7
T8
T9
T10
T11
T12
T13
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T39
T40
T41
T50
T52
T54

T1 Serial download/control	ISIS COM 10 9600,8,n,1	CTD; 9600,8,n,1
T2 Serial control, TSIP	ISIS COM 4 9600,8,o,1	TRIMBLE; 9600,8,o,1
T3 Ethernet (X) data	ISIS IP: 192.168.0.82 input	RESON PU IP: 192.168.0.83 output
T5 Ethernet data	ISIS IP: 192.168.0.83 input	LAUNCH SWITCH- **TPU Network**
T6 Serial (X)output, TELEMOUT	ISIS COM 9 output; 9600,8,n,1	HYPACK COM 8 Input; 9600,8,n,1
T7 Serial (X) output, DELPH	ISIS COM 7 input;9600,8,n,1 ISIS COM 8 input; 9600,8,n,1	HYPACK COM 7 output; 9600,8,n,1
T8 Ethernet	ISIS IP: 10.48.16.28	LAUNCH SWITCH- **THOMAS JEFFERSON Network**
T9 Video	ISIS Analog video output	Analog video input
T10 Video	ISIS Analog video output	Analog video input
T11 Serial (X) control	ISIS COM 1 9600,8,n,1	KLEIN TPU COM 1; 9600,8,n,1
T12 Serial (X) control	ISIS COM 6 19200,8,n,1	RESON PU COM 2; 19200,8,n,1
T13 Serial POSITION	ISIS COM 3 (MBES)input; 19200,8,n,1	BLACK BOX output; 19200,8,n,1
T14 Serial POSITION	ISIS COM 5 (SSS)input; 19200,8,n,1	BLACK BOX output; 19200,8,n,1
T22 Video	HYPACK Analog video output	Analog video input
T23 Ethernet	HYPACK IP: 10.48.16.27	LAUNCH SWITCH- **THOMAS JEFFERSON Network**
T30 Port GPS antenna	POS PCS antenna cable	POS PCS antenna cable
T31 Stbd GPS antenna	POS PCS antenna cable	POS PCS antenna cable
T32 Serial (X) ATTITUDE	POS PCS COM 2 output; 38400,8,n,1	RESON PU COM 3 input; 38400,8,n,1
T33 Serial (X) POSITION	POS PCS COM 1 output; 19200,8,n,1	BLACK BOX input; 19200,8,n,1
T34 Data cable to IMU	POS PCS Data cable	IMU Data cable
T35 Ethernet	POS PCS IP: 10.48.16.29	LAUNCH SWITCH- **THOMAS JEFFERSON Network**
T36 Serial DIFF	POS PCS DGPS input	TRIMBLE DIFF output
T39 Ethernet	KLEIN TPU IP:192.168.0.91	LAUNCH SWITCH- **TPU Network**
T40 Data cable	KLEIN TPU	KLIEN TOWFISH data cable
T41 Serial POSITION	KLEIN TPU COM 2 input; 19200,8,n,1	BLACK BOX output; 19200,8,n,1
T50 Serial POSITION	RESON PU COM 1 input; 19200,8,n,1	BLACK BOX output; 19200,8,n,1
T52 Data cable	RESON PU data cable	RESON TRANSDUCER data cable
T54 Video	RESON PU Analog video output	Analog video input

POS MV v3 OUTPUTS	COM 1 POSITION: $VTG, $GGA, $HDT, $ZDA, $UTC; 5Hz COM 2 ATTITUDE: TSS Format 1; 25Hz	Ethernet Logging: *Group* 101, 102, 111; 25 Hz(True Heave) To MBES ISIS, and Hypack

NOAA Ship THOMAS JEFFERSON Launch 3102
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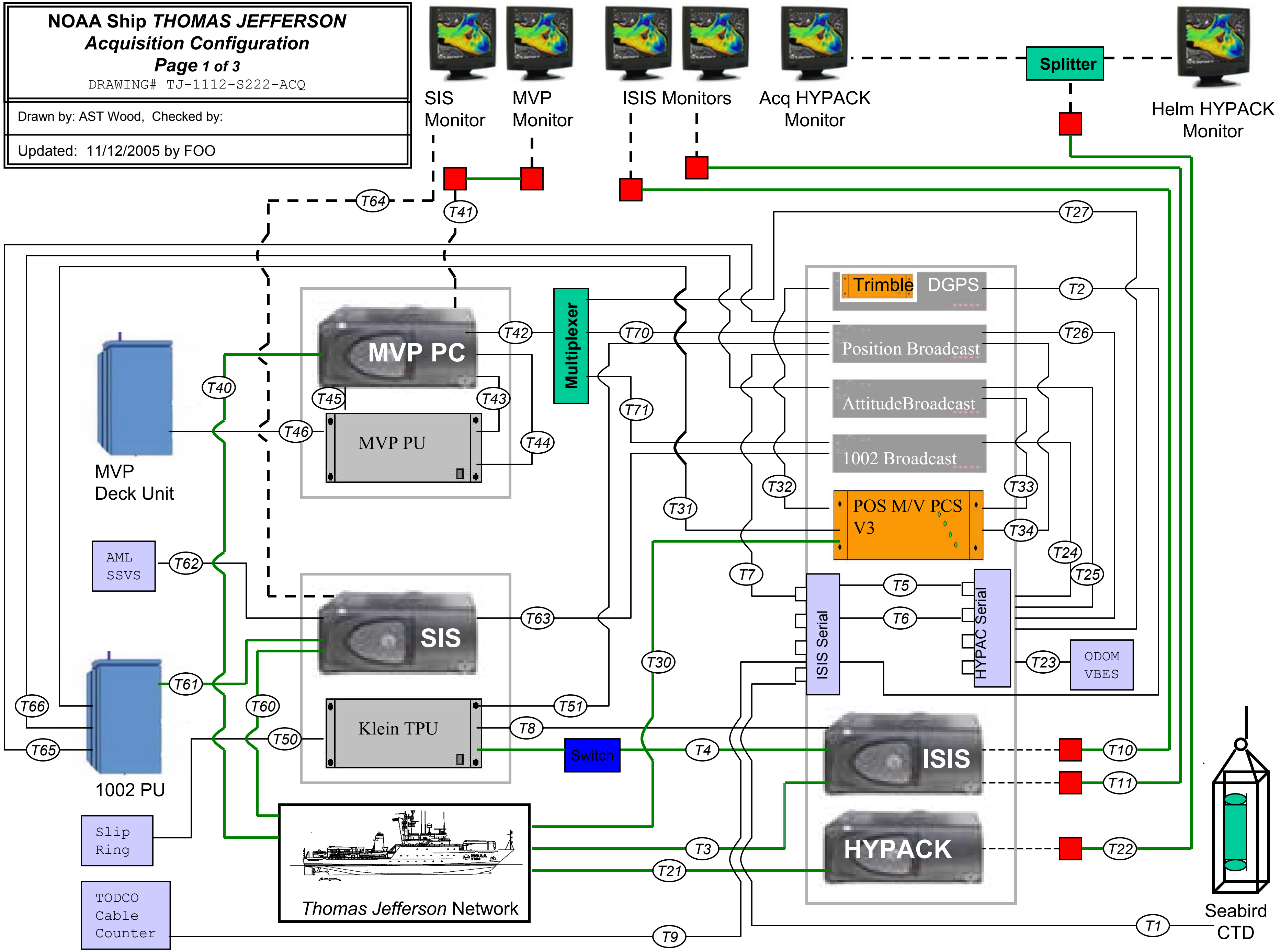
NOAA Ship THOMAS JEFFERSON
Acquisition Configuration
Page 1 of 3
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Drawn by: AST Wood, Checked by:
Updated: 11/12/2005 by FOO
SIS Monitor
MVP Monitor
ISIS Monitors
Acq HYPACK Monitor
Splitter
Helm HYPACK Monitor
T64
T41
T27
Trimble DGPS
T2
Multiplexer
MVP PC
T42
T70
Position Broadcast
T26
MVP Deck Unit
T40
T45
T43
MVP PU
T46
T44
T71
AttitudeBroadcast
1002 Broadcast
T32
T33
T31
POS M/V PCS V3
T34
AML SSVS
T62
T7
T24
T25
ISIS Serial
T5
T6
HYPAC Serial
SIS
T63
T30
T23
ODOM VBES
1002 PU
T61
T66
T60
T51
Klein TPU
T8
T65
T50
Switch
T4
ISIS
T10
T11
Slip Ring
T3
HYPACK
T22
T21
Thomas Jefferson Network
TODCO Cable Counter
T9
T1
Seabird CTD

T1 Serial download/control	ISIS COM 10 9600,8,n,1	CTD; 9600,8,n,1
T2 Serial control, TSIP	ISIS COM 4 9600,8,o,1	TRIMBLE; 9600,8,o,1
T3 Ethernet	ISIS IP: 10.48.16.23	THOMAS JEFFERSON Network
T4 Ethernet data	ISIS IP: 192.168.0.82 input	**Switch - TPU Network**
T5 Serial (X)output, TELEMOUT	ISIS COM 9 output; 9600,8,n,1	HYPACK COM 8 Input; 9600,8,n,1
T6 Serial (X) input, DELPH	ISIS COM 7 input;9600,8,n,1	HYPACK COM 7 output; 9600,8,n,1
T7 Serial POSITION	ISIS COM 3 input; 19200,8,n,1	POSITION BLACK BOX output; 19200,8,n,1
T8 Serial (X) control	ISIS COM 1 9600,8,n,1	KLEIN TPU COM 1; 9600,8,n,1
T9 Serial (X) input	ISIS COM 10 9600,8,n,1	**TODCO cable counter output**
T10 Video	ISIS Analog video output	Analog video input to RJ45 converter
T11 Video	ISIS Analog video output	Analog video input to RJ45 converter
T21 Ethernet	HYPACK IP: 10.48.16.22	THOMAS JEFFERSON Network
T22 Video	HYPACK Analog video output	Analog video input to RJ45 converter
T23 Serial VBES input	HYPACK COM 6 input; 9600,8,n,1	ODOM VBES output
T24 Serial 1002 input	HYPACK COM 4 input; 9600,8,n,1	1002 BLACK BOX output; 9600,8,n,1
T25 Serial ATTITUDE	HYPACK COM 5 input; 19200,8,n,1	ATTITUDE BLACK BOX output; 19200,8,n,1
T26 Serial POSITION	HYPACK COM 3 input; 19200,8,n,1	BLACK BOX output; 19200,8,n,1
T27 Serial DEPTH output	HYPACK COM 10 output; 9600,8,n,1	MVP Multiplexer input
T30 Ethernet	POS PCS IP: 10.48.16.30	THOMAS JEFFERSON Network
T31 Data output	POS PCS GPS PPS output	EM1002 PU PPS input
T32 Serial DIFF	POS PCS input	Trimble DIFF output
T33 Serial ATTITUDE	POS PCS COM 2 output; 19200,8,n,1	ATTITUDE BLACK BOX input
T34 Serial POSITION	POS PCS COM 1 output; 19200,8,n,1	POSITION BLACK BOX input
T40 Ethernet	MVP PC IP: 10.48.16.224	THOMAS JEFFERSON Network
T41 Video	MVP PC Analog video output	Analog video input to RJ45 converter
T42 Serial COMPOSITE	MVP PC COM 2 input; 38000,8,n,1	MVP Multiplexer output
T43 Serial Winch	MVP PC COM 1 input	MVP PU output
T44 Serial Towfish	MVP PC COM 3 input	MVP PU output
T45 Serial (X) control/data	MVP PC input/control	MVP PU output/control
T46 control	MVP PU control	MVP deck unit control
T50 control/data	KLEIN TPU control/data	KLEIN towfish control/data via Slip Ring
T51 Serial POSITION	KLEIN TPU COM 2 input; 9600,8,n,1	POSITION BLACK BOX output
T52 Ethernet data	KLEIN TPU IP: 192.168.0.83	Switch - TPU Network

T60 Ethernet	SIS PC IP:	THOMAS JEFFERSON Network
T61 Ethernet data	SIS PC IP:	EM1002 PU
T62 Serial SSVS	SIS PC COM XX input; 9600,8,n,1	AML SSVS output
T63 Serial 1002	SIS PC COM XX output; 9600,8,n,1	1002 DEPTH BLACK BOX input
T64 Video	SIS PC Analog video output	SIS PC monitor
T65 Serial POSITION	EM1002 PU COM XX input; 19200,8,n,1	POSITION BLACK BOX output
T66 Serial ATTITUDE	EM1002 PU COM XX input; 19200,8,n,1	ATTITUDE BLACK BOX output
T70 Serial POSITION	MVP Multiplexer input; 9600,8,n,1	POSITION BLACK BOX output
T71 Serial 1002	MVP Multiplexer input; 9600,8,n,1	1002 BLACK BOX output

POS MV v3 OUTPUTS	COM 1 POSITION: $VTG, $GGA, $HDT, $ZDA; 2Hz
	COM 2 ATTITUDE: SIMRAD 1000 (Tate-Bryant); 25Hz
HYPACK OUTPUTS	Shared Memory/NEMA OUTPUT: $DBT; 9600,8,n,1
SIS OUTPUTS	Depth at Nadir: $DBT; 9600,8,n,1
Multiplexer OUTPUTS	COMPOSITE: $VTG, $DBT, $GGA, $ZDA

HYPACK Devices

DELPH	delph.dll	ODOM	echotrack.dll
TELEMOUT	isis.dll	1002	nema.dll
POSITION	kinomatic.dll		
ATTITUDE	posmv3000.dll		

ISIS Devices

POSITION	NEMA0183{NOVTG}{SAVERAW}	Cable counter	XX{*10}o
DELPH	XXXXXXi0yxXXXXXXXXXX		
TELEMOUT	TELEMOUT		

NOAA Ship THOMAS JEFFERSON Acquisition Configuration
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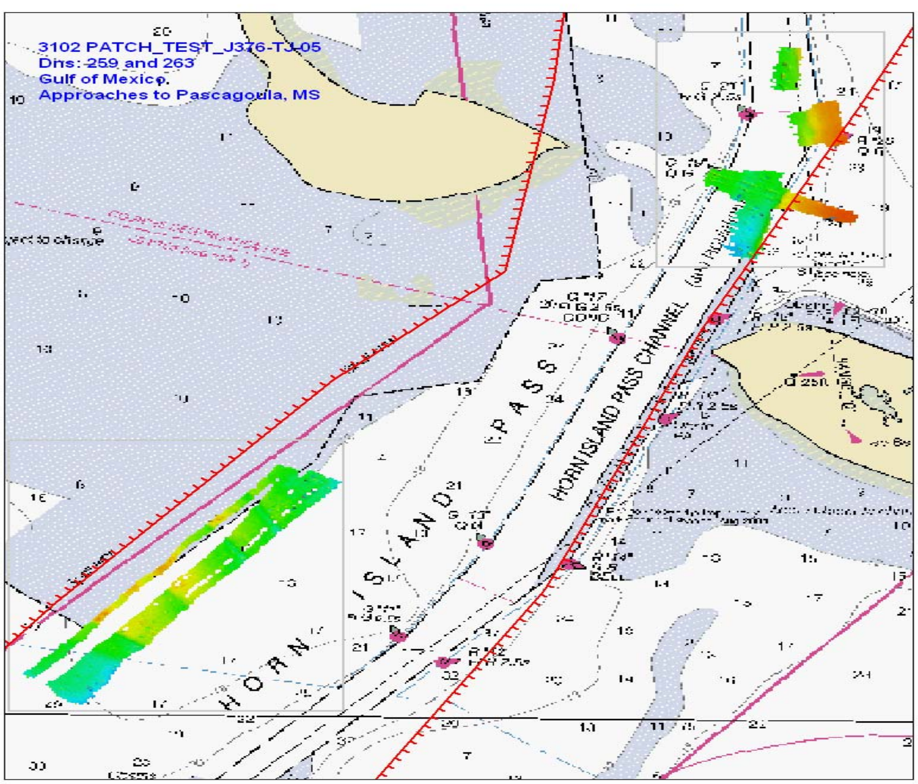
APPENDIX II – Patch Tests

FIELD CALIBRATION REPORT
THOMAS JEFFERSON's Launch 3102
Multibeam Reson SeaBat 8101
Approaches to Pascagoula, MS

Background:
Launch 3102 is a Multi-purpose Survey vessel, 31 feet in length capable of acquiring either Multi-beam bathymetry or High-resolution side scan sonar. The sonar used is a Reson SeaBat 8101. This unit is a 240 KHZ Multi-beam Echosounder System (MBES) which measures the relative water depths across a wide swath perpendicular to a vessel's track. The 8101 has a Projector (transmit array) and Hydrophone (receiver) that has a selectable maximum range scale of 480 meters, illuminates a swath on the sea floor that is 150 degrees across track by 1.5 degrees along track and consists of 101 individual 1.5 degree by 1.5 degree beams with the bottom detection range resolution of 1.25 cm. Residual biases due to misalignment of sonar were assessed in CARIS HIPS and entered in the CARIS vessel configuration file specifically named Patch_Test_259_3102_Reson8101.hvf and the Reson 8101 installation parameters. The system configuration used has Lever Arm Position of the sounding at IMU.

Location, Dates, and Personnel:
Prior to conducting MBES data in Approaches to Pascagoula, MS, on 16-17 and 20 September 2005 (Julian days 259, 260 and 263), ENS's Jaskoski, Adler, ST's Lewit, Campbell and Wood conducted a field calibration of the Reson SeaBat 8101 system for Precise Time delay, Pitch, Roll, and Heading (Yaw) biases. The Patch test was performed in The Approaches to Pascagoula, MS Project, within the Survey limits of the Sheet. See Chart #: 11375_1 for the illustrated acquisition area below.

Figure # 1. Acquisition Area



Equipment:

Reson 8101 Multibeam Echosounder

PU: 13976SN

SN: 31381

TSS POS/MV 3

SN: 402

Trimble DSM 212L DGPS receiver

SN: 0220168291

Seacat SBE19plus Sound Velocity Profiler

SN: 4486

Procedure: As defined in Appendix I of 2005 FPM

Sound velocity casts were performed every hour, for a total of three casts.

PROCESSING

Performed by: Chief Survey Technician Gardner
Assistant Survey Technician Wood

Initial values in the CARIS vessel configuration file TJ_3102_Reson8101.hvf were set to zero. The data sets were compared using the Calibration tool in CARIS 5.4 and 6.0. The calibrations were processed in the order specified: precise timing, pitch, roll, and heading (yaw). The value for each bias was immediately entered into a vessel configuration file specific to this patch test **(Patch_Test_259_3102_Reson8101.hvf).** All lines were remerged between data sets, in order to ensure that the new biases were applied to the data before making the next adjustment.

Precise time error: One line was run at a constant speed over a flat bottom surface. Using CARIS Calibration Mode: "roll time error", data from the outer beam was analyzed. The "roll time error" value was adjusted until the line appeared smooth. Both processors determined a roll time error value independently and these values were averaged. The reciprocal value of this average was entered into the .hvf file in the "swath, timing error" field each time and data was merged.

Pitch: Two pairs of coincident lines were run at the same speed and different directions. For each pair, one line was run up slope and one down slope. One pair of lines was run at a slow speed and one pair was run at the fastest survey speed. Nadir beams of each pair of lines were reviewed in CARIS Calibration Mode: Transducer 1: Pitch bias values were adjusted until the pair of lines matched. Each processor obtained values for both pairs. The four values were averaged and entered into the .hvf file and data was merged. Also, the Roll time error value was entered as with each bias adjustment.

Roll: One pair of coincident lines was run at the same speed and different directions in depths of 18 to 21 meters. One checkline was run perpendicular to the pair of lines at the same speed for outer beam comparison. The pair of lines was reviewed in CARIS Calibration Mode: Roll bias values were adjusted until the outer beams of the two lines overlapped simultaneously. Each processor calculated a bias for the pair of lines and the two biases were averaged. The average value was entered into the .hvf file and data was merged. Also, the Roll time error value was entered as with each bias adjustment.

Yaw: One pair of lines was run across to know sand waves (65m line spacing) at the same speed and in the same direction. The pair of lines was reviewed in CARIS Calibration Mode: Yaw. The sand waves slope and position was noticeable by the Base surface generated. Yaw error values were adjusted until the positions for each line matched. Each processor determined a value independently and these two values were averaged. Also, the Roll time error value was entered as with each bias adjustment.

Patch Test Data Acquired JD: 259-260 and 263

Figure #2

Results and Recommendations:

3102 Patch Test Results	Calculated Error	Verified Values by ENS Ford
Precise Timing Error:	0.06	-0.092
Pitch bias:	1.190	-0.470
Roll bias:	-1.935	-1.850
Yaw bias:	-0.042	-0.663

Verified values were entered into the HVF.

FIELD CALIBRATION REPORT
SURVEY LAUNCH 3101
Multibeam Reson 8125
Author: AST Ethridge

Introduction:

Launch 3101 is a Jensen 31 foot survey platform capable of acquiring Multibeam bathymetry. Multibeam bathymetry is acquired by using a Reson 8125 Shallow-Water Multibeam (SWMB) echosounder, which is attached to a lever-arm that is raised and lowered through a "trap door" in the hull of the launch. The Reson 8125 has a nominal frequency of 455 kHz, with a ping rate of 10-40 Hz with 240 beams and a maximum range of approximately 30 m. Residual biases due to the misalignment of the sonar were assessed in CARIS HIPS and entered in the CARIS vessel configuration file TJ_3101_RESON8125_253.

Location, Date, and Personnel:

On date September 10, 2005 Julian Day (253), HIC AST Campbell, Crew AST Wood, and Cox'n ENS Kurizian conducted a field calibration of the SeaBat 8125 for time delay, pitch, roll, and heading bias. The patch test was performed at the approaches to Pascagoula, MS. See Chart: (chart# 11373_1) and figure 1 below.

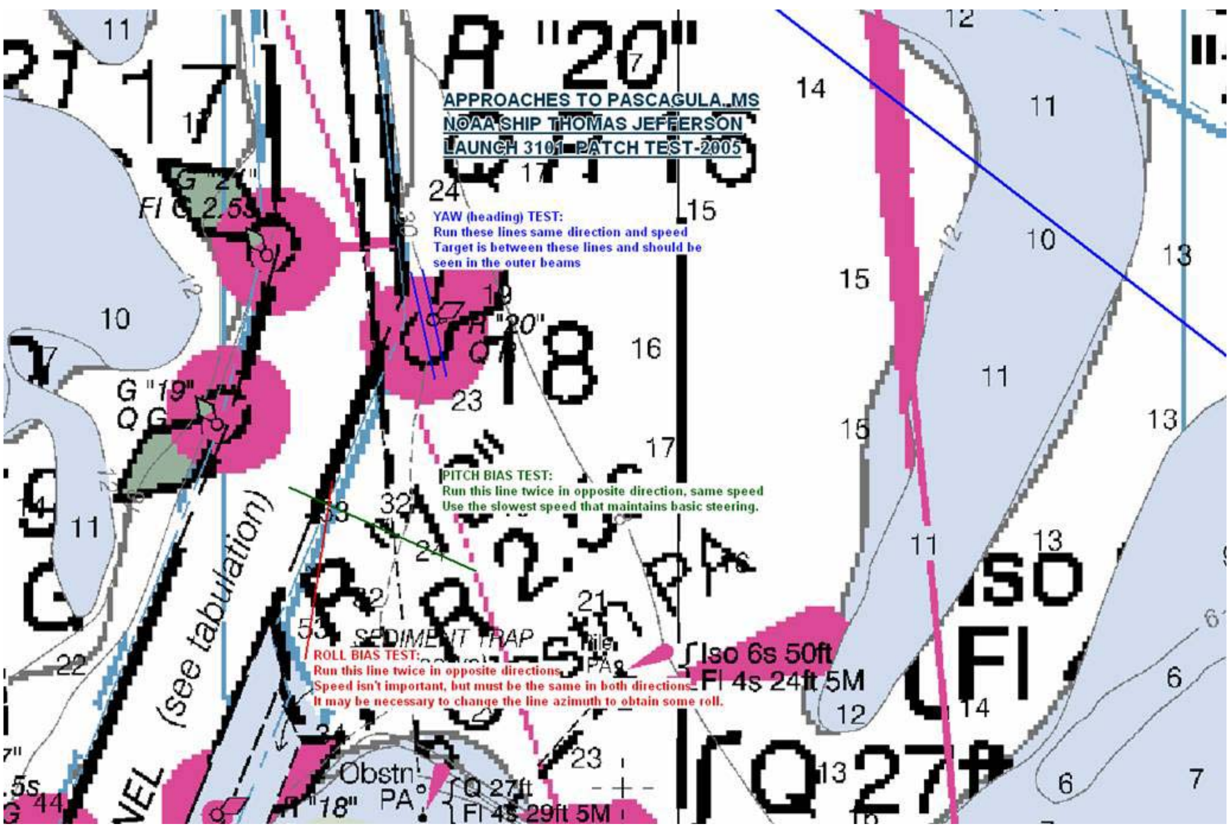


Figure 1: Approaches to Pascagoula, Chart 11373
Patch Test Lines for Launch 3101

Equipment:

Equipment Name	Serial Number
Reson 8125 Multibeam Echosounder	31381
TSS POS/MV 4	2207
Trimble DSM 212L DGPS receiver	60080888
SeaCat SBE19 Plus	4487

Procedure: As defined in Appendix I of 2005 FPM

Sound velocity and frequency of casts

For the duration of the patch test one sound velocity profile was obtained.

PROCESSING

Initial values in CARIS vessel configuration file TJ_3101_RESON8125_253 were set to zero and time latency was evaluated first. The data sets were compared using the Calibration tool in CARIS 6.0. The calibrations were processed in the order specified: time, pitch, yaw, and roll. The value for each bias was immediately entered into the vessel configuration file for TJ_3101_RESON8125_253. All lines were remerged between data sets, in order to ensure that the new biases were applied to the data before making the next adjustment. Time bias is rechecked as the other parameters are determined. See "Results and Recommendations" table below.

Time Latency, Pitch, Roll and Yaw: The lines were reviewed in CARIS calibration mode. AST Ethridge determined the first set of biases and AST Glomb performed a second scan as a quality assurance check. Glomb and Ethridge analysis agreed and an average for each bias was determined. See H11512_3101_Patch_Test_253.xls saved on H:\ProjectData\HSC_Tests_05\Launch Patch Tests\3101_September_2005. The hydrographer recommends using the following bias values in HIPS Vessel Configuration file: TJ_3101_RESON8125.hvf.

Patch Test Data Acquired JD253

Results and Recommendations:

3101 Patch Test Results	DN 253 09/10/05	ENS Ford Values		
Navigation Time Error:	-0.01	0.00		
Pitch bias:	0.18	0.170		
Roll bias:	0.18	0.190		
Yaw bias:	0.08	0.08		

These values were checked by ENS Ford and modified accordingly and entered into the HVF.

S222 Patch Test August 2005

Wildcat Knoll, MA

File Location:
H:\ProjectData\HSC_Tests_05\S222_Patch05\Aug05_WildcatKnoll\S222Patch0805_WildcatKnoll.lnw

Procedure:

Navigation Time delay: Run two pair of coincident lines at different speeds and same direction. One pair up slope and one down slope, each line within a pair run at 4.5 and 8.5 knots over a 10º slope. Each pair of lines will be reviewed in CARIS calibration mode.

Pitch: Run two pair of coincident lines at same speed and different direction. One pair up slope and one down slope, each line run at 5 knots over a 10º slope. Each pair of lines will be reviewed in CARIS calibration mode.

Roll: Run one pair of coincident lines at same speed and different direction in depths of 18 to 21 meters. Run one checkline perpendicular to the pair of lines at the same speed for outer beam comparison. The pair of lines will be reviewed in CARIS calibration mode.

Yaw: Run one pair of lines offset approximately 15 meters to either side of a charted wreck at same speed in same direction. The pair of lines will be reviewed in CARIS calibration mode.

Yaw was not solved for this bias test. Although there was a well defined wreck in the survey area, additional lines were not run to solve for Yaw. The previous value of 0.140 was retained in the HVF.

Results and Recommendations:

Bias	*Lines Used*	*Observed Value AST Campbell*	*Verified Values by CST Gardner*
Navigation Time	0011 and 0013	1.04	1.04
Navigation Time	0012 and 0014	1.04	1.04
Pitch	0011 and 0012	0.190	0.200
Pitch	0013 and 0014	0.190	0.180
Roll	Data in H11421	-0.070	-0.070
Yaw	-Not Solved-	0.140	