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

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey: Navigable Area

Time Frame: 2001 Field Season

2001

CHIEF OF PARTY

LCDR Andrew L. Beaver, NOAA

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Data Acquisition and Processing Report to Accompany 2001 Hydrographic Surveys

NOAA Ship RUDE (s590) LCDR Andrew L. Beaver, NOAA, Commanding

A. EQUIPMENT

A.1 Platforms

All data were acquired from NOAA Ship RUDE (s590, EDP #9040), NOAA Survey Launch 1419 (DNs 212-341), and NOAA Survey Launch 1017 (on loan from the Mid-Atlantic Navigation Manager DNs 331-341). RUDE is equipped with multi-beam and vertical beam echosounders and side scan sonar, while Launches 1419 and 1017 carry vertical beam echosounders and side scan sonar. RUDE is a Class V Hydrographic Survey Ship, 90 feet in length overall, with a 22-foot beam and 7-foot draft. Launch 1419 is a 23 foot SeaArk aluminum launch, with a 8.5 foot beam, and 1.5 foot draft. Launch 1017 is a 29 foot aluminum Jensen launch, with a 10 foot beam and 2.5 foot draft. Refer to Appendix III for more detailed vessel descriptions and equipment positioning diagrams.

A.2 Sounding Instruments

Vertical Beam Echo Sounder

RUDE and Launch 1419 are equipped with Odom Echotrac DF3200 MKII Dual Frequency Vertical-Beam Echosounders (VBES) configured for 24 and 200 kHz operation. Both frequencies are digitized and recorded at 5 Hz. Actual ping rates are dependent on the depth of water. Aboard RUDE, the VBES is used primarily for quality control and serves as a backup to the ship's multi-beam echosounder system (see below). On Launch 1419, the VBES is the primary sounding instrument.

NOAA Launch 1017 is equipped with an Innerspace model 448 VBES. The Innerspace is a single frequency unit, and is the primary sounding instrument aboard the vessel.

On all platforms, VBES data is logged by the Hypack software package (see section A.5 below), but paper records are acquired and retained for comparison with digitized depths during processing.

In regions with only VBES coverage (typically inshore of the 6 meter contour), survey lines were run approximately perpendicular to depth contours at an initial spacing of 25 m. After review, sounding density was increased in areas where shoaling was suspected by splitting these lines to 12.5m spacing, or as narrow as

required to accurately depict the bottom. In areas where the VBES was operated in conjunction with side scan sonar or multi beam echo sounder, line spacing was dictated by the swath width of these systems.

Shallow Water Multi-Beam Echosounder

RUDE is equipped with a RESON Seabat 9003 Shallow Water Multi-Beam Sonar System (SWMB), a 455 kHz multi-beam sonar designed for waters up to 100 meters deep. The 9003 utilizes an integrated transmit/receive head, which is pole mounted on the port side of the vessel. The 9003 projects a single transmit pulse, which is formed on receive into 40 beams, each 3° (across track) by 1.5° (along track). Due to excessive noise in the 9003's bottom detection algorithm at shallow grazing angles, the outer two beams on either side (1, 2, 39, and 40) were rejected during post-acquisition processing. The ping rate for the 9003 is approximately 3-15 Hz, depending on range scale. Although the 9003 does offer automatic transmit power and receive gain control, in general RUDE personnel manually adjusted these parameters to produce the most accurate sounding data, minimizing returns from water column clutter and surface reflection. During SWMB data acquisition, the ship was operated at speeds resulting in a minimum of 3.2 pings / 3 meters along track bottom coverage. The 9003 produces exclusively digital sounding data, with no paper record, and is logged by the ISIS software package (see section A.5 below).

A reference surface test was conducted in spring 2001 to assess the precision of the SWMB system. This test showed that under the prevailing conditions at that time and location, RUDE's sonar systems exceeded the International Hydrographic Organization "Special Order" specification. See the report attached in Appendix V for complete results. During data acquisition SWMB and VBES are continuously compared using the ISIS "Bathymetry Confidence" utility.

To achieve 100% MBES coverage, lines were run parallel to bottom contours at spacing of approximately 2 ½ times the water depth. After initial acquisition, coverage plots were generated and reviewed, and additional lines were planned to fill any gaps. In regions where the SWMB system was operated in conjunction with SSS, lines were spaced as required for the desired SSS coverage.

Side Scan Sonar

RUDE and Launch 1419 carry Edgetech (EG&G) model 272T Side Scan Sonar (SSS) towfish and Analog Control Interfaces (ACIs). The Edgetech model 272T tow fish emits two 50° wide beams tilted down 20° from horizontal. All side-scan sonar data were recorded digitally through the ACI and associated analog-to-digital converter card using the ISIS software and archived in the Extended Triton Format (*.XTF) files (see section A.5). Aboard RUDE, side scan and multibeam sonar data are logged concurrently to a single .xtf file. XTF files

from Launch 1419 contain SSS data only. RUDE and Launch1419's towfish transmit at 100 kHz only.

Launch 1017 also carries a 100kHz Edgetech 272T SSS towfish, but logs data using the Edgetech 260TH analog recorder rather than the ACI. The analog output of the 260TH is digitized by an AU32 analog-to-digital converter card and recorded in .xtf format in ISIS.

Water column turbulence generated by the ship's wake limits SSS acquisition by RUDE to depths greater than approximately 10 meters. SSS from Launches 1419 and 1017 are similarly limited to depths greater than roughly 6 meters.

Side scan sonar lines were planned to run parallel to bottom contours, spaced according to the range scale appropriate for the water depth. Range scales of up to 100 meters were selected based on the requirement that the fish altitude be maintained between 8 and 20% of the range scale selected. When this height could not be maintained, coverage was computed using an effective range scale of 12.5 times the actual fish altitude. In general, lines were planned with 10m of overlap with adjacent swaths on either side.

Vessel speed was adjusted to ensure that an object one meter in characteristic size would be detected and clearly imaged across the sonar swath. Confidence checks were performed and noted frequently to ensure this standard of resolution was met.

Although RUDE's Seabat 9003 is equipped with Option 019, the Side Scan Sonar Upgrade, this imagery cannot be viewed or logged under the current data acquisition configuration.

Lead Line

A lead line was used to confirm the calibration of RUDE's VBES and SWMB systems in the spring of 2001. This test showed that under the conditions at the time of the calibration, RUDE's sonar systems exceed the IHO "Special Order" specification. See the report attached in Appendix V for complete results.

Diver Least Depth Gauge

RUDE divers were equipped with a diver least depth gauge for item investigations. This instrument was calibrated in January 2001. The calibration report is included in Appendix V. The accuracy of RUDE's diver least depth gauge was also assessed as part of the Lead Line comparison test motioned above.

A.3 Positioning and Attitude Instruments

RUDE

Seapath 200

RUDE's primary positioning and attitude sensor is a Seatex Seapath 200. This system combines data from an inertial attitude sensor and carrier-phase GPS receivers to compute position, heading, heave, pitch, and roll to the accuracy required for shallow water multibeam sonar surveys. The major components of the Seapath are a Seatex MRU-5 inertial motion reference unit mounted at the ship's center of motion, an array of two GPS antennas on the ship's mast, and a processing unit on the bridge. Differential GPS corrector input from an external source is required. The GPS receivers in the Seapath processor compute RUDE's position by traditional means, and ship's heading by measuring the phase difference of the L1 GPS signals arriving at the two antennas and computing the vector between them. The resulting GPS position and linear and angular acceleration values are corrected for the lever arm from the antennas to the center of motion, and combined with raw attitude and acceleration data from the MRU-5 in the processor Kalman filter. This filter is designed to produce output that reflects high frequency changes in vessel position and attitude as measured by the MRU while constraining the drift of this sensor with the long term stability of GPS. The Kalman filter's acceleration and heading outputs are compared with the MRU's raw data to aid the MRU in correcting the apparent gravity vector to true vertical.

Heave is computed by double integration of acceleration in the vertical axis as measured by the MRU-5. Since this measurement is subject to long term drift, the data are high pass filtered with a rolloff frequency and damping coefficient selected to stabilize the measurement while preserving the phase and amplitude of the ship's vertical position in sea states anticipated in RUDE's area of operations.

The final position, heave, and attitude data are output to the Hypack and Isis data acquisition systems via RS-232 serial. The system is configured for 10 Hz output of the "TSS" Heave / Roll / Pitch message and 2 Hz output of the NMEA-0183 GGA, VTG, and HDT messages. All data are corrected to the position of the MRU.

Trimble DSM-212L

RUDE's backup positioning system is a Trimble DSM-212L DGPS receiver. The DSM-212L is an integrated unit combining a 12 channel L1 C/A code receiver with a 2 channel Differential Beacon receiver. This unit is used primarily to receive USCG Differential Beacon messages, which are passed to the Seapath in RTCM-104 format. Although the DSM-212L has the ability to automatically select stations based on signal

strength or geographic proximity, the receiver was manually tuned to avoid unexpected and undocumented changes in the differential beacon in use.

Position, time, and velocity data from the Trimble is available in a 1 Hz NMEA message as a backup to the Seapath. The DSM-212L was configured using the "TSIP Talker" software to suspend output in the event NOS Hydrographic Position Control specifications were not met.

Magnavox MX-50
The MX-50 is a manually tuned single channel differential beacon receiver which is carried as a backup to the Trimble DSM-212L

Sperry Mk-32 Gyrocompass
RUDE is equipped with a Sperry Mk-32 gyrocompass. While this instrument serves primarily as a heading reference for navigation, its output can be fed to the hydrographic survey systems as well. The Mk-32 is configured to deliver the NMEA-0183 HDT message at 1 Hz.

Mid-Season Failure
From the beginning of the field season until September 11, 2001 (DN 254), RUDE's position, velocity, attitude, and heave were measured by the Seapath 200 system. However, over the course of the season, what had been intermittent problems with the system's GPS receivers increased, and on September 11, the unit failed completely. RUDE personnel, working with vendor and program support, were unable to find or correct the source of the problem in the field. As a result, RUDE's data acquisition system was reconfigured as follows:

The Seatex MRU-5, installed as part of the Seapath 200 system, is also capable of standalone operation. The instrument was reconfigured and connected directly to the Hypack and Isis data acquisition systems. However, because the sensor no longer received GPS aiding from the Seapath processor, accuracy suffered during maneuvers causing high angular or linear acceleration. To ensure data quality, heave, pitch, and roll data from the MRU-5 were continuously monitored and RUDE survey procedures altered to allow adequate "run-in" for the attitude sensor to settle before logging data. Also, it was found that the heave filter constants, which had provided high quality data when the unit was configured as part of the Seapath, were not appropriate for standalone operation. Several days of testing were conducted to find a new filter cutoff frequency and damping coefficient which would yield satisfactory results over a range of sea states.

After the failure of the Seapath, position, timing, and velocity data came from the Trimble DSM-212L. No reconfiguration of the receiver was

necessary, but the offsets from the Trimble antenna to the ship's center of motion were re-measured to ensure correct computation of vessel position in post-acquisition data processing.

Heading data were taken from RUDE's Sperry Mk-32 gyrocompass. Although this unit is believed to have approximately 3 degrees of error and was not designed as a "survey grade" instrument, program personnel approved its temporary use. The appropriate outer beams of the multibeam swath were rejected in water depths where this maximum heading error would result in positioning error of soundings greater than allowed by NOS Hydrographic Position Control specifications.

After the reconfiguration for RUDE's data acquisition system, a patch test was conducted to measure new sensor calibration errors. This test confirmed that positioning and attitude accuracy, while degraded, was still acceptable under NOS hydrographic specifications.

LAUNCH 1419

Starlink DNAV-212

Launch 1419 is equipped with primary and backup Starlink DNAV-212 DGPS receivers, which provide position, timing, velocity, and course. The Starlink is an integrated 12 Channel L1 C/A code and 2 Channel Differential Beacon receiver. The Starlink receivers were configured with the "Starinit" software to suspend output in the event NOS Hydrographic Position Control specifications are not met, and manually tune the differential beacon receiver to the desired frequency. The Starlink receivers produce the NMEA-0183 GGA and VTG messages at 1 Hz.

Heave and Attitude

Launch 1419 is not equipped with heave or attitude sensors. During acquisition, vertical beam sonar records and sea state were continuously monitored to ensure that NOAA limitations governing uncorrected heave and attitude artifacts in sonar data were not exceeded.

LAUNCH 1017

Trimble DSM-212L

Launch 1017 is equipped with a Trimble DSM-212L DGPS receiver, which provide position, timing, velocity, and course. The Trimble receiver was configured using Trimble's TSIP Talker software to produce the NMEA-0183 GGA and VTG messages at 1 Hz.

A.4 Ancillary Instruments

Sound Velocity

Conductivity, temperature, and depth profiles were acquired using two Seabird Seacat SBE-19 Conductivity, Temperature, and Depth (CTD) profilers. The SBE-19 is a self contained, battery powered unit with a serial interface for configuration and data download. RUDE's SBE-19's are equipped with a 300 psi pressure gauge to provide high resolution data in the relatively shallow water typical of RUDE's areas of operations. Sound velocity files in CARIS format were computed using the "Velociwin" software described in section A.5.

During MBES data acquisition, CTD casts were conducted when starting work in an area and every 4 hours thereafter, or when the surface sound velocity was observed to have drifted outside accepted limits as discussed below. For VBES data, casts were conducted weekly or when survey personnel suspected a significant change in the properties of the water column. The calibration records from December 2000 are included in the Appendix V.

Surface sound velocity was continuously monitored during acquisition with a Odom Hydrographic Digibar Pro sound velocimeter. During MBES data acquisition, a new CTD cast was taken if the surface sound velocity was observed to have changed more than +/-2 m/s from its value at the last CTD cast. This unit suffered a transducer failure in July 2001 and was out of service for repair for approximately one month The calibration records for this instrument from December 2000 are included in Appendix V.

Monthly comparisons of the two Seacat CTDs and weekly comparisons between the CTD in use and the Digibar Pro were conducted to monitor data quality from these instruments.

Cable Counter

RUDE is equipped with an MD Totco Cable counter which measures the side scan towfish tow cable by counting revolutions of the towing block on the A-frame. The length of cable deployed is computed automatically and output to Hypack.

Launches 1419 and 1017 do not have cable counters. On these vessels, the side scan tow cable was marked, and the length of cable paid out manually entered into Hypack.

Bottom Sampler

Where required by project instructions, RUDE personnel acquired sediment samples from the sea floor in the survey area. The primary tool for this operation is a "clamshell" style gravity-closed sediment sampler, which penetrates approximately 0.05m into the bottom.

A.5 Data Acquisition and Processing Software

Coastal Oceanographics Hypack Max is used for survey navigation, and VBES and Detached Position (DP) data logging. Hypack is also used for overall data acquisition control, and passes file names, line start and end messages, and fix numbers to ISIS via a serial link. In addition, during side scan sonar operations, Hypack collects cable out data and computes towfish position, which, along with raw water depth from the VBES, was also passed to ISIS.

Shallow Water Multibeam and Side Scan Sonar data is collected in the Triton Elics International ISIS software package (v5.29) and logged in the "eXtended Triton Format (.xtf) file format. Because of improved timing precision, vessel position is logged to the "sensor" field of the XTF data structure, and towfish position, if present, was recorded in the "ship" position. Water depth, required for recomputation of towfish position, is stored in "Aux 1".

The PCs running Hypack and Isis were automatically synchronized to UTC time from the NMEA-0183 GPS messages.

CTD casts were downloaded and processed in the Velociwin program supplied by the Hydrographic Systems and Technology Program (HSTP). This software was also used to process diver's least depth gauge readings.

Preliminary tide data was either directly collected from the Center for Operational Oceanographic Products and Services world wide web site, or sent to RUDE via the "Tidebot" automated tides email system. Verified tides were downloaded from the CO-OPS web site as they became available. All tide data was zone corrected using HSTP's "HP Tools" software.

All sonar data was processed in the CARIS HIPS system, running on RUDE's SGI Octane workstation.

Processed soundings, side scan sonar contacts, dives, and DPs were inserted and analyzed in HSTP's "Pydro" software. This system was used for all feature assessment and bathymetry excessing.

Final plots were generated in the Mapinfo Professional GIS. Bathymetry gridding for surface analysis in Mapinfo was accomplished using Northwood Geosciences "Vertical Mapper".

Please refer to Appendix II for tables listing data acquisition and processing hardware serial numbers and software versions.

B. QUALITY CONTROL

Please refer to Appendix III for detailed Data Acquisition and Processing Flow Diagrams

B.1 Bathymetry Data

Vertical Beam Sonar Data

Vertical Beam sonar data were converted from Hypack to CARIS format using the CARIS "Hypack" data converter. The converter was configured for the sensors present by reading the device numbers from the header of the Hypack data file. Soundings less than 1m and greater than 500m were rejected on conversion, as were position fixes falling outside a box roughly corresponding to the limits of the current project. High frequency (200 kHz) soundings were converted as the default "selected" soundings

After conversion, the data were opened in CARIS HDCS. Attitude data (if present) were checked for errors or gaps. Vessel navigation data was manually checked for speed jumps greater than 2 kts. For RUDE data, data showing these speed jumps were rejected with interpolation. For data from Launches 1419 and 1017, weather and sea state conditions during acquisition were considered before deciding to reject navigation points.

Survey personnel scanned raw VBES soundings in CARIS "SBEdit". The digital data were compared with analog paper records to ensure no valid depths were missed by the bottom detection algorithm. Low frequency soundings found to be shoaler than the corresponding high frequency depths were manually "selected".

Multibeam Sonar Data

Multibeam sonar data were converted from ISIS .xtf format to CARIS using the CARIS "XTF" converter, with vessel position converted "from sensor" and heading "from attitude".

After conversion, the data were opened in CARIS HDCS. Attitude data was checked for errors or gaps. Vessel navigation data was manually checked for speed jumps greater than 2 kts, which were rejected with interpolation.

Survey personnel scanned raw MBES soundings in CARIS "SwathEdit". Occasionally, bottom type of the survey area or sea state during acquisition caused obvious incorrect soundings. These "fliers" were identified as depths approximately twice those of the surrounding data or clusters of soundings close to the surface, and were rejected. In areas where data had large numbers of erroneous soundings and the bottom was known to be basically flat, survey personnel employed the CARIS depth filter to facilitate cleaning. The filter was configured as a window with appropriate upper and lower bounds chosen based on the expected mean depth and the variability of bathymetry. After applying

the filter, survey personnel reviewed the data to ensure that only those soundings which were clearly incorrect had been rejected.

Survey personnel examined all other questionable soundings on a case by case basis, with consideration given to any side scan sonar features in the area, the receive strength of the echo, and the number of individual soundings collected on at the suspicious depth. All soundings which remained ambiguous after this process were identified for further investigation and left in the data set.

Final Processing of Sounding Data

After the initial scan of VBES and MBES soundings, the data were sound velocity corrected. Care was taken to ensure that SV casts were grouped and applied according to the vessel and area where they were acquired.

Zoned tides were applied in the field to all bathymetry data. Preliminary observed water levels were obtained from either the CO-OPS web site or through Tidebot email. Navigation files for each vessel were created in CARIS, and these navigation files, the tide zone .mix file provided with the project instructions, and the raw gauge data were input to the HP Tools "Create Zoned Tides" feature. The resulting zoned tide files for each vessel were applied to the corresponding data in CARIS, and merged. When Verified Tides became available, these data were downloaded from the CO-OPS site and the bathymetry was re-merged.

Once data acquisition and processing was complete for a particular area, senior survey personnel check scanned all soundings in CARIS subset mode. Subset mode was used for check scanning because it provides an opportunity to examine data in the context of surrounding lines, therefore highlighting errors which may have affected only a specific line or day. In areas of 100% MBES coverage, overlap also allowed many of the ambiguous soundings identified during the initial scan to be resolved.

After final data cleaning and correction was complete, survey personnel imported all bathymetry data into a CARIS workfile. The data was imported line by line into 3m by 3m shoal biased grid, from which digital terrain models and sun illuminated images were drawn with 5m resolution. Senior survey personnel analyzed these products to assess coverage and highlight any remaining data problems.

B.2 Side Scan Sonar Imagery

All side scan sonar imagery was cleaned and examined in CARIS SIPS. Data were converted from XTF to CARIS format using the CARIS XTF converter, configured to convert ship position "from sensor", and towfish position "from ship". Data collected from RUDE were converted with ship and towfish heading

converted “from attitude”, while heading data from Launches 1419 and 1017 (which do not carry a heading or attitude sensor) were converted “from sensor”. Water depth, used in recomputation of towfish position, was converted from the “aux 1” field of the XTF file. On conversion, CARIS computes towfish depth by subtracting towfish altitude (logged from the towfish bottom track during acquisition) from raw water depth (passed to ISIS from Hypack and logged in the XTF file). This computation does not correct for the draft of the survey vessel. Negative results of this calculation are treated as zero towfish depth.

After conversion, the data were opened in the CARIS “SSMOS” application. Survey personnel checked vessel attitude (if present), cable out, and computed towfish depth for gaps or errors. Vessel navigation data was manually checked for speed jumps greater than 2 kts. For RUDE data, data showing these speed jumps were rejected with interpolation. For data from Launches 1419 and 1017, weather and sea state conditions during acquisition were considered before deciding to reject these navigation points.

After confirming the validity of the vessel navigation, cable out, and towfish depth values, survey personnel then recomputed towfish navigation. The CARIS towfish positioning is based on a smoothed course made good value from the towing vessel rather than instantaneous vessel heading as used by Hypack and therefore results in a more realistic towfish track. Replacing the original Hypack towfish position with the CARIS computed position yields more accurate contact positions and mosaic imagery.

Side scan sonar data were scanned in CARIS “SSEdit”. Survey personnel corrected errors in bottom tracking, slant range corrected the imagery at default resolution (0.1m), and scanned the data for significant contacts. Contacts deemed “significant” included, but were not limited to, contacts with a shadow indicating a contact height of 1 m or greater in water 20m or less deep or 10% of the water depth in water deeper than 20m. Other contacts considered significant by RUDE personnel included smaller contacts in particularly shoal areas or channels, cables and pipelines, large sand wave ridges, and contacts of possible historical significance.

Point feature contacts were picked using CARIS “single point contacts”, and surrounded by a 40m by 40m bounding box. Larger and line features were picked using CARIS “multipoint contacts”. All contacts were descriptively labeled and feature codes selected if conclusive identification was possible. Tif images of all contacts were saved.

After the initial SSS imagery scan, senior survey personnel conducted a check scan of all data.

Survey personnel assessed SSS coverage by using CARIS to mosaic side scan data. These mosaics were drawn at 1m resolution, using the “interpolation” and

"autoseam" options. For side scan imagery where the towfish height dipped below 8% of the water depth, range was limited to 12.5 times the actual towfish altitude.

B.3 Data Analysis

HSTP's Pydro software package was the primary tool for sounding and feature integration and assessment. Side scan contacts and detached positions were inserted into the Pydro Preliminary Smooth Sheet (PSS). Bathymetry was imported into Pydro at a 15m by 15m shoal biased grid. Survey sheet officers used Pydro to assess and categorize contacts, and suppress soundings to produce a shoal biased bathymetry data set at the scale of the survey.

Pydro provides 4 flags for categorizing features: "Significant", "Chart", "Investigate", and "DTON". In addition, pydro provides "Primary" and "Secondary" flags for grouping correlated features.

After insertion, SSS features were first categorized by significance. Contacts which met the standard of significance described in section B.2. were marked as such; those contacts which were deemed insignificant were marked "Resolved" and not investigated further. Also, multiple contacts representing the same physical feature were grouped. The contact which the hydrographer believed to best represent the feature (typically, the most clear SSS image) was selected as the "Primary" contact, while the rest were flagged as "Secondary."

Significant contacts were then reassessed to determine if additional investigation (typically SWMB development) was required. Using the "bathymetry grid" feature of pydro, the hydrographer checked the bathymetry coverage of the contact in question. If additional bathymetry was required, the "investigate" flag was checked. This could then be queried in Mapinfo to select only those contacts requiring development for line planning.

After contacts were sufficiently investigated, they were further assessed for charting and DTON status. Features which the hydrographer believed should be added or retained on the chart were marked as such. Charted features which posed a special threat to vessel traffic were marked as "DTONS", and a Danger to Navigation Report was generated.

It is also possible to select soundings as features in Pydro. This capability was used to select specific shoal soundings not associated with a side scan feature as DTONS, and was also used to select the least depth on side scan features as the position for charting.

Using Pydro, a single physical feature selected for charting can have as many as three "Primary" features associated with it. The first is the SSS feature, which

has imagery of the contact, but low positional accuracy. Second, the contact can have a significant bathymetry sounding selected, which contains the least depth and position at which the feature should be charted. Finally, if the feature was investigated by divers, the detached position from the dive may be selected as a primary feature as well.

Contacts and bathymetry analyzed in Pydro were opened in Mapinfo for plotting and contact development planning. Contact and sounding plots were printed at survey scale for final survey assessment.

C. CORRECTIONS TO ECHOSOUNDINGS

It is OCS and RUDE policy that all data be acquired and logged in raw format without application of any corrections for vessel offsets, sensor alignment, sound velocity profile, or tides. These factors are logged separately or contained in the CARIS "Vessel Configuration File" (VCF), and applied in post-acquisition data processing.

C.1 Vessel Offsets and Static Draft

RUDE

Vessel offsets for NOAA Ship RUDE were last measured during the 1999-2000 winter inport while the ship was in drydock. After the Seapath 200 position and attitude sensor failed on September 11, 2001, the Trimble DSM-212L became RUDE's primary positioning device, and the position of the antenna was reconfirmed. These measurements are reflected in the offset drawing included in Appendix III.

Launch 1419

Launch 1419's offsets were measured on July 26, 2001 after the boat was delivered from SeaArk Marine. See Appendix III for 1419's offset diagram

Launch 1017

Launch 1017's offsets were measured on November 27, 2001, while the boat was on loan to RUDE from the Mid-Atlantic Navigation Manager. See Appendix III for 1017's offset diagram.

Application

Static transducer draft is applied to all bathymetry data during the CARIS "SVP Correct" operation. Horizontal offsets are applied during CARIS "Merge".

C.2 Dynamic Draft

RUDE

RUDE's dynamic draft was determined by traditional rod leveling methods on February 20, 2001. A report describing this operation and its results is included in Appendix III

Launch 1419

Launch 1419's dynamic draft was determined by traditional rod leveling methods on July 26, 2000. A report describing this operation and its results is included in Appendix III

Launch 1017

Launch 1017's dynamic draft was measured by Atlantic Hydrographic Branch personnel, and supplied to RUDE with the vessel.

Application

Dynamic Draft corrections are applied to all bathymetry data in the CARIS "SVP Correct" operation.

C.3 Attitude and Heave

RUDE

RUDE carries a Seatex Seapath 200 position and attitude sensor, as described in Section A.3. This system has specified accuracy of 0.05° at 1σ in pitch and roll, 0.075° at 1σ in heading, and 0.05m at 1σ in heave.

On March 14, 2001, RUDE conducted a patch test to determine navigation timing and multi-beam head alignment errors for the CARIS Vessel Configuration File. The results of this operation are included in Appendix III.

As noted in section A.3, the Seapath 200 processor failed on DN 254 of the 2001 field season. As a temporary solution, the Seatex MRU-5 inertial motion sensor, previously integrated as part of the Seapath system, was configured for stand-alone operation. This does not change the specified accuracy in heave, pitch, and roll, but without GPS aiding the MRU-5's accuracy degrades with increased linear and angular acceleration of the vessel.

After the failure of the Seapath 200, RUDE's Sperry Mk-32 navigation gyro was used as a heading reference. This unit has an estimated accuracy of approximately 3°, which was sufficient to meet NOS standards for horizontal control in the relatively shallow water of RUDE's area of operations.

An informal patch test was conducted after the Seapath's failure to confirm the performance of the MBES with the new attitude and positioning sensor

configuration, and update the navigation timing error in the CARIS VCF for the change from the Seapath to the Trimble DSM-212L.

Launches 1419 and 1017
As discussed in section A.3, Launches 1419 and 1017 are not equipped with attitude sensors.

Application
Heave, pitch, and roll corrections are applied to all bathymetry data in the CARIS "SVP Correct" operation. Yaw corrections are applied during CARIS "Merge".

C.4 Sound Velocity Profile

RUDE carries two Seabird SBE-19 Conductivity, Temperature, and Depth profilers. These instruments are returned to the manufacturer yearly for calibration. Records of the latest calibrations are included in Appendix IV

RUDE personnel conducted weekly CTD data quality assessments comparing CTD readings to surface sound velocity and sea water temperature measured by the Digibar Pro and engine room sea chest thermometer. In addition, dual CTD casts were conducted monthly, and processed using the Velociwin "comparison cast" feature.

As described in Section A.4, A.5, and B.1, raw conductivity, temperature and depth data were processed to produce sound velocity files in CARIS format. These profiles are applied in CARIS "SVP Correct".

C.5 Water Levels

Soundings were corrected to Mean Lower Low Water using first Preliminary Unverified tides, and then Verified tides when available, according to the procedure described in Section B.1. All raw tide data were corrected according to the zoning provided with the relevant project instructions prior to application to bathymetry data.

During bathymetric data collection, subordinate gauges included in the project instructions were monitored via the CO-OPS web site, "Tidebot" email, and the CORMS Morning Report. When water level measurement problems were suspected, RUDE personnel brought them to the attention of CO-OPS staff before continuing bathymetric data acquisition.

Water level corrections are applied during CARIS "Merge".

D. APPROVAL SHEET

LETTER OF APPROVAL

Data acquisition and processing were conducted under my direct supervision with frequent personal checks of progress and adequacy. All equipment was continuously monitored for proper operation during data acquisition and all supplemental and supporting records were reviewed in their entirety.

This Data Acquisition and Processing Report is adequate to accompany all Descriptive Reports for surveys including data collected during NOAA Ship RUDE's 2001 Field Season.

Respectfully Submitted:

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Benjamin K. Evans
Lieutenant (junior grade), NOAA
Field Operations Officer
NOAA Ship RUDE

Approved:

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Andrew L. Beaver
Lieutenant Commander, NOAA
Commanding Officer
NOAA Ship RUDE

APPENDIX I

Data Acquisition Equipment Summary Table

Data Acquisition and Processing Software Summary Table

Summary Table of Data Acquisition Equipment

Equipment Description	Serial Number	Dates Used
RUDE		
Reson Seabat 9003 SWMB	10496-447020	all
Odom Echotrac Mk II VBES	9641	all
Edgetech 272-T SSS Towfish	various*	all
Edgetech ACI interface	26247	all
Seatex Seapath 200 Navigation System	0544	through DN 254
Seatex MRU-5 H/P/R sensor (standalone)	unknown	after DN 254
Trimble DSM-212L DGPS Receiver	0220227632	all
Magnavox MX-50 Beacon Receiver	079	all
Seabird Seacat SBE-19 CTD	1251	through DN 262
	1991	all
	1060	after DN 262
Odom Digibar Pro SV Sensor	98013	all
Sperry Mk-32 Gyrocompass	unknown	after DN 254
Launch 1419		
Odom Echotrac Mk II VBES	9643	all
Edgetech 272-T SSS Towfish	various*	all
Edgetech ACI interface	27569	all
Starlink DNAV-212 DGPS Receiver	850	all
Launch 1419		
Innerspace model 448 VBES	203	all
Edgetech 272-T SSS Towfish	various*	all
Edgetech 260TH SSS Recorder	16673	all
Trimble DSM-212L DGPS Receiver	0220159722	all

*****At the start of RUDE's 2001 field season, the ship was issued three Edgetech 272T SSS towfish from the NOAA Mission Support Division MOC-A depot for use on RUDE and her associated survey platforms. Due to the age of these towfish, several serial numbers were illegible. As the season progressed, problems developed with some towfish which were returned to MSD and replaced. Accurate records of which towfish were used on which vessel, and when towfish were returned to MSD and replaced were not kept.

Summary Table of Data Acquisition and Processing Software

Software Description	Version	Dates Used
Coastal Oceanographics Hypack Max	various*	all
Triton Elics International ISIS	5.29	all
Trimble TSIP Talker	2.00	all
Starinit	unknown	all
HSTP HP Tools	10.1.5	all
HSTP Velociwin	5.05	through DN 289
	6.01	after DN 289
CARIS HIPS and SIPS	4.3.2	all
HSTP Pydro	various**	all
Mapinfo Professional	5.5	through DN 273
	6.5	post DN 273
Vertical Mapper	2.5	all

*Several versions of Hypack Max were provided by HSTP personnel during the 2001 season, as minor software bugs were identified and corrected by the vendor. Accurate records were not kept of when these upgrades were installed on RUDE and her associated survey platforms.

**Pydro was under development during the 2002 Field Season. New releases were distributed approximately monthly, often with more frequent unofficial “updates” in between, making it difficult to track which version was used to analyze what data at any given time. Final processing of all surveys was completed in Pydro v2.5.2.

APPENDIX II: Data Acquisition and Processing Flow Diagrams

RUDE Data Acquisition Setup, Pre-DN254

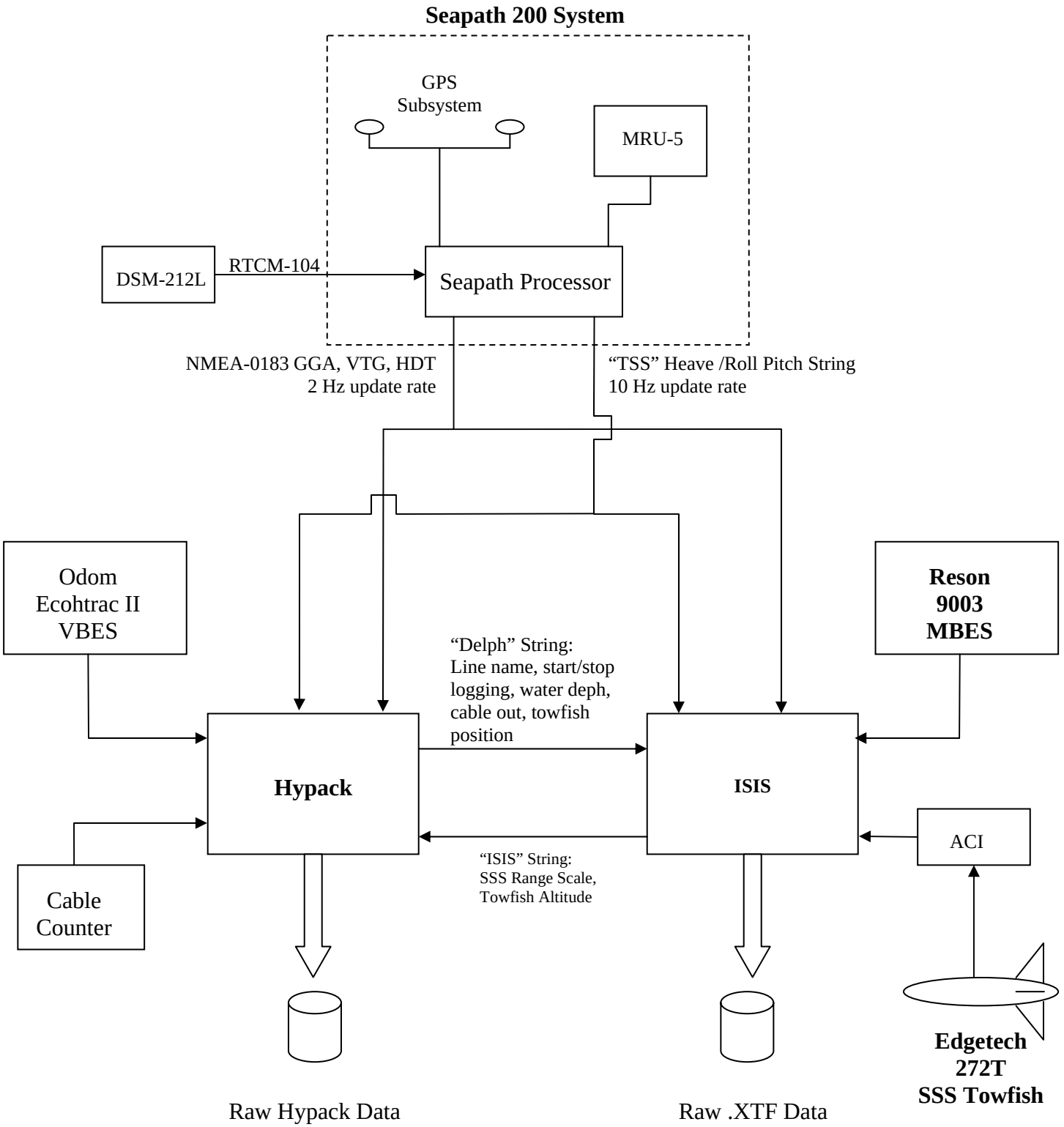
RUDE Data Acquisition Setup, Post-DN254

Launch 1419 Data Acquisition Setup

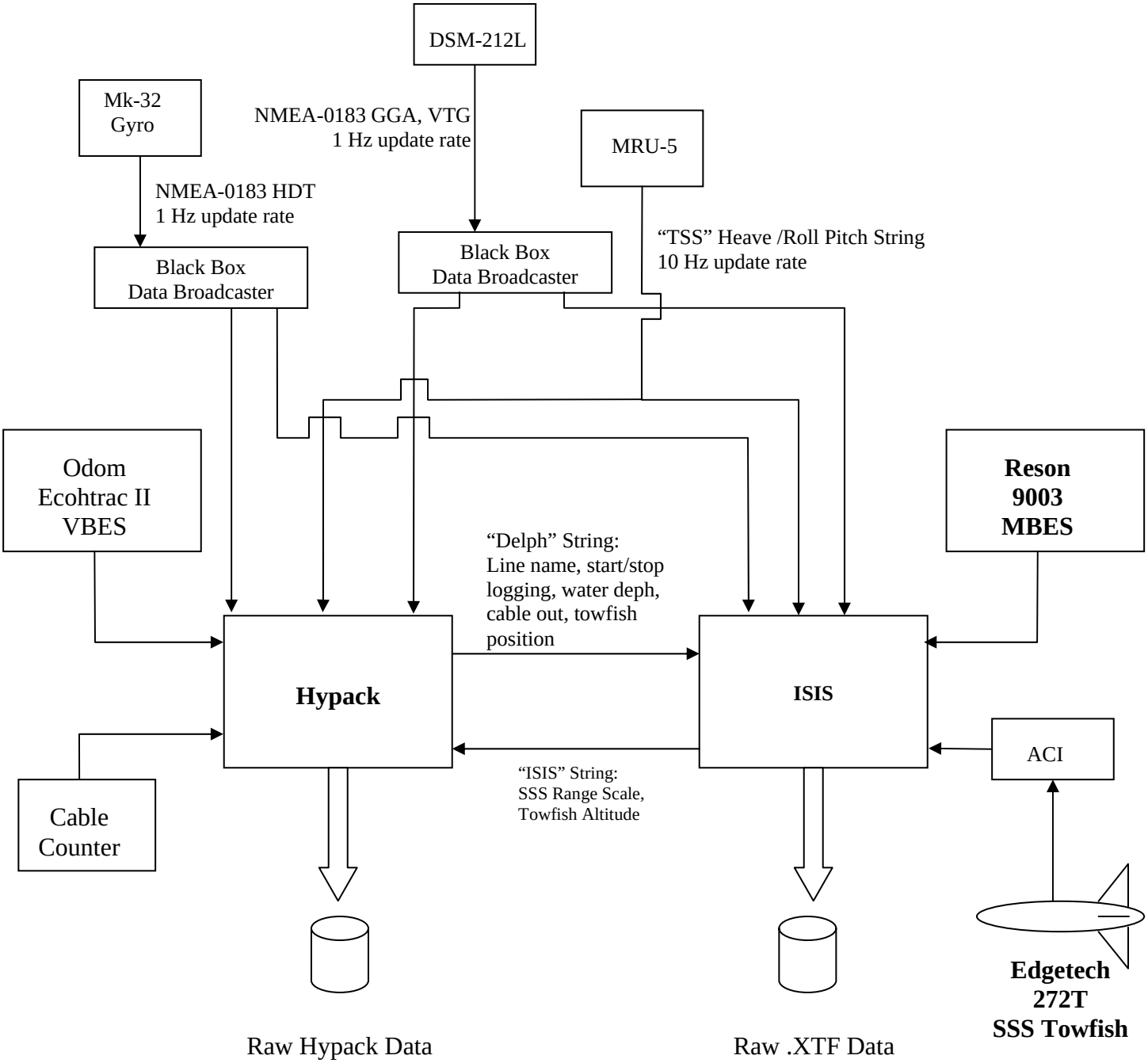
Launch 1017 Data Acquisition Setup

CARIS Data Processing Diagram

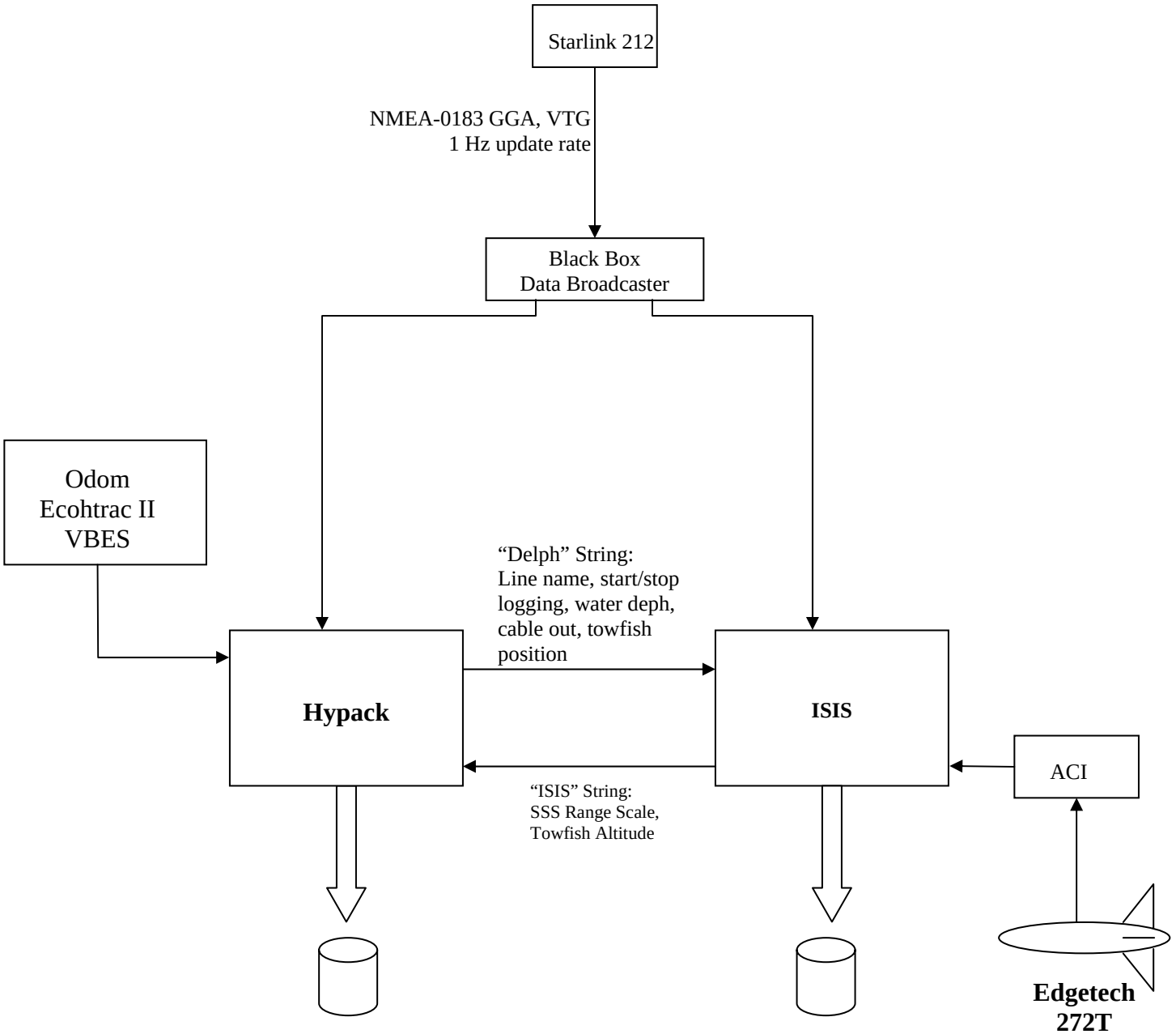
Pydro Data Processing Diagram



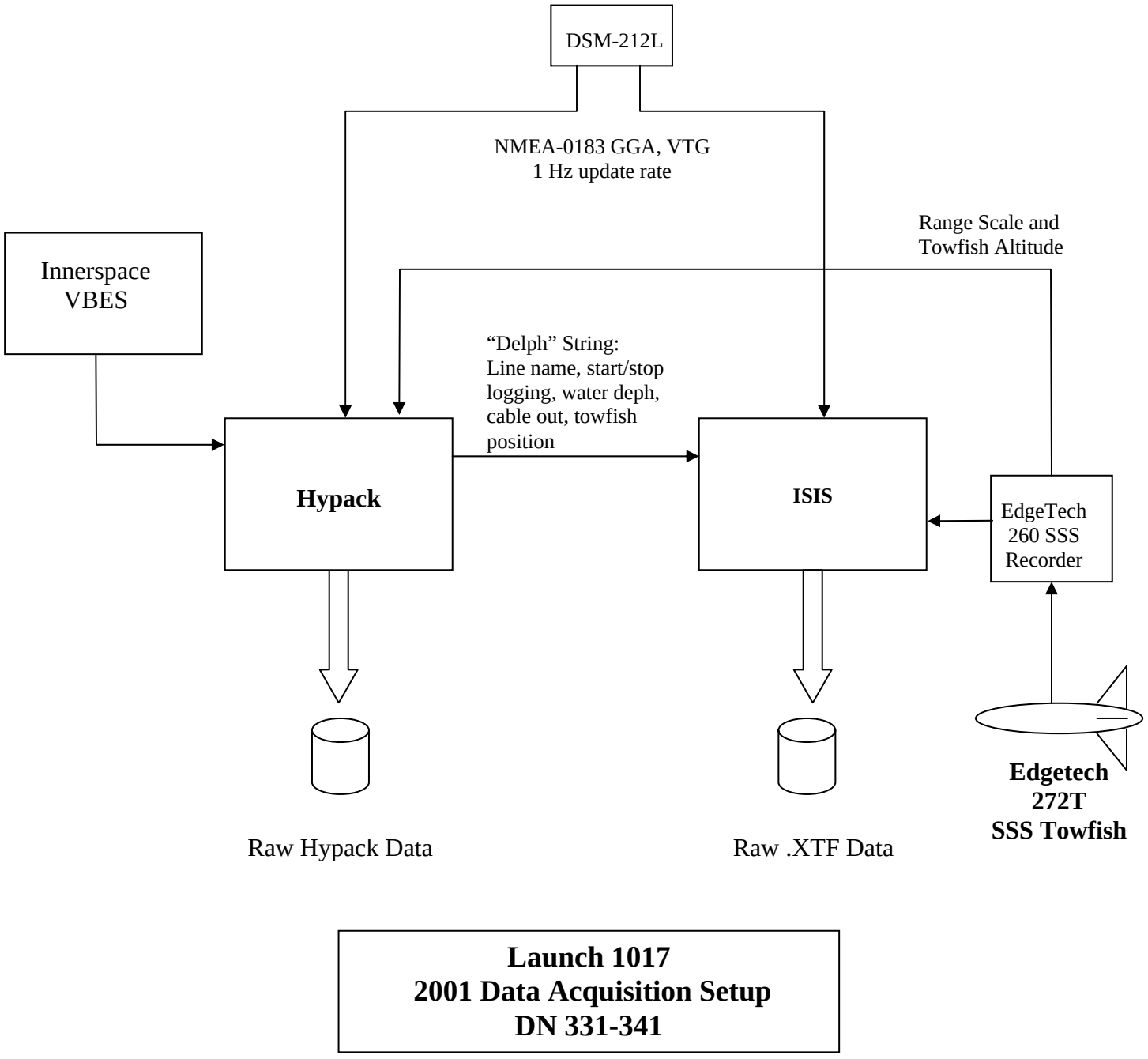
RUDE 2001 Data Acquisition Setup
Pre-DN254



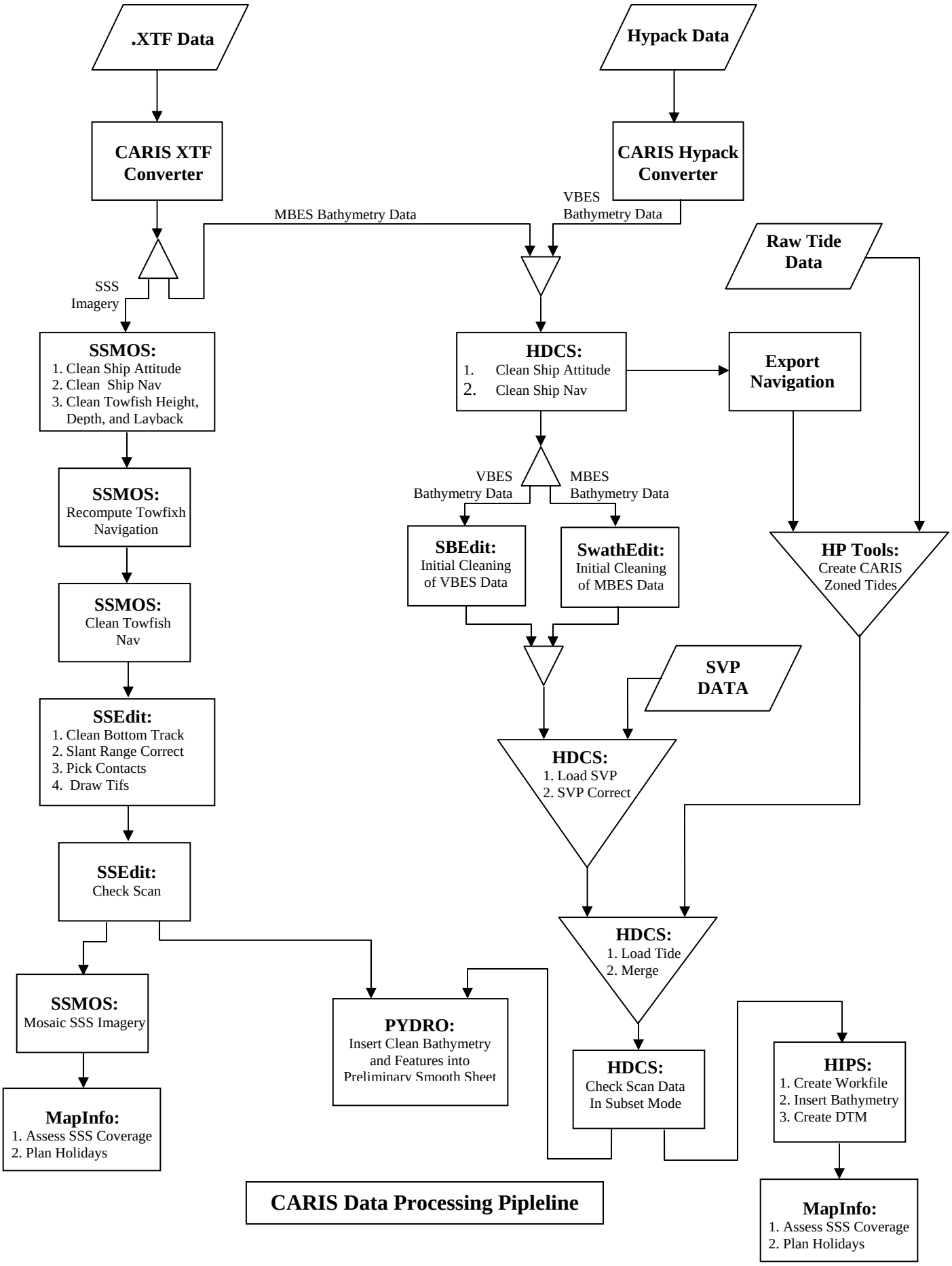
RUDE 2001 Data Acquisition Setup
Post-DN254



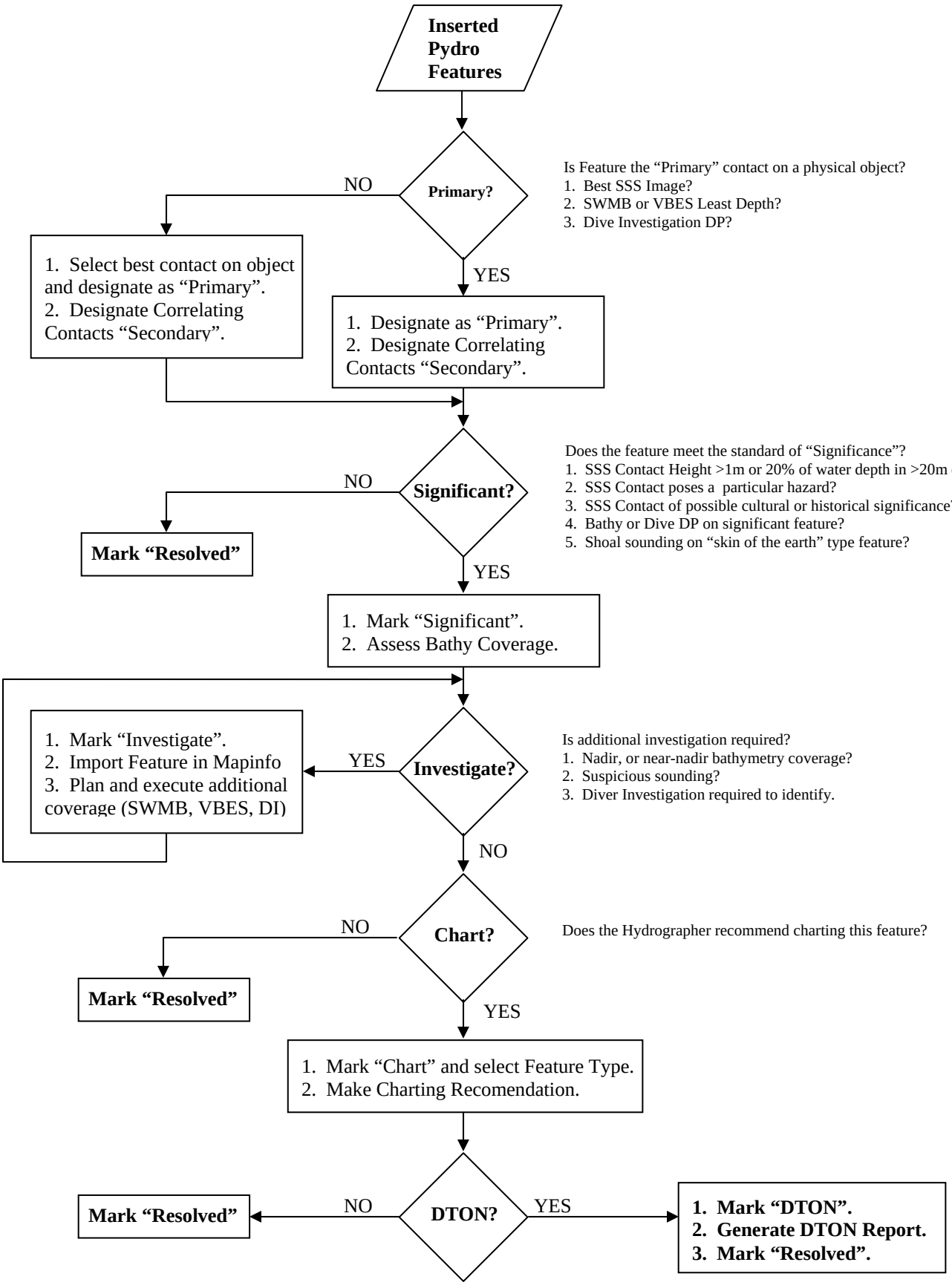
Launch 1419
2001 Data Acquisition Setup



Launch 1017
2001 Data Acquisition Setup
DN 331-341



CARIS Data Processing Pipleline



PYDRO Data Processing Pipleline

APPENDIX III

RUDE Offset Diagram

RUDE CARIS Vessel Configuration File Reports

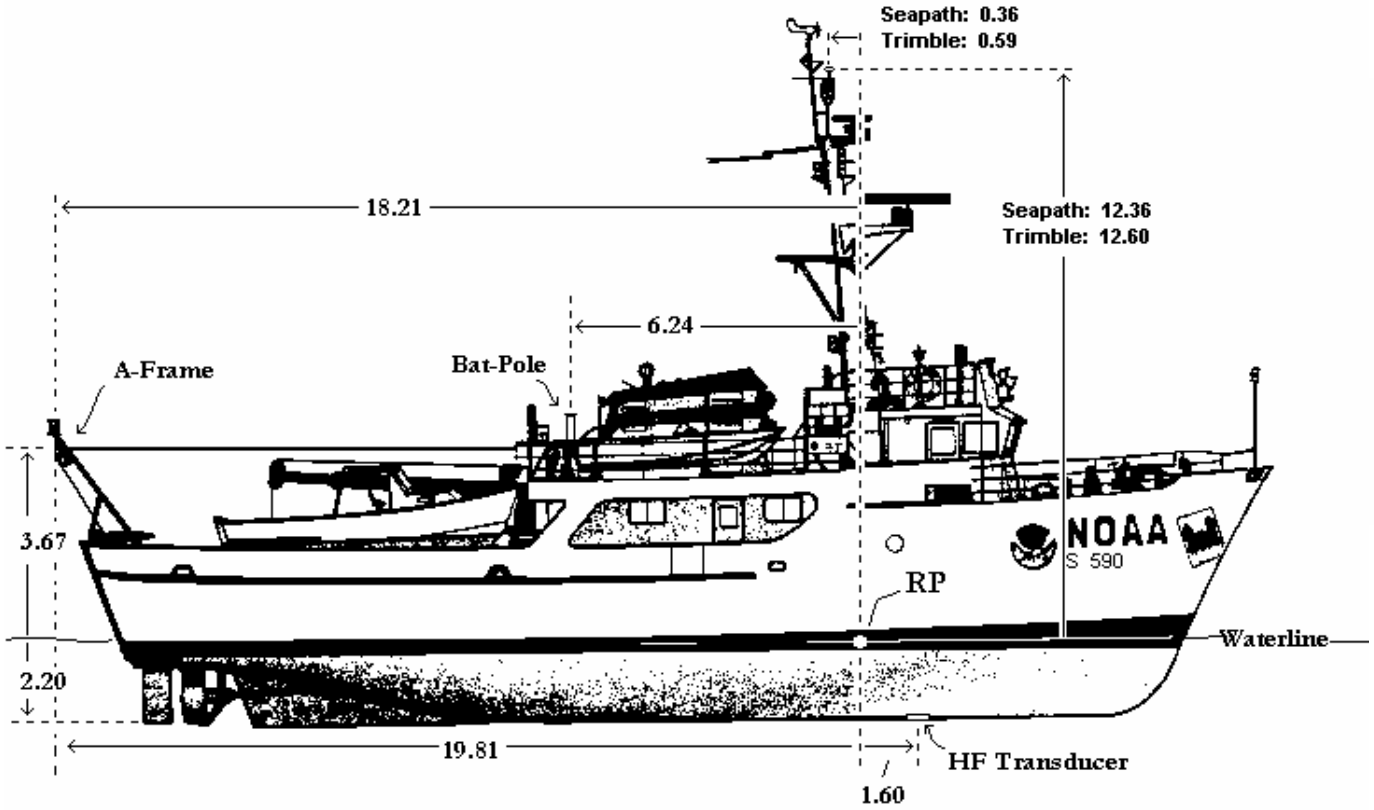
Launch 1419 Offset Diagram

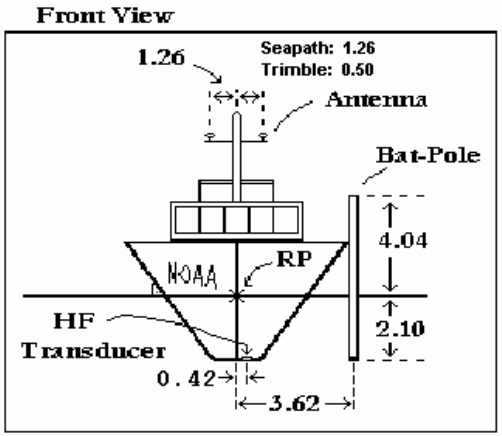
Launch 1419 Vessel Configuration File Reports

Launch 1017 Offset Diagram

Launch 1017 Vessel Configuration File Reports

NOAA Ship Rude 2000 Offsets





OFFSETS

06/08/00

System origin: **Reference Point** (Point of Least Nausea)

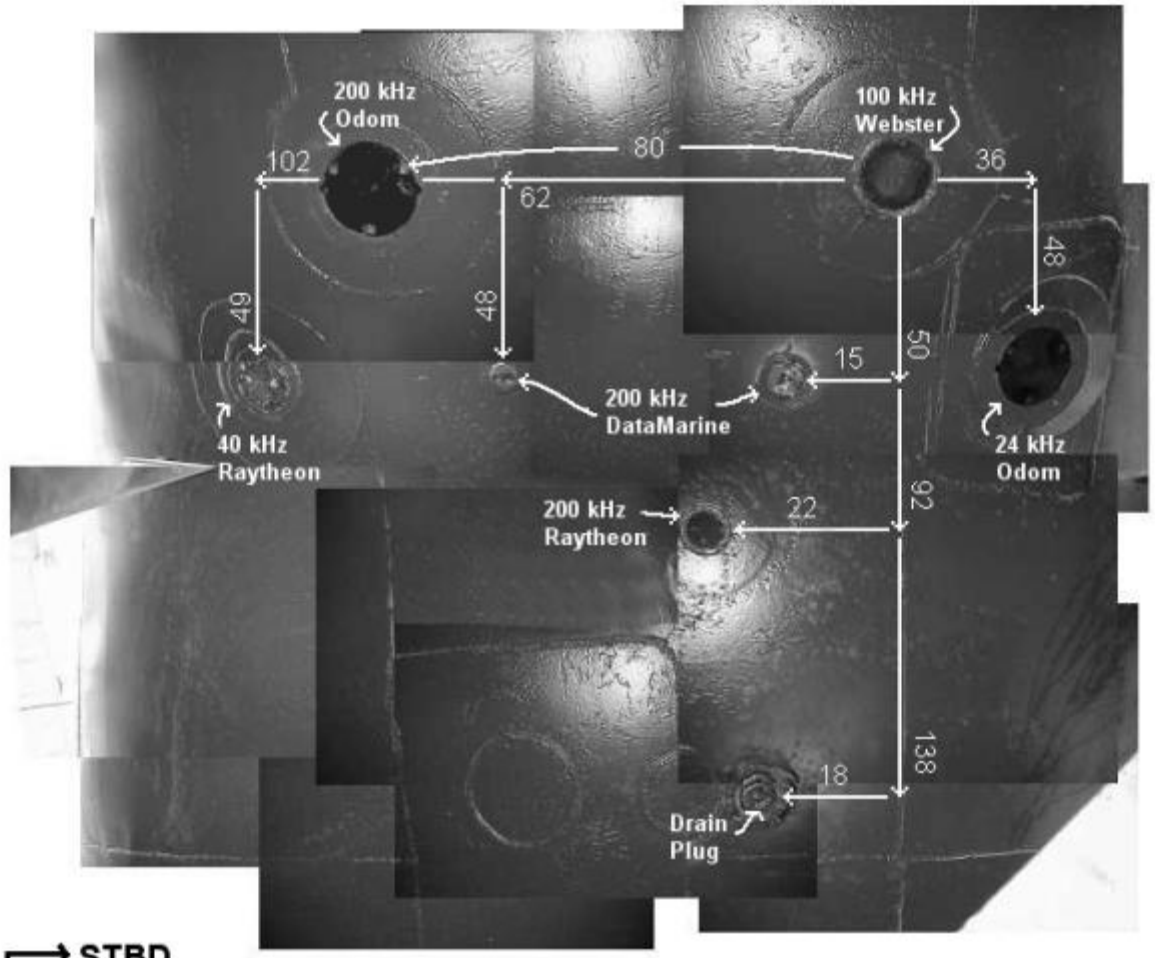
X-axis 0 at RP, positive towards starboard.
Y-axis 0 at RP, parallel with keel, positive towards bow.
Z-axis 0 at RP, positive downward.

all measurements in METERS.

SENSOR	X-axis (+ towards stbd)	Y-axis (+ towards bow)	Z-axis (+ down)
ODOM HI FREQ	-0.42	1.60	2.20
ODOM LO FREQ	0.74	1.12	2.20
SEAPTH PORT	-1.26	-0.36	-12.31
SEAPTH STBD	1.26	-0.36	-12.31
TRIMBLE ANT	-0.50	-0.59	-12.60
SEABAT HEAD	-3.62	-6.24	2.10
A-FRAME	0.00	-18.21	-3.67

Filename and location: D:\Field Ops\Sensors\Sensor Offsets\ru00offsets_image.doc

NOAA Ship RUDE Transducer Offsets



Measurements made from the 100 kHz Webster Transducer
Values in cm

CARIS Vessel RU00_MB_navgyro VCF Report

Depth Sensor:

Time Stamp: 1999-061-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.10
Roll Offset: 0.38
Azimuth Offset: -0.40

DeltaX: -3.62
DeltaY: -6.24
DeltaZ: 2.10

Manufacturer:
Model:
Serial Number:

Time Stamp: 1999-062-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.77
Roll Offset: 0.29
Azimuth Offset: 0.79

DeltaX: -3.62
DeltaY: -6.24
DeltaZ: 2.10

Manufacturer:
Model:
Serial Number:

Time Stamp: 2000-061-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.47
Roll Offset: 0.38
Azimuth Offset: 0.00

DeltaX: -3.62
DeltaY: -6.24
DeltaZ: 2.10

Manufacturer:
Model:
Serial Number:

Time Stamp: 2001-001-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 2.04
Roll Offset: 0.40
Azimuth Offset: 1.32

DeltaX: -3.62
DeltaY: -6.24
DeltaZ: 2.10

Manufacturer:
Model:
Serial Number:

Sound Velocity Correction:
Time Stamp: 1998-062-00:00

Pole #1:

Pole Top X: -3.62

Pole Top Y: -6.24
Pole Top Z: -4.04

Pole Bottom X: -3.62
Pole Bottom Y: -6.24
Pole Bottom Z: 2.10

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Gyro Sensor:

Time Stamp: 1999-062-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2001-001-00:00
Time Error: 0.00
Gyro Error: -1.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Heave Sensor:

Apply In Merge: YES

Time Stamp: 1999-062-00:00
Time Error: 0.00

Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-141-00:00
Time Error: -0.46
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-284-00:00
Time Error: -0.08
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-289-00:00
Time Error: -0.46
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-290-00:00
Time Error: -0.08
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Pitch Sensor:

Apply In Merge: YES

Time Stamp: 1999-062-00:00
Time Error: 0.00
Pitch Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-141-00:00
Time Error: -0.08

Pitch Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Roll Sensor:

Apply In Merge: YES

Time Stamp: 1999-062-00:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-141-00:00
Time Error: -0.08
Roll Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Navigation Sensor:

Time Stamp: 1999-062-00:00

Time Error: 0.41
Ellipsoid: NA83

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2000-061-00:00
Time Error: 0.18
Ellipsoid: NA83

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2001-001-00:00
Time Error: 0.10
Ellipsoid: WG84

DeltaX: -0.50
DeltaY: -0.59
DeltaZ: -12.60

Manufacturer:
Model:
Serial Number:

Draft Sensor:

Apply in Merge: YES

Time Stamp: 1999-062-00:00

Entry Number	Vessel Speed	Vessel Draft

01	2.00	0.00
02	3.00	0.01
03	3.80	0.02
04	4.90	0.04
05	5.80	0.06
06	6.50	0.08
07	7.20	0.10
08	8.60	0.15
09	10.00	0.21
10	99.00	0.21

Towed SSS:

Time Stamp: 1998-062-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 0.00
DeltaY: -17.29
DeltaZ: -3.97

Manufacturer:
Model:
Serial Number:

Time Stamp: 2000-001-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 0.00
DeltaY: -18.21
DeltaZ: -3.67

Manufacturer:
Model:
Serial Number:

WaterLine:

Apply In Merge: NO

WaterLine: 0.00
Apply In Merge: NO

WaterLine: 0.00

CARIS Vessel RU00_MB VCF Report

Depth Sensor:

Time Stamp: 1999-061-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.10
Roll Offset: 0.38
Azimuth Offset: -0.40

DeltaX: -3.62
DeltaY: -6.24
DeltaZ: 2.10

Manufacturer:
Model:
Serial Number:

Time Stamp: 1999-062-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.77
Roll Offset: 0.29
Azimuth Offset: 0.79

DeltaX: -3.62
DeltaY: -6.24
DeltaZ: 2.10

Manufacturer:
Model:
Serial Number:

Time Stamp: 2000-061-00:00

Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.47
Roll Offset: 0.38
Azimuth Offset: 0.00

DeltaX: -3.62
DeltaY: -6.24
DeltaZ: 2.10

Manufacturer:
Model:
Serial Number:

Time Stamp: 2001-001-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 2.04
Roll Offset: 0.40
Azimuth Offset: 1.32

DeltaX: -3.62
DeltaY: -6.24
DeltaZ: 2.10

Manufacturer:
Model:
Serial Number:

Time Stamp: 2002-113-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00

Azimuth Offset: 0.00

DeltaX: -3.60
DeltaY: -6.15
DeltaZ: 2.19

Manufacturer:
Model:
Serial Number:

Sound Velocity Correction:

Time Stamp: 1998-062-00:00

Pole #1:

Pole Top X: -3.62
Pole Top Y: -6.24
Pole Top Z: -4.04

Pole Bottom X: -3.62
Pole Bottom Y: -6.24
Pole Bottom Z: 2.10

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Time Stamp: 2002-112-00:00

Pole #1:

Pole Top X: -3.07
Pole Top Y: -6.15
Pole Top Z: -4.04

Pole Bottom X: -3.07
Pole Bottom Y: -6.15
Pole Bottom Z: 2.19

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Gyro Sensor:

Time Stamp: 1999-062-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2001-001-00:00
Time Error: 0.19
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2002-112-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: -0.12
DeltaY: 0.00
DeltaZ: 0.29

Manufacturer: TSS
Model: POS/MV
Serial Number:

Heave Sensor:

Apply In Merge: YES

Time Stamp: 1999-062-00:00
Time Error: 0.00
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-141-00:00
Time Error: -0.08
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2002-112-00:00
Time Error: 0.00
Heave Error: 0.00

DeltaX: -0.12
DeltaY: 0.00
DeltaZ: 0.29

Manufacturer: TSS
Model: POS/MV
Serial Number:

Pitch Sensor:
Apply In Merge: YES

Time Stamp: 1999-062-00:00
Time Error: 0.00
Pitch Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-141-00:00
Time Error: -0.08
Pitch Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2002-112-00:00
Time Error: 0.00
Pitch Error: 0.00

DeltaX: -0.12
DeltaY: 0.00
DeltaZ: 0.29

Manufacturer: TSS
Model: POS/MV
Serial Number:

Roll Sensor:

Apply In Merge: YES

Time Stamp: 1999-062-00:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2001-141-00:00
Time Error: -0.08
Roll Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Apply In Merge: YES

Time Stamp: 2002-112-00:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: -0.12
DeltaY: 0.00
DeltaZ: 0.29

Manufacturer: TSS
Model: POS/MV
Serial Number:

Navigation Sensor:

Time Stamp: 1999-062-00:00
Time Error: 0.41
Ellipsoid: NA83

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2000-061-00:00
Time Error: 0.18
Ellipsoid: NA83

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2001-001-00:00
Time Error: 0.19
Ellipsoid: NA83

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2002-112-00:00
Time Error: 0.00
Ellipsoid: WG84

DeltaX: -0.12
DeltaY: 0.00

DeltaZ: 0.29

Manufacturer: TSS
Model: POS/MV
Serial Number:

Draft Sensor:

Apply in Merge: YES

Time Stamp: 1999-062-00:00

Entry Number	Vessel Speed	Vessel Draft
01	2.00	0.00
02	3.00	0.01
03	3.80	0.02
04	4.90	0.04
05	5.80	0.06
06	6.50	0.08
07	7.20	0.10
08	8.60	0.15
09	10.00	0.21
10	99.00	0.21

Apply in Merge: YES

Time Stamp: 2002-108-00:00

Entry Number	Vessel Speed	Vessel Draft
01	0.00	0.00
02	2.85	0.01
03	4.80	0.03
04	6.75	0.09
05	7.95	0.11
06	9.10	0.19
07	10.15	0.24
08	11.10	0.28
09	20.00	0.28

Towed SSS:

Time Stamp: 1998-062-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 0.00
DeltaY: -17.29
DeltaZ: -3.97

Manufacturer:
Model:
Serial Number:

Time Stamp: 2000-001-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 0.00
DeltaY: -18.21
DeltaZ: -3.67

Manufacturer:
Model:
Serial Number:

Time Stamp: 2002-112-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 0.00
DeltaY: -17.87
DeltaZ: -3.80

Manufacturer:
Model:
Serial Number:

WaterLine:
Apply In Merge: NO

WaterLine: 0.00
Apply In Merge: NO

WaterLine: 0.00

CARIS Vessel RU00_SB_Seapath VCF Report

Depth Sensor:

Time Stamp: 2001-001-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00
Azimuth Offset: 0.00

DeltaX: -0.42
DeltaY: 1.60
DeltaZ: 2.20

Manufacturer:
Model:
Serial Number:

Sound Velocity Correction:

Time Stamp: 2001-001-00:00

Pole #1:

Pole Top X: -0.42
Pole Top Y: 1.60
Pole Top Z: 0.00

Pole Bottom X: -0.42
Pole Bottom Y: 1.60
Pole Bottom Z: 2.20

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Gyro Sensor:

Time Stamp: 2001-001-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Heave Sensor:

Apply In Merge: YES

Time Stamp: 2000-001-00:00
Time Error: 0.00
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Pitch Sensor:

Apply In Merge: YES

Time Stamp: 2001-001-00:00
Time Error: 0.00
Pitch Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:

Model:
Serial Number:

Roll Sensor:
Apply In Merge: YES

Time Stamp: 2001-001-00:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Navigation Sensor:
Time Stamp: 2001-001-00:00
Time Error: 0.00
Ellipsoid: NA83

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Draft Sensor:
Apply in Merge: YES

Time Stamp: 2001-001-00:00

Entry Number	Vessel Speed	Vessel Draft
01	2.00	0.00
02	3.00	0.01

03	3.80	0.02
04	4.90	0.04
05	5.80	0.06
06	6.50	0.08
07	7.20	0.10
08	8.60	0.15
09	10.00	0.21
10	99.00	0.21

Towed SSS:

Time Stamp: 2001-002-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 0.00
DeltaY: -18.21
DeltaZ: -3.67

Manufacturer:
Model:
Serial Number:

WaterLine:

Apply In Merge: NO

WaterLine: 0.00

CARIS Vessel RU00_SSS_Trimble VCF Report

Depth Sensor:

Time Stamp: 2001-001-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00
Azimuth Offset: 0.00

DeltaX: -0.42
DeltaY: 1.60
DeltaZ: 2.20

Manufacturer:
Model:
Serial Number:

Sound Velocity Correction:

Time Stamp: 2001-001-00:00

Pole #1:

Pole Top X: -0.42
Pole Top Y: 1.60
Pole Top Z: 0.00

Pole Bottom X: -0.42
Pole Bottom Y: 1.60
Pole Bottom Z: 2.20

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Gyro Sensor:

Time Stamp: 2001-001-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Heave Sensor:

Apply In Merge: YES

Time Stamp: 2000-001-00:00
Time Error: 0.00
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Pitch Sensor:

Apply In Merge: YES

Time Stamp: 2001-001-00:00
Time Error: 0.00
Pitch Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:

Model:
Serial Number:

Roll Sensor:
Apply In Merge: YES

Time Stamp: 2001-001-00:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Navigation Sensor:
Time Stamp: 2001-001-00:00
Time Error: 0.18
Ellipsoid: NA83

DeltaX: -0.50
DeltaY: -0.56
DeltaZ: -12.51

Manufacturer:
Model:
Serial Number:

Draft Sensor:
Apply in Merge: YES

Time Stamp: 2001-001-00:00

Entry Number	Vessel Speed	Vessel Draft
01	2.00	0.00
02	3.00	0.01

03	3.80	0.02
04	4.90	0.04
05	5.80	0.06
06	6.50	0.08
07	7.20	0.10
08	8.60	0.15
09	10.00	0.21
10	99.00	0.21

Towed SSS:

Time Stamp: 2001-001-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 0.00
DeltaY: -18.21
DeltaZ: -3.67

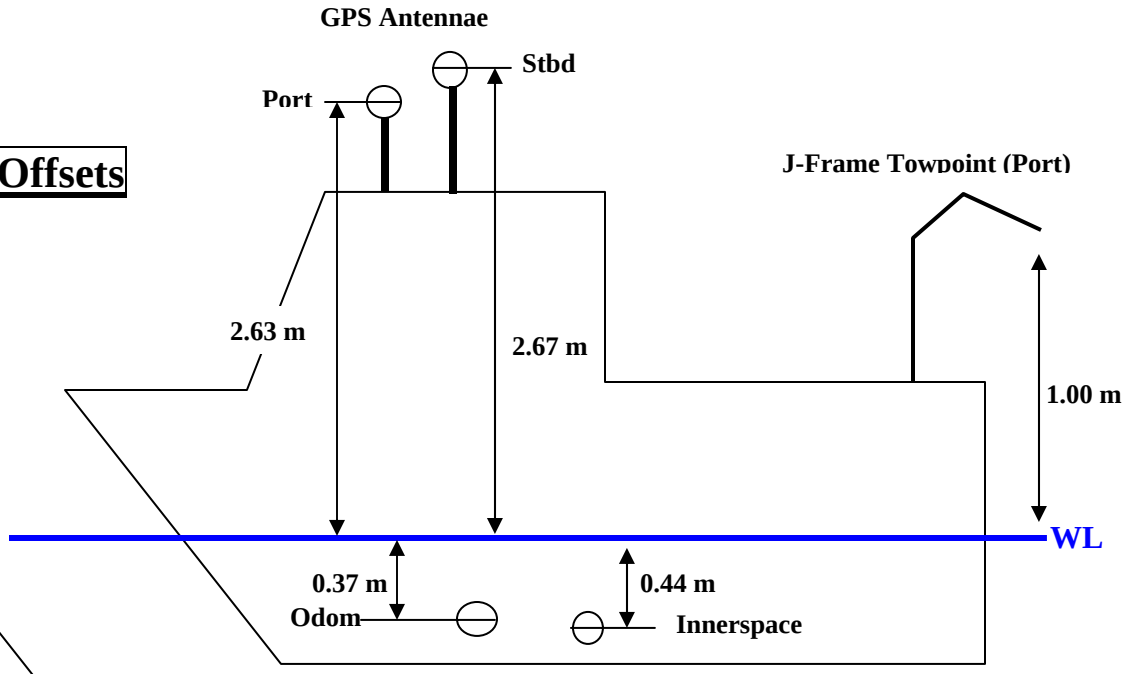
Manufacturer:
Model:
Serial Number:

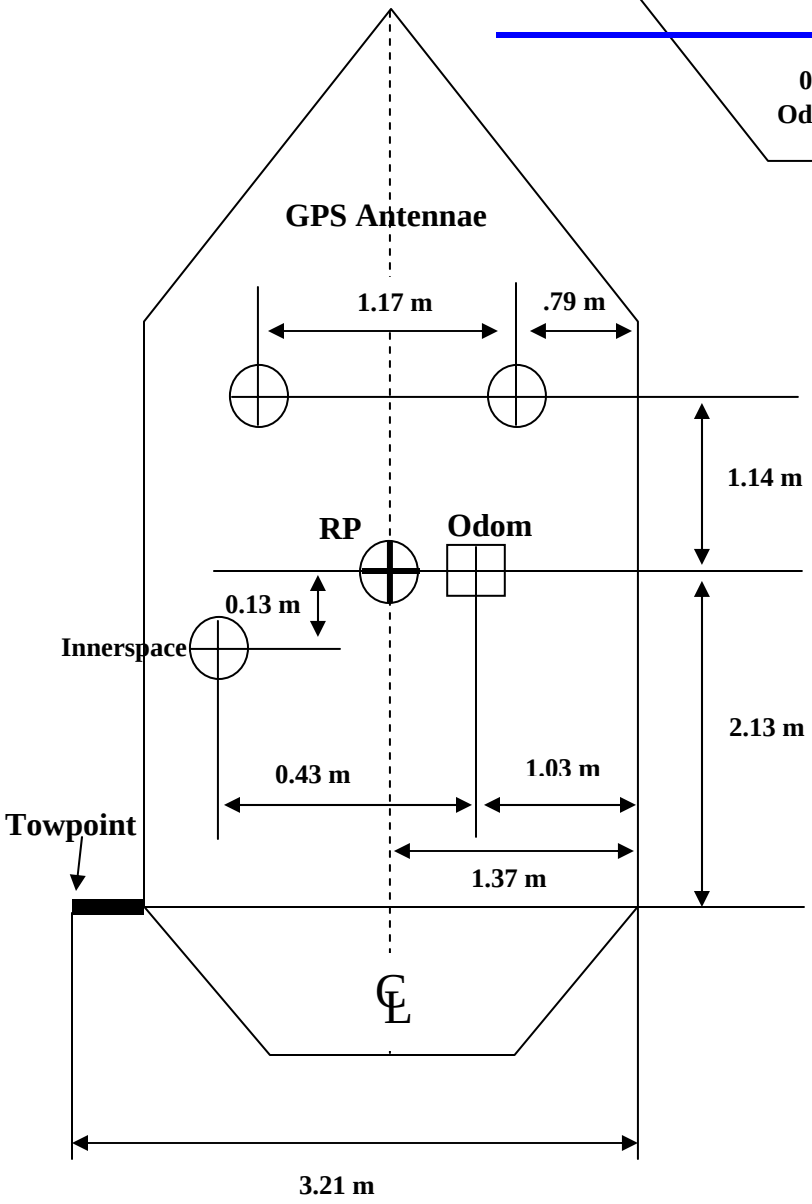
WaterLine:

Apply In Merge: NO

WaterLine: 0.00

Launch 1419 Offsets





Launch 1419 Offsets		
July 1, 2000		
Vertical Offsets above Odom Transducer	Inches	Meters
Odom to Port Antenna	118.00	2.99
Odom to STBD Antenna	119.75	3.04
Odom to J-frame towpoint	85.25	2.16
Vertical Offsets to Innerspace Transducer		
Innerspace to Port Antenna	120.50	3.06
Innerspace to STBD Antenna	122.25	3.10
Innerspace to J-frame towpoint	87.75	2.23
Odom Offsets Fore and Aft		
Odom Port Antenna	45.00	1.143
Odom STBD Antenna	45.00	1.143
Odom Towfish Towpoint	83.75	2.12725
Odom Offsets Port-STBD		
Odom Port Antenna	36.5	0.9271
Odom STBD Antenna	9.5	0.2413
Odom Towfish Towpoint	87.875	2.232025
Innerspace Offsets for AFT		
Inner to Port	50	1.27
Inner to STBD	50	1.27
Inner to Towpoint	78.75	2.00025
Innerspace Offsets Port-STBD		
Inner to Port Antenna	19.5	0.4953
Inner to STBD Antenna	26.5	0.6731

CARIS Vessel RU01_SB VCF Report

Depth Sensor:

Time Stamp: 2001-211-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00
Azimuth Offset: 0.00

DeltaX: 0.34
DeltaY: 0.00
DeltaZ: 0.37

Manufacturer:
Model:
Serial Number:

Sound Velocity Correction:

Time Stamp: 2001-211-00:00

Pole #1:

Pole Top X: 0.34
Pole Top Y: 0.00
Pole Top Z: 0.37

Pole Bottom X: 0.34
Pole Bottom Y: 0.00
Pole Bottom Z: 0.37

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Gyro Sensor:

Time Stamp: 2001-211-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2002-070-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Heave Sensor:

Apply In Merge: YES

Time Stamp: 2002-070-00:00
Time Error: -0.12
Heave Error: 0.00

DeltaX: -0.69
DeltaY: 0.27
DeltaZ: -0.14

Manufacturer:
Model:
Serial Number:

Pitch Sensor:

Apply In Merge: YES

Time Stamp: 2002-070-00:00
Time Error: -0.12
Pitch Error: 0.00

DeltaX: -0.69
DeltaY: 0.27
DeltaZ: -0.14

Manufacturer:
Model:
Serial Number:

Roll Sensor:

Apply In Merge: YES

Time Stamp: 2002-070-00:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: -0.69
DeltaY: 0.27
DeltaZ: -0.14

Manufacturer:
Model:
Serial Number:

Navigation Sensor:

Time Stamp: 2001-211-00:00
Time Error: 0.00
Ellipsoid: WG84

DeltaX: 0.58
DeltaY: 1.14
DeltaZ: -2.67

Manufacturer:
Model:

Serial Number:

Draft Sensor:

Apply in Merge: YES

Time Stamp: 2001-211-00:00

Entry Number	Vessel Speed	Vessel Draft
01	0.00	0.00
02	1.70	-0.01
03	3.20	0.01
04	5.00	0.01
05	5.60	0.04
06	6.00	0.05
07	7.00	0.03
08	7.80	0.01
09	10.20	-0.08
10	13.70	-0.19

Towed SSS:

Time Stamp: 2001-211-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: -1.84
DeltaY: -2.13
DeltaZ: -1.79

Manufacturer:
Model:
Serial Number:

WaterLine:

Apply In Merge: NO

WaterLine: 0.00

CARIS Vessel RU01_SSS VCF Report

Depth Sensor:

Time Stamp: 2001-211-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00
Azimuth Offset: 0.00

DeltaX: 0.34
DeltaY: 0.00
DeltaZ: 0.37

Manufacturer:
Model:
Serial Number:

Sound Velocity Correction:

Time Stamp: 2001-211-00:00

Pole #1:

Pole Top X: 0.34
Pole Top Y: 0.00
Pole Top Z: 0.37

Pole Bottom X: 0.34
Pole Bottom Y: 0.00
Pole Bottom Z: 0.37

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Gyro Sensor:

Time Stamp: 2001-211-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2002-070-00:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Heave Sensor:

Apply In Merge: NO

Time Stamp: 2002-070-00:00
Time Error: 0.00
Heave Error: 0.00

DeltaX: -0.69
DeltaY: 0.27
DeltaZ: -0.14

Manufacturer:
Model:
Serial Number:

Pitch Sensor:

Apply In Merge: NO

Time Stamp: 2002-070-00:00
Time Error: 0.00
Pitch Error: 0.00

DeltaX: -0.69
DeltaY: 0.27
DeltaZ: -0.14

Manufacturer:
Model:
Serial Number:

Roll Sensor:

Apply In Merge: NO

Time Stamp: 2002-070-00:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: -0.69
DeltaY: 0.27
DeltaZ: -0.14

Manufacturer:
Model:
Serial Number:

Navigation Sensor:

Time Stamp: 2001-211-00:00
Time Error: 0.00
Ellipsoid: WG84

DeltaX: 0.58
DeltaY: 1.14
DeltaZ: -2.67

Manufacturer:
Model:

Serial Number:

Draft Sensor:

Apply in Merge: YES

Time Stamp: 2001-211-00:00

Entry Number	Vessel Speed	Vessel Draft
01	0.00	0.00
02	1.70	-0.01
03	3.20	0.01
04	5.00	0.01
05	5.60	0.04
06	6.00	0.05
07	7.00	0.03
08	7.80	0.01
09	10.20	-0.08
10	13.70	-0.19

Towed SSS:

Time Stamp: 2001-211-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: -1.84
DeltaY: -2.13
DeltaZ: -1.79

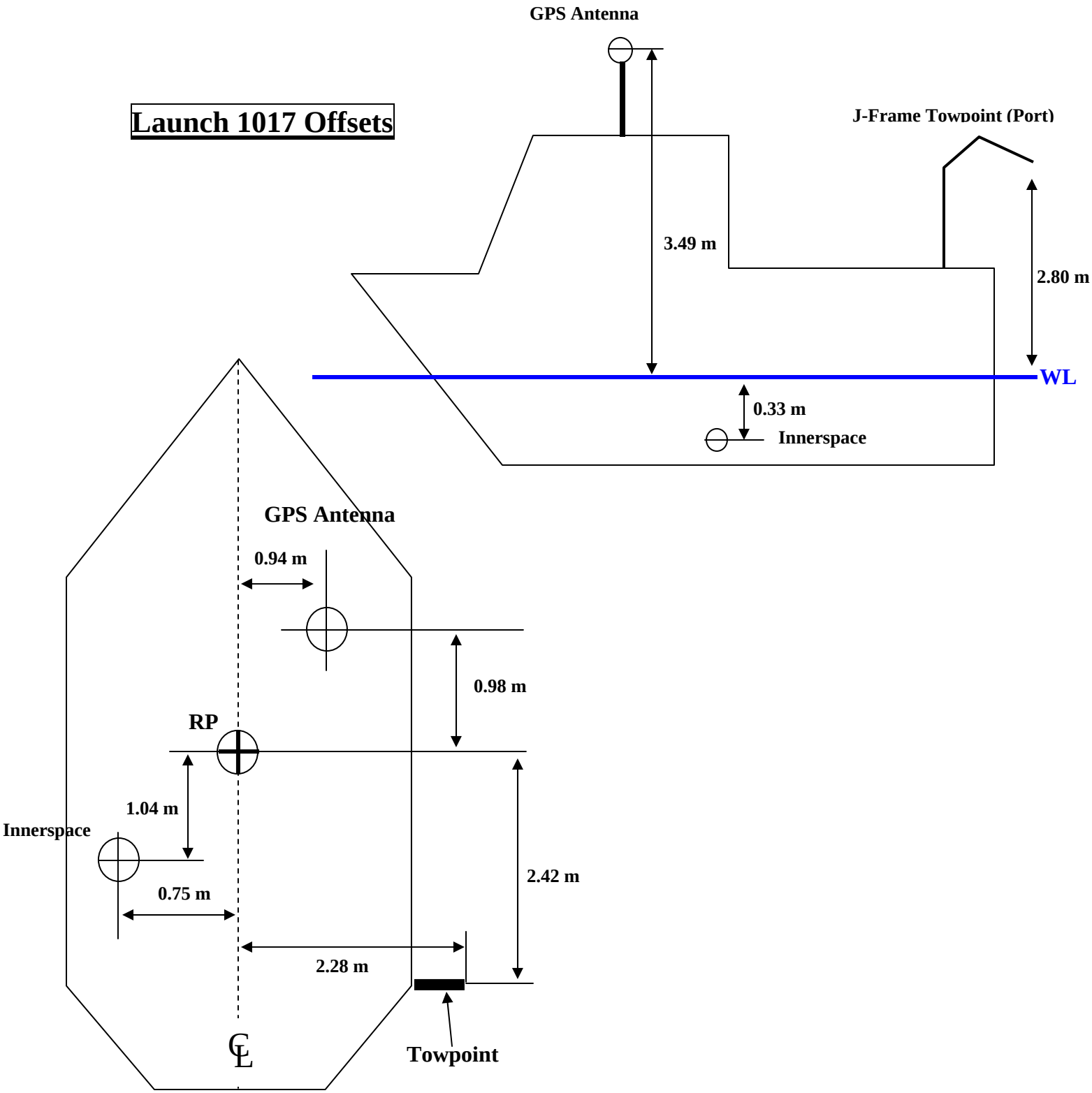
Manufacturer:
Model:
Serial Number:

WaterLine:

Apply In Merge: NO

WaterLine: 0.00

Launch 1017 Offsets



CARIS Vessel RU02_SB VCF Report

Depth Sensor:

Time Stamp: 2001-001-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00
Azimuth Offset: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2001-001-01:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00
Azimuth Offset: 0.00

DeltaX: -0.75
DeltaY: -1.04
DeltaZ: 0.33

Manufacturer:
Model:
Serial Number:

Sound Velocity Correction:

Time Stamp: 2001-001-01:00

Pole #1:

Pole Top X: -0.75
Pole Top Y: -1.04
Pole Top Z: 0.33

Pole Bottom X: -0.75
Pole Bottom Y: -1.04
Pole Bottom Z: 0.33

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Gyro Sensor:

Time Stamp: 2001-001-01:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Heave Sensor:

Apply In Merge: NO

Time Stamp: 2001-001-00:00
Time Error: 0.00
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Pitch Sensor:
Apply In Merge: NO

Time Stamp: 2001-001-01:00
Time Error: 0.00
Pitch Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Roll Sensor:
Apply In Merge: NO

Time Stamp: 2001-001-01:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Navigation Sensor:
Time Stamp: 2001-001-01:00
Time Error: 0.00
Ellipsoid: NA83

DeltaX: 0.94
DeltaY: 0.98
DeltaZ: -3.49

Manufacturer:
Model:
Serial Number:

Draft Sensor:

Apply in Merge: YES

Time Stamp: 2001-001-01:00

Entry Number	Vessel Speed	Vessel Draft
01	0.00	0.00
02	1.70	0.10
03	6.00	0.00
04	10.00	-0.10

Towed SSS:

Time Stamp: 2001-001-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 2.28
DeltaY: -2.42
DeltaZ: -2.80

Manufacturer:
Model:
Serial Number:

WaterLine:

Apply In Merge: YES

WaterLine: 0.00

CARIS Vessel RU02_SSS VCF Report

Depth Sensor:

Time Stamp: 2001-001-00:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00
Azimuth Offset: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Time Stamp: 2001-001-01:00
Sensor Class: Swath

Time Error: 0.00
Draft Error: 0.00

Pitch Offset: 0.00
Roll Offset: 0.00
Azimuth Offset: 0.00

DeltaX: -0.75
DeltaY: -1.04
DeltaZ: 0.33

Manufacturer:
Model:
Serial Number:

Sound Velocity Correction:

Time Stamp: 2001-001-01:00

Pole #1:

Pole Top X: -0.75
Pole Top Y: -1.04
Pole Top Z: 0.33

Pole Bottom X: -0.75
Pole Bottom Y: -1.04
Pole Bottom Z: 0.33

Roll Offset: 0.00
Pitch Offset: 0.00
Azimuth Offset: 0.00

Gyro Sensor:

Time Stamp: 2001-001-01:00
Time Error: 0.00
Gyro Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Heave Sensor:

Apply In Merge: NO

Time Stamp: 2001-001-00:00
Time Error: 0.00
Heave Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Pitch Sensor:
Apply In Merge: NO

Time Stamp: 2001-001-01:00
Time Error: 0.00
Pitch Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Roll Sensor:
Apply In Merge: NO

Time Stamp: 2001-001-01:00
Time Error: 0.00
Roll Error: 0.00

DeltaX: 0.00
DeltaY: 0.00
DeltaZ: 0.00

Manufacturer:
Model:
Serial Number:

Navigation Sensor:
Time Stamp: 2001-001-01:00
Time Error: 0.00
Ellipsoid: NA83

DeltaX: 0.94
DeltaY: 0.98
DeltaZ: -3.49

Manufacturer:
Model:
Serial Number:

Draft Sensor:

Apply in Merge: YES

Time Stamp: 2001-001-01:00

Entry Number	Vessel Speed	Vessel Draft
01	0.00	0.00
02	1.70	0.10
03	6.00	0.00
04	10.00	-0.10

Towed SSS:

Time Stamp: 2001-001-00:00
Time Error: 0.00
Layback Error: 0.00

DeltaX: 2.28
DeltaY: -2.42
DeltaZ: -2.80

Manufacturer:
Model:
Serial Number:

WaterLine:

Apply In Merge: YES

WaterLine: 0.00

APPENDIX IV

RUDE Settlement and Squat Report

Launch 1419 Settlement and Squat Report

RUDE Reference Surface Report

Lead Line / Divers Least Depth Gauge Comparison Report

CTD Calibration Reports

Digibar Pro Calibration Reports

Divers Least Depth Gauge Calibration Report

Level Calibration Report

Reference Surface Test Report

NOAA Ship RUDE (s590)
14 March 2001 (DN073)

On Wednesday, March 14 2001, NOAA Ship RUDE conducted a reference surface test to assess the performance of the Seabat 9003 (SN 10496-447020) Shallow Water Multi-Beam system. Data from this test were processed according to standard RUDE procedure, and analyzed using the "QC Report" utility in CARIS HIPS. Statistical comparison of inner and outer beams confirmed that under the conditions of this test, RUDE's SWMB system meets the IHO S44 4th Ed. "Order 1" standard for hydrographic surveys as specified in the NOAA Specifications and Deliverables.

The reference surface test was performed in approximately 20 meters of water over a flat bottom in an area 4 nautical miles northwest of Cape Charles Harbor in Chesapeake Bay. Seabat 9003 data was acquired over a pattern of 16 crossing lines spaced to allow approximately 50% swath overlap between adjacent lines. The north-south lines were treated as main scheme lines, while the east-west lines were imported as checklines. A chartlet showing the test area and survey lines is attached to this report.

Weather and sea conditions during the time of the test were ideal, with light wind, seas less than 1 foot, and no swell. All data was acquired according to standard RUDE procedures, with ship speed held to 5 knots to increase sounding density in the areas of overlap to increase the size of the data set for statistical analysis.

Multibeam soundings were processed in CARIS-HIPS according to standard RUDE procedure. Sound velocity correctors derived from a CTD cast taken at the time of the survey were applied, and the data was merged with offsets values determined from a patch test conducted earlier in the day. A HIPS workfile was created, and the north-south lines (300-307) were imported as main scheme lines, while the east-west lines (308-315) were imported as checklines. No binning was applied to the soundings on import. A DTM of the main scheme lines was created at 1m grid size.

The “QC Report” utility was run to compare the main scheme and cross lines, the results of which are attached. "Classification Report 2" shows that under the conditions at the time of the survey, all beams processed used to generate soundings (3-38) meet the IHO S44 4th Ed. "Order 1" standard, as required in the NOAA Specifications and Deliverables. In addition, "Classification Report 1" shows that for this survey, beams 3-38 also met the "Special Order" standard.

Lead Line Comparison Report

NOAA Ship RUDE (s590)
27 February 2001 (DN058)

On Tuesday, February 27 2001 (DN 058) at approximately 2045 UTC, NOAA Ship RUDE conducted a lead line comparison check to confirm the performance of the ship's multibeam and singlebeam echosounders, and resolve questions regarding the accuracy of RUDE's diver least depth gauge. A second least depth gauge was borrowed from NOAA Ship WHITING for the test for comparison with the RUDE's gauge.

The ship was anchored in approximately twelve meters of water in the Lynnhaven Roads "B" Anchorage. Before anchoring, a cursory multi-beam echosounder survey was conducted to confirm that the bottom at the proposed test site was flat and free of obstructions. After anchoring, divers were deployed in buddy pairs, each pair with a diver least depth gauge. Once the divers were in the water, single beam and multi beam data acquisition was started. The lead line was deployed from the port rail immediately aft of the multi-beam sonar head. While sonar data was acquired, each pair of divers dove to the bottom twice to read its gauge. When the divers at the bottom signaled that they were ready, the divers at the surface continuously reported lead line readings to a recorder on deck. During the dives, a CTD cast was taken to correct the echosounder and diver least depth gauge data. Once each of the diver least depth gauges had been read twice and the corresponding lead line depths were recorded, sonar data acquisition was secured.

Conditions at the test site were calm with wave heights less than one foot and no observable swell. The time of the test coincided with slack water at low tide. The divers observed a slight (~0.25 knot) current during the test, which had a negligible affect on the lead line reading accuracy. The bottom at the test site was a hard clay-sand mixture, covered with a layer of silty sand.

All data were acquired and processed according to standard RUDE procedures. Lead line depths were obtained by averaging the stream of readings reported by the divers at the surface for each least depth gauge reading, and converting to meters. Likewise, single and multi-beam depths were obtained by averaging a range of observed depths at the time of each dive. Diver least depth gauge depths were processed in Velociwin 5.05. As the test was conducted at low water and was complete within 10 minutes, no tide correctors were applied to the soundings.

Results of the test are tabulated on the following page. These results confirmed that under the prevailing conditions at the time of the test, RUDE's survey systems meet the IHO S44 4th Edition "Order 1" standard for hydrographic survey depth sounding accuracy as specified in the NOAA Specifications and Deliverables.

NOAA Ship RUDE

Lead Line Calibration

February 27, 2001

2045 UTC

Test Location-

"B" Anchorage, Lynnhaven Roads
lattitude 36° 57' 24"N, longitude 76° 04' 36" W

Equipment-

Single Beam Echosounder:	Odom Echotrac DF3200 Mk II, SN 9641
Multi Beam Echosounder:	Reson Seabat 9003, SN 10496-447020
RUDE Diver Least Depth Gauge:	SN 68336
WHITING Diver Least Depth Gauge:	SN 68332

Personnel-

Acquisition:	LCDR Jamie Verlaque
Divers:	LT Jim Crocker
	ENS Ben Evans
	ENS Wally Pierce
	ST Prentiss Lund
Lead Line:	CB Gordon Pringle
Recorder:	OS Dennis Riley

Results-

Dive	Time (UTC)	Lead Line Depth (ft)	Lead Line Depth (m)	RU Gauge Depth	WH Gauge Depth	SBES Depth	MBES Depth
1	2045	39.25	11.96	12.08	11.86	11.9	11.9
2	2049	39.25	11.96	12.05	11.86	11.9	11.9