Standard Operation Procedures

R/V SHEARWATER

US GEOLOGICAL SURVEY

Post Hurricane Sandy
Inner Shelf Bathymetry Survey

REVISION HISTORY						
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Table Of Contents

1. GENERAL

1.2 Abbreviations

Alpine	Alpine Ocean Seismic Survey
CD ROM	Compact Disk Read Only Memory
CTD	Conductivity, Temperature, Depth
GAMS	GPS Azimuth Measurements Subsystem
GPS	Global Positioning System
HAZID	Hazard Identification
IMU	Inertial Measurement Unit
MBES	Multibeam Echosounder
MRU	Motion Reference Unit
NAVD	North American Vertical Datum
NMEA	National Marine Electronic Association
PDOP	Position Diluition of Precision
PPK	Post Processing Kinematic
PPS	Pulse Per Second
QA	Quality Assurance
QC	Quality Control
R/V	Research Vessel
SOW	Scope of Work
SVP	Sound Velocity Profiler
UTM	Universal Transverse Mercator (Charting Projection)
XTF	eXtended Triton Format (standard hydrography data format)
WD	Water Depth
ZDA	NMEA sentence containing Data and Time

1.1 Purpose and Scope

The scope of the work includes the acquisition of swath bathymetry data of the inner continental shelf off the coastline of Western New York. The specific project areas of the BASIC SOW are: western New York in Queens, Nassau and Suffolk Counties, including:

1) Rockaways
2) Long Beach
3) Fire Island Inlet to Watch Hill

up to 5 km offshore.

OPTIONAL WORK may include an additional optional area within Suffolk County:

4) Watch Hill to Moriches Inlet, up to 8 km offshore
5) Fire Island to Watch Inlet, extended from 5 km to 8 km offshore

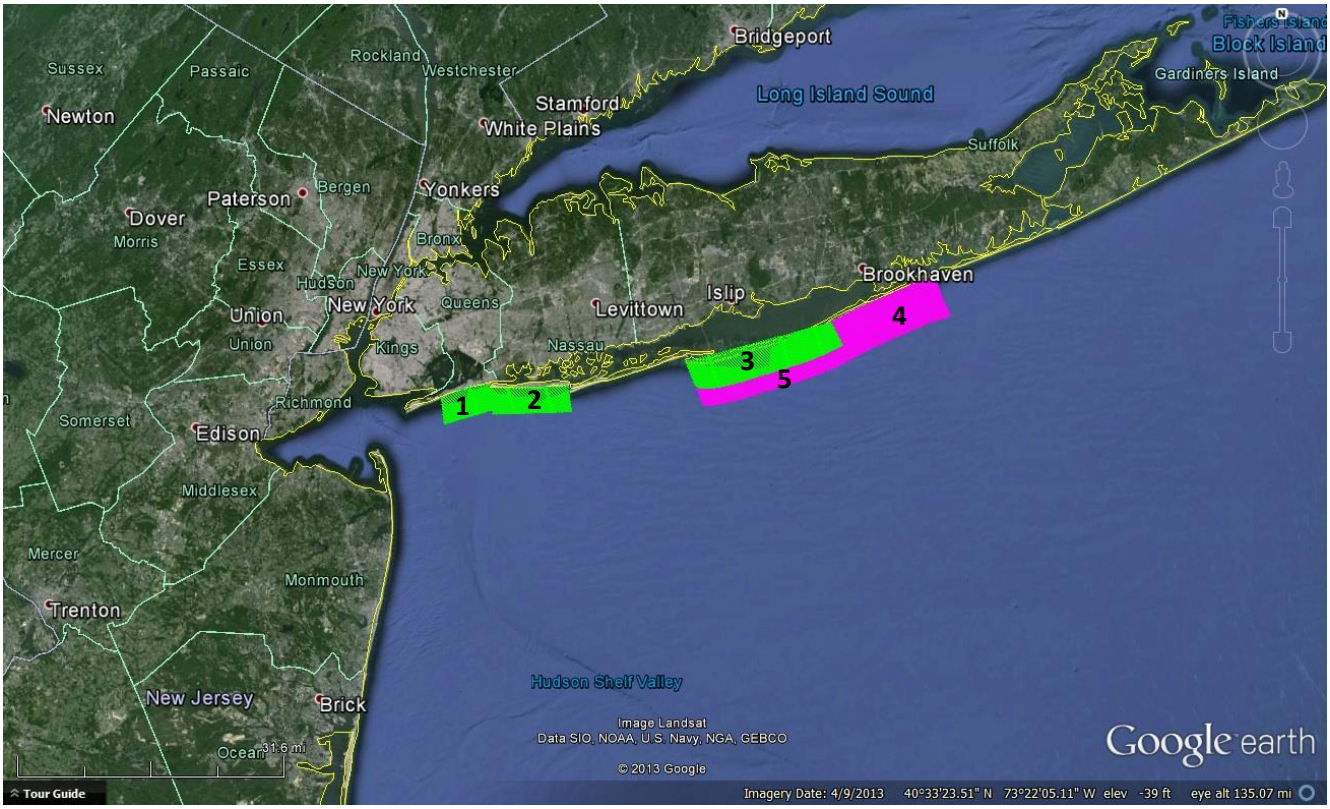

Figure 1 - Survey Areas

2. SUMMARY OF PROJECT

2.1 Geodetic Parameters and Reference Datum

The horizontal datum will be WGS 84 with UTM 18N projection. The unit of measure will be meters.

2.2 Vertical Datum

The vertical datum will be NAVD88, meters.

2.3 Equipment

To carry out the service, Alpine will employ the following equipment:

- 2 x R2Sonic 2024 MBES (dual head configuration), to provide high resolution and wide swath bathymetry (up to 9 x WD)
- Valeport Mini-SVS, for MBES beam forming
- AML Plus –X SVP and/or YSI CastAway CTD, to collect sound velocity profile along the water column
- Applanix PosMV, for positioning and attitude correction, composed of a dual GPS antenna receiver and a IMU.
- QINSy software, for navigation, multibeam data acquisition and QC

- PosPac software for data positioning QC and PPK correction
- CARIS software for multibeam data processing
- Autocad software for onboard charting

All of the above equipment will be installed on the R/V Shearwater, a 110 foot aluminum tri-maran research vessel owned by Alpine.

In Figure 2 is presented a scheme of the proposed installation, while Figure 3 shows a schematic diagram of the equipment interfacing.

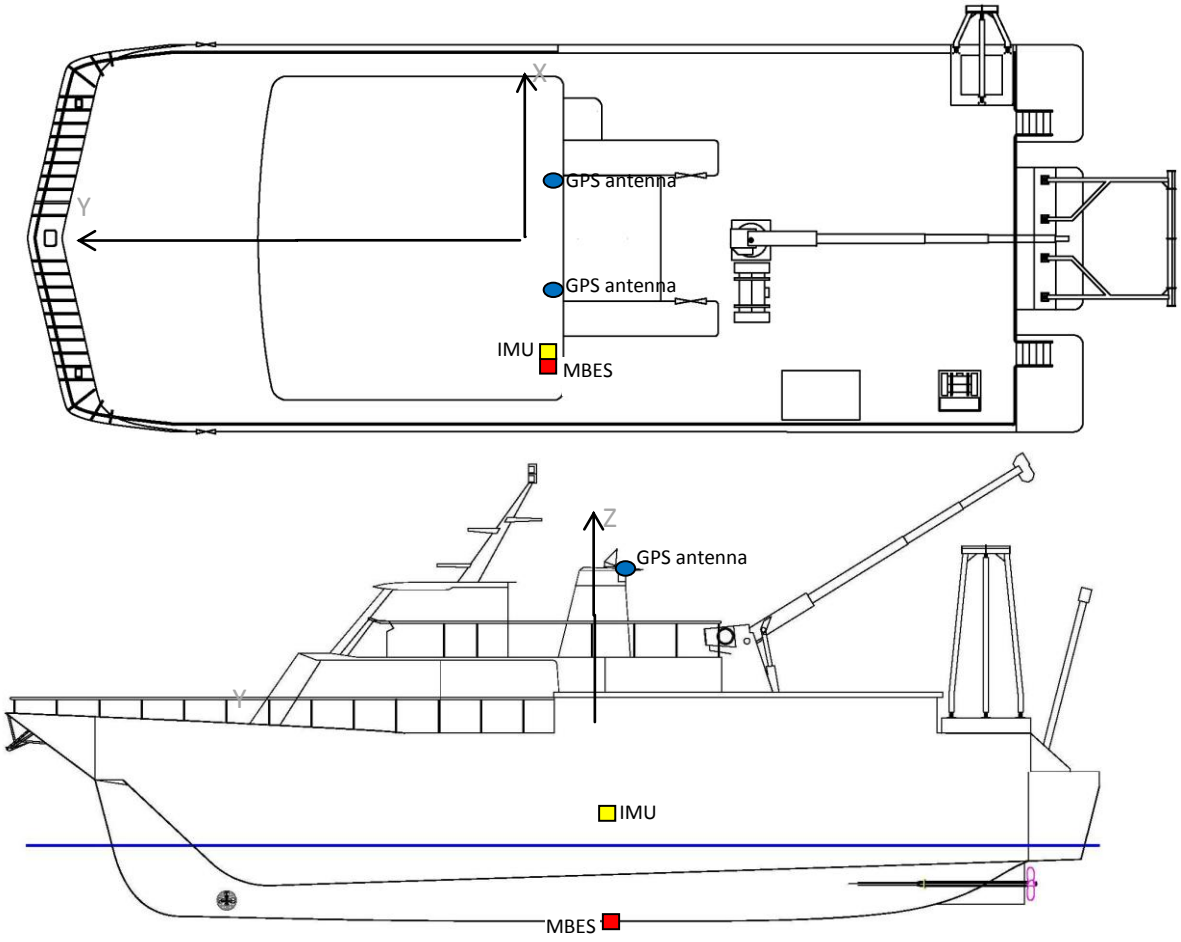

Figure 2 - Equipment Installation Diagram (not to scale).

The MBES will be mounted on the port side moon pool, while the IMU will be installed on the top moon pool plate, above the MBES transducers. The two GPS antennas (which will provide position and heading), will be installed on a custom designed support on the second deck.

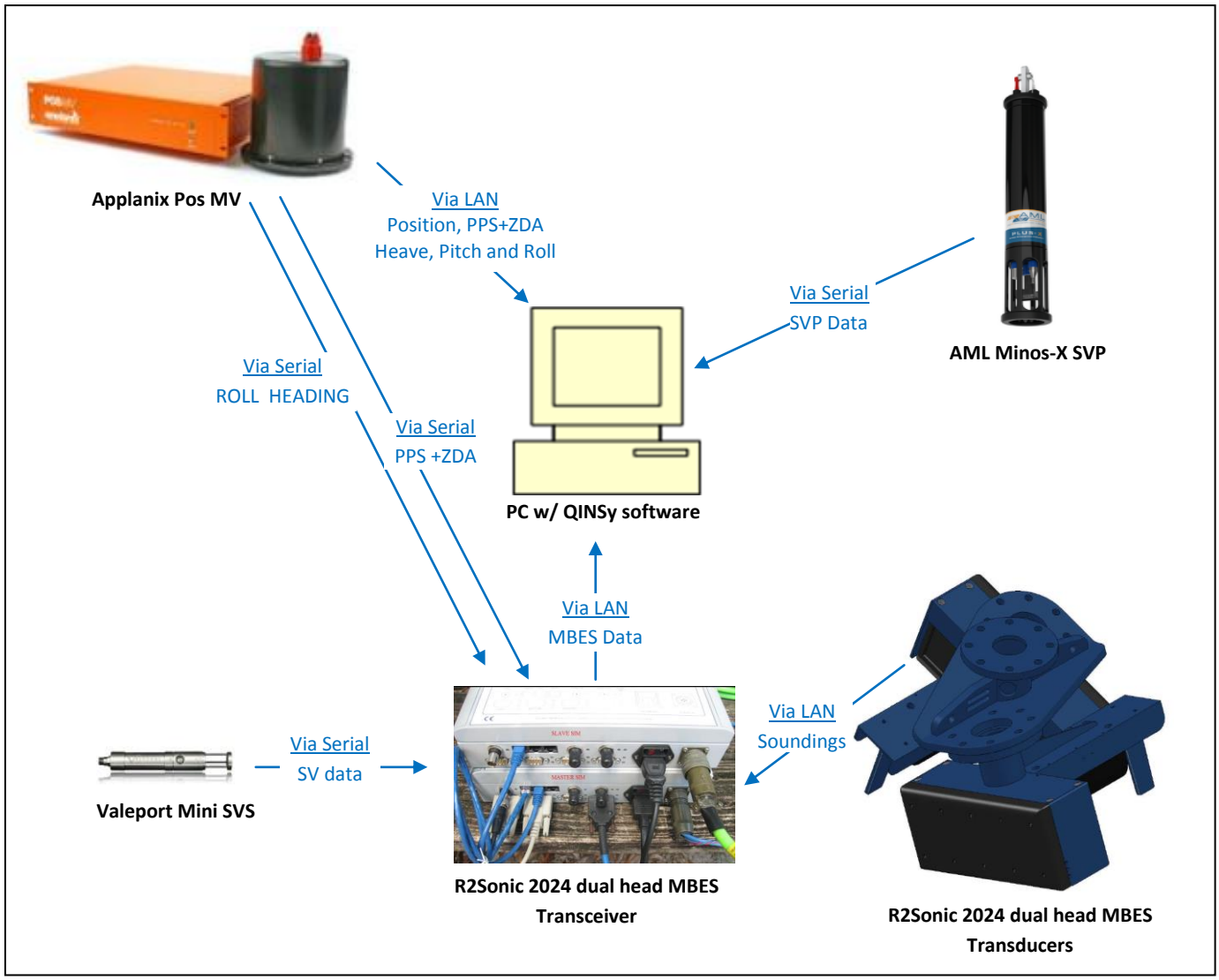

Figure 3 -Equipment Interfacing Diagram

2.4 Line Plan

The survey areas will be investigated by a series of parallel lines spaced at 100m intervals. The data will be collected from the nearest point to shore feasible for safe vessel operations (nominally 15 feet WD) out to 5 km offshore. Survey will be extended up to 8 km in optional areas of Fire Island (4 and 5 in Figure 1).

The estimated total km of survey lines for the basic SOW amount to 3,013 km and to 2,578 for the optional SOW.

3. MOBILIZATION AND CALIBRATION

3.1 Preparation & Mobilization

All the equipment will be tested and prepared for shipment at Alpine's office, following the detailed procedures and specific forms as per Alpine's QC/QA manual and the Project Specific HSE Plan and HAZID.

3.2 Equipment Installation, Testing and Calibration

3.2.1 POS MV

The Applanix PosMV 320 will be used both for positioning and MRU.
The IMU sensor will be installed inside the boat, on top of the moon pool where the multibeam will be deployed through. The two antennas will be positioned on the second deck, on a custom built support (see Figure 2). The position for the IMU and antennas are materialized on the vessel by the respective mounting supports permanently welded into the boat. These positions have been surveyed with a total station and will be re-checked for QC before commencing the survey. The antenna mountings have been installed at a 90 degrees angle with the boat longitudinal axis (Y axis on Figure 2), while the IMU has been carefully aligned along the same axis.
Nevertheless, the factory suggested calibration sequence will be followed for QC purposes to verify and proof the correct installation.

The GPS Azimuth Measurement Subsystem (GAMS) Solution will be calculated as follows:

- The GAMS calibration will only be performed when the number of satellites in view exceeds 5 and PDOP is less than 3.0. If the GPS environment is OK, and SVs do not fix within 45 minutes, there may be a multipath problem. This will be adjusted prior to starting GAMS calibration
- The vessel will be maneuvered through moderately aggressive turns (figure 8's) incorporating changes of speed and direction.
- The operator will then wait for the Heading Accuracy to show accuracy below the threshold value entered (more than zero and less than 1 degree - trying to obtain lowest value possible) and for the GAMS Status to show Ready Offline.
- Vessel motion will then be stopped and the vessel held to a constant heading.
- GAMS Calibration will be started.
- Once GAMS calibration is completed the values will be saved into the system.
- The GAMS calibration values will also be recorded on the POS MV calibration log for future reference.

3.2.2 Multibeam Echosounder

The MBES will be installed on the port side moon pool (see Figure 2). The offset for the transducer mounting has been measured with a total station, but will be verified onboard before commencing the survey.
On the side of the MBES transducer a Valeport Mini-SV will be installed. This instrument will be directly interfaced with the MBES processor and will send continuously the Sound Velocity readings. These values will be used by the MBES to generate the correct beam forming.

The MBES receives directly from the PosMV the PPS+NMEA ZDA for the synchronism and the gyro and roll correction for the beam steering.
MBES data are visualized and recorded into QINSy software through an Ethernet connection (see Figure 3).
MBES system calibration will be accomplished by running lines over specific bottom terrain in a standardized way for each error correction. Since the Patch Test only works on overlapping data, particular care will be taken to follow the survey line.

SVP profiles along the water column will be taken as a minimum every 12 hours. Additional profiles may be recorded if weather or environmental conditions indicate that additional SVP soundings are warranted.

Prior to starting calibration procedures, the operator will verify the Swath Bathymetry system's power and gain settings in order to minimize spikes. Once the proper settings have been determined the lines will be run in order to give the QINSy software the data it needs to properly calibrate the system. The two heads will be calibrated separately and the data collected will be compared after calibration.

The data collection for **roll** correction has to be done over a flat sea floor. One line is surveyed twice, in reciprocal directions and at survey speed (approximately 3 knots). When the data, from the two data collections, are looked at in profile, there will be two seafloors sloped in opposite directions. Most patch test programs will go through a series of iterations to determine when the difference between the two surfaces is the smallest, and this is the roll offset.

Roll is perhaps the most critical correction value in the patch test routine as an error in roll will result in an error in sounding depths. However, the computation to determine the roll misalignment is usually the easiest and most consistent.

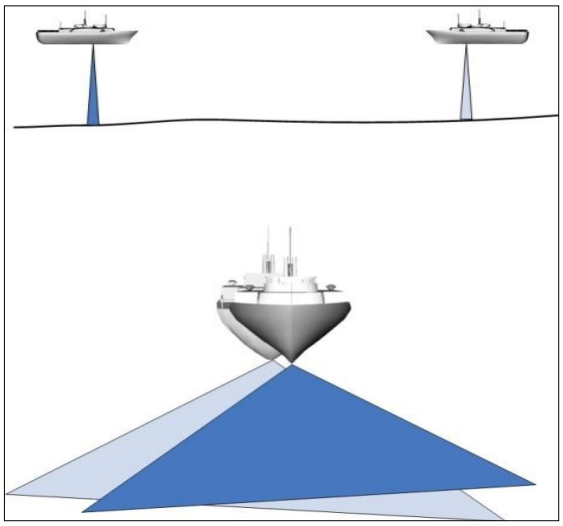

Figure 5 – Roll calibration

The collection of **pitch** correction data will be done over a steep slope or detectable feature on the sea floor. One line is surveyed, twice, in reciprocal directions at survey speed (approximately 3 knots). It is very critical that the sonar head passes over the same exact part of the slope on each run.

A profile of the data will show two different slopes, which represent the reciprocal data collections. The patch test software goes through a series of iterations of pitch angle corrections until the difference between the two surfaces will be minimized.

Whatever the angle of correction, which results in the minima or null, that angle will be reported as the pitch misalignment.

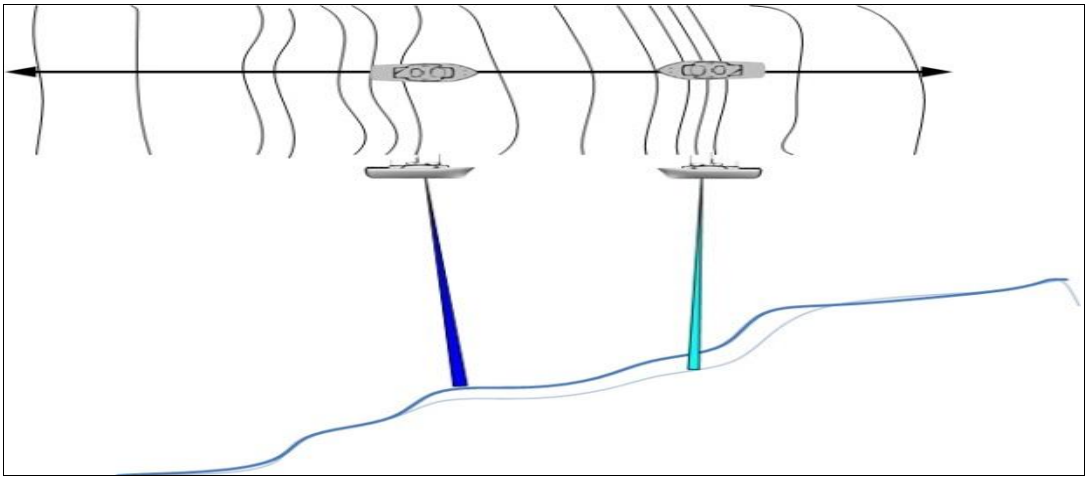

Figure 6 – Pitch calibration

The collection of **yaw** data correction and subsequent solution for the yaw offset is usually the most difficult of the tests that comprise a patch test. This is especially true if a slope is used for the yaw computation; a feature generally works much better. The reason for this is that the area that is used for the computation is not directly under the vessel, but in the outer beams and the slope may not be perfectly perpendicular in relation to the course of the vessel.

For the Yaw data collection two parallel lines are used, with the vessel surveying in the same direction on those lines. The lines are to be on either side of a sea floor feature or over a slope.

The lines should be approximately 2 – 3 times water depth in separation. A yaw error will result in a depth position error, which increase with the distance away from nadir.

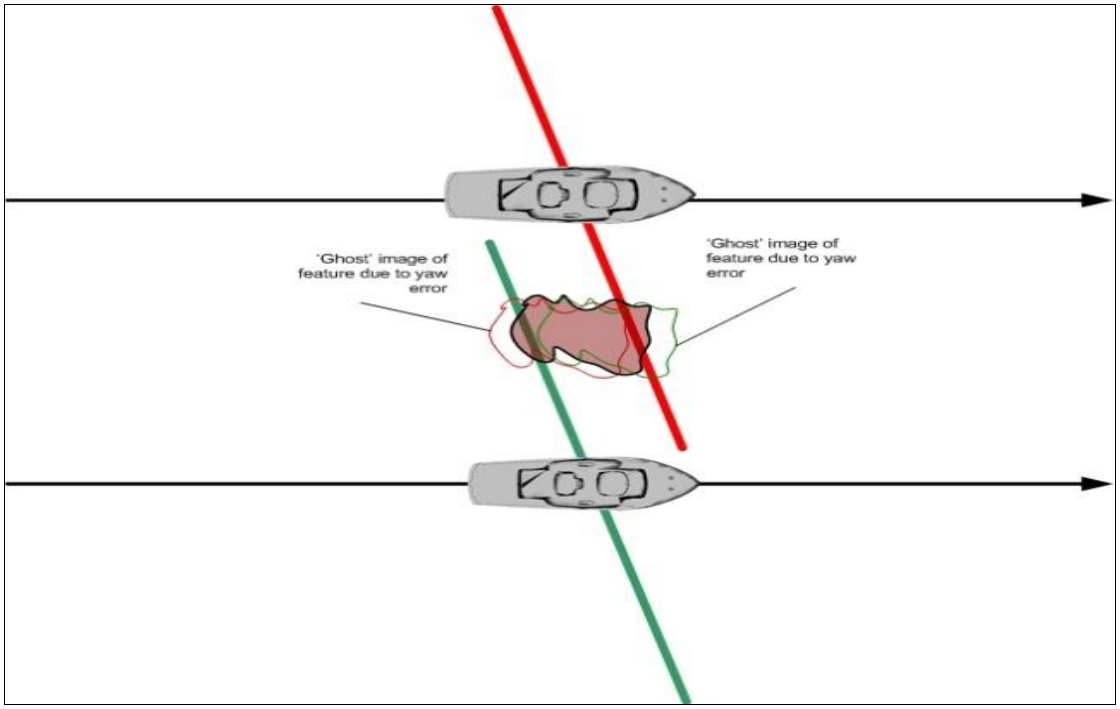

Figure 7 – Yaw calibration

An extra line, perpendicular to the set of lines run for roll, pitch and jaw calibration, will be added for QC purpose and to verify the correctness of the offsets inserted into the system.

In order to insure that no errors have been introduced by possible equipment malfunction, environmental conditions, or physical movement of the transducer mount, the patch test should be repeated whenever the system's configuration is modified.

Data from the MBES system will be acquired, stored and quality controlled in real time through QINSy software. The software package will allow for on-board QC of data quality and coverage.

Latency calibration will be omitted because of synchronization of the whole system (Positioning – MBES – MRU) through a PPS and NMEA ZDA. The synchronization brings to a latency value virtually equal to zero (smaller than 10 milliseconds).

Final calibration results will be obtained reprocessing the data once the PPK data will be usually available after 48 hours from acquisition.

4. SURVEY DOCUMENTATION

4.1 Operational Reports

During the survey, the following reports and logs will be maintained:

4.1.1 Daily Progressive Reports

This report will be kept by the Field Supervisor, signed by him and countersigned or witnessed by the onboard/onsite client representative. It will consist of a diary of each day's activity and will include such items as systems operating or on standby, lines completed and record of an event having impact on the survey. Final format for the DPR will be discussed with Client Representative before job commencing.

4.1.2 Navigation Log

The navigation log will consist of position information from the navigation system. Event reports concerning navigation activity, equipment details, and calibration details will be added by the Senior Navigator.

4.1.3 QC Logs

Multibeam operators will periodically fill a QC logs, usually at 3 hours interval.

A series of "gates" and "alarms" will be set on the system to draw the surveyor attention if certain acquisition parameters are out of the set ranges. Prompt action will be taken to assess the situation and problem and solution will be logged in addition to the periodic checks.

QC logs will be provided to the processor and, if needed, clarified before or during the processing of that data set.

4.1.4 Backup of Digital Records

A formal backup will be completed at every crew shift (12 hours). However, the acquisition computer will be connected, via LAN, to a server computer equipped with four RAID HD, were the data can be transferred in real time and immediately available for onboard data processing.

4.2 Preliminary Data Processing

All survey data and logs will be passed to the processing team onboard. Data will be processed using CARIS software. Processing will start after acquisition and validation of the first survey line, however, final data processing can be completed only after a 48 hours lag time, when PPK data will be available for download.

Processors will follow a detailed processing procedure and will keep track of the operation filling the appropriated data processing log.

4.3 Final Data

At the end of the survey, the data will be brought to Alpine office for the last QC and editing. All products will be reviewed for quality control prior to submittal.

As required, included with each submittal there will be a separate Quality Control Section indicating the quality control processes performed together with an extent of compliance. This extent of compliance will include the producer of the product, the internal reviewer, the original QA/QC review comment and its date, the comment response and where in the product changes, if any, were made.

A certification that the QC process was performed satisfactorily will also be included.

Accordingly to the SOW the following final data will be provided to the client:

- Color Coded Shaded Relief GeoTIFF (at 5 feet interval – to be confirmed)
- ArcGIS grids and ASCII raster files (grid cell dimension 10 x 10m, to be confirmed)
- XYZ ASCII files of final DTM (grid cell dimension 10 x 10m, to be confirmed)
- Edited CARIS database (for USGS) that has all the obvious erroneous soundings edited out of the line files
- CARIS field sheet (for USGS) of the final, edited line files after the survey
- Digital Plan View Plots in .DGN format. The maps will be in 3-D format with survey elements placed at their corrected x, y and z locations. TH maps will be compliant with the survey requirements presented in EM 1110-2-1807 “Standard Manual for U.S. Army Corps of Engineers

Computer Aided Design and Drafting Systems". THE data will be developed by features into individual levels within the design files, as outlined in EM 1110-2-1807. All survey data will be submitted in CD ROM (or other magnetic support, previous agreement). Metadata Files will be provided using Corpsmet95 for all geospatial data produced. The Tri-Services Standards (A/E/C/CADD and Spatial Data Standards) will be used. The metadata files will comply with Federal Geographic Data Committee (FGDC) content Standards for Digital Geospatial Metadata version 1.0 or higher. All field notes shall be submitted to the USGS and the New York District, including locations of control points used.