Best Practice for Calibrating SonTek RiverSurveyor M9/S5 Compass

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August 30, 2012

The calibration procedures for the compass used in SonTek RiverSurveyor M9/S5 ADCPs are evolving as we learn more about the compass and its calibration characteristics and SonTek improves the user interface and feedback for the calibration. Some of what OSW recommended as the best practice in the past has changed, and this document represents the best practice we know as of August 30, 2012 and supersedes previously presented and taught procedures.

Background

The USGS has been testing the RiverSurveyor M9/S5 since 2008. During this time it has been observed that the compass calibration procedures frequently did not result in a well calibrated and accurate compass. SonTek replaced the compass in early versions of the RiverSurveyor M9/S5 with a new compass they developed in-house. Although this resulted in some improvements, inaccurate compass calibrations which resulted in inconsistent discharges measured using GGA or VTG as the navigation reference and loop tests that did not close accurately were still common. During the 2011 and 2012 there has been a concerted effort by both the USGS, OSW and SonTek to document and identify the calibration issues and develop a solution that will result in consistent accurate compass calibrations. Although a final solution has not been achieved, several findings have resulted in a modification of the best procedures for calibrating the compass.

Important Characteristics

The following are important characteristics of the SonTek compass and its calibration algorithms:

- The compass appears to be more sensitive to magnetic interference than compasses used in older ADCPs.
- The M-score used to determine whether a calibration was successful is highly sensitive to pitch and roll and has been shown during controlled tests to be an overall poor predictor of the accuracy of the calibration.
- The calibration algorithm only uses 2 minutes of data. Calibrations that collected more than 2 minutes of data only used the last 2 minutes of data, as the memory uses a first in, first out approach.
- Very short calibrations with high pitch and roll resulted in a low M-score and indicating that the compass was well calibrated, even though it was not.
- Concentrating the calibration in the range of pitch and roll that the ADCP will be used in results in a better calibration than pitching and rolling the instrument through large angles, as previously recommended.
- Errors in heading increase dramatically if the ADCP is pitched and rolled outside the range in which it was calibrated.

- Motion during calibrations needs to be smooth, replicating the natural accelerations typical of the deployment platform (tethered or manned boats).

Currently Recommended Procedures

There is currently no method available for evaluating the accuracy of a compass calibration for the RiverSurveyor. The best that can be done is to follow good calibration procedures and then carefully observe the collected data for potential compass errors. *Given the current situation, use of the stationary moving-bed test will be consistently more accurate than the loop test and is recommended as the preferred moving-bed test for RiverSurveyors until the compass calibration issues can be completely resolved.* The following are the procedures that should be used for calibration and use of the compass in a RiverSurveyor:

1. Calibrate the compass in as magnetically clean environment as is possible for the site and deployment platform you are using. Avoid calibrating on or near a bridge or near steel posts or guard rails. On a manned boat move batteries, ferrous objects (tools), and other sources of potential magnetic interference as far from the ADCP as is practical. For tethered boat deployments, mount the PCM box with the connectors towards and the batteries away from the ADCP.
2. Collect data for a minimum of 1-minute and a maximum of 2 minutes. RiverSurveyor Live 3.5 will not permit calibrations less than 1 minute nor greater than 2 minutes. Previous versions of the software although allowing calibrations greater than 2 minutes only used the last 2 minutes of calibration data.
3. Complete at least one and preferably two 360-degree rotations of the instrument. These rotations should be smooth and at a uniform speed to allow the compass to obtain a uniform distribution of calibration data. RiverSurveyor Live 3.5 provides graphical aids that should help the user ensure a uniform distribution of data.
4. While rotating the instrument, smoothly pitch and roll the instrument and deployment platform about +/- 10-15 degrees. The goal is to achieve a uniform distribution of the pitch and roll angles for the complete rotation. The range of motion should represent the maximum limits of pitch and roll that the instrument will experience during data collection. On a manned boat, this may be difficult. It is not recommended that the instrument be pitched and rolled independently of the boat, such as by swinging the mount or removing the mount and instrument from the boat. Although pitching and rolling the instrument and/or mount was previously recommended, this can lead to an incorrect calibration. If the boat is the source of magnetic interference, the compass is being artificially moved relative to the source of interference and this is not representative of the magnetic field the instrument will experience during data collection.
5. Once the calibration is complete, any data collected that depends on the compass should be carefully monitored for errors in compass heading. These errors often appear as a difference in the ship track direction based on orientation of the instrument.
6. If the discharge or velocity data being collected will require use of GGA or VTG as the reference, the accuracy of the compass is critical. In this situation, if the compass appears to

be inaccurate on one or more headings, try recalibrating the compass or collecting the data such that the heading of the compass changes are minimized.