Bottom Mode 7 Test Plan

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INTRODUCTION

RD Instruments (RDI) has introduced a new bottom-tracking mode (BM7) that promises to allow bottom tracking in 1 ft of water and better performance on steep slopes. Bottom mode 5 would only bottom track down to about 2 to 2.5 ft of water. Bottom mode 7 achieves its performance by using a multiple lag technique. Because pulses are sent and processed at multiple lags rather than a single lag, bottom mode 7 is slower than bottom mode 5 and will slow down the data collection rate for identical configurations. This reduction in the data collection rate has been verified during preliminary testing.

Preliminary tests with bottom mode 7 have resulted in both successes and apparent problems. Bottom mode 7 has provided more robust bottom tracking on steep slopes and rugged bottom conditions but it has failed in some conditions where mode 5 did not have a problem. Bottom mode 7 was able to bottom track in depths 13 cm below the transducer face compared with 19 cm for mode 5, however, this was for a very flat slope with smooth sand bottom.

COMPARISON MEASUREMENTS

A variety of comparison measurements and tests are necessary to fully evaluate bottom mode 7. Discharge comparisons made using bottom mode 7 will help prove that bottom mode 7 will yield an acceptable discharge; however, this approach includes the effect of the water mode. Bottom tracking tests using GPS with verifiable accuracy and comparisons with data collected with bottom mode 5 are also needed. It is recommended that the characteristics of the GPS unit used in such tests be documented by placing the GPS antenna on a tripod in a clear area, not effected by multi-path, and logging at least one hour of data (could use BBTalk for this). These data should be included with your comparison data. You must provide all the documentation to support the comparison with your submission of comparison data. All discharge data must be collected using standard procedures defined in the attached document.

1. **Comparison to simultaneous cup meter measurement.** The most defensible comparison is made when the discharge is measured simultaneously with both a cup meter and an ADCP. To minimize the effects of unsteady flow, the cup meter and ADCP measurements should start and stop at the same time. This may mean that many more than 4 ADCP transects are collected. The comparison discharge should be based on the average of all ADCP transects collected during the cup meter measurement. This could be combined with simultaneous cup meter measurements made with bottom mode 5 to provide a comparison between bottom mode 5 and 7 performance.

2. **Comparison to a rating curve.** At locations where it can be demonstrated that the rating curve is accurate and does not change significantly, measurements can be compared to the rated discharge. For this situation, it is recommended that the rating curve be verified twice on the day of the comparison, once at the beginning of the comparison period and once at the end. Verification can be by a standard cup meter measurement or by an ADCP using bottom mode 5. Individual comparison measurements can contain as few as four transects that fall within 5 percent of the mean of those 4 transects. However, for the bottom mode 7 measurements a minimum of 8 transects are preferred. By collecting more transects, statistics on the variability of a particular configuration can be computed more accurately.

3. **Comparison to GPS.** GPS positioning can be used as an external check of the ADCP bottom tracking accuracy, provided the errors in GPS positioning are minimized. Errors in GPS positioning can be minimized by bottom tracking over long paths such that an error in GPS position at the beginning and end of the path is less than 0.5% of the total distance. The recommended procedure is to traverse a course (~800 m) at a constant speed and compass heading (do not start recording until the boat is at the speed and heading that will be maintained during the entire course). The position of the GPS antenna on the boat and the location of the test path should minimize or eliminate any multi-path errors. Because WinRiver records both bottom track and DGPS and provides comparisons of the two methods, therefore, it is very important that bottom tracking is maintained during the entire path or the bottom tracking results will be too short. The ratio of distance measured by bottom tracking compared with GPS is the "BC/GC" value in the Compass Calibration Tabular View in WinRiver. Any deviation from unity multiplied by 100 is the percent difference between bottom track and GPS. Typically this value should be less than +/- 0.5%. This type of test should be completed over a variety of bottom types in order to verify the robustness and limitations of bottom mode 7.

4. **Comparison of sequential ADCP measurements.** Where it is not practical to measure the discharge with conventional methods and the rating curve is unreliable, but the flow is steady, sequential ADCP measurements can be used for comparison. This involves making a bottom mode 5, discharge measurement using standard procedures and then making a bottom mode 7, discharge measurement. Buoys should be used to mark the starting and ending points of the cross section so that both the discharges and widths determined using bottom mode 5 and 7 (GPS would be optional) can be compared. All other aspects of the setup for the measurements should be kept the same (extrapolation methods, etc).

5. **Comparison of bottom track limitations.** This comparison is similar to number 4 in that it requires sequential ADCP measurements using bottom modes 5 and 7 but it compares under what conditions the modes successfully bottom tracked. Sites with various bed material types and bank slopes are needed to fully evaluate

the bottom modes (see table in Test section below). The objective is to determine the shallowest depths and maximum bottom variability for which bottom mode 5 and 7 will work. When testing on a slope each bottom mode should be tested moving up the slope and down the slope to determine the shallowest depth at which it can bottom track in each direction. It is possible that the instrument may track into shallower depths when coming from a deeper depth than when being started in a shallow depth. The test should be conducted so that both the minimum depth that the mode will track into and the minimum depth at which tracking is initialized is evaluated. You should start and stop the tests in the same location so that bottom track comparison can be made.

6. **Stationary test.** The ADCP has random noise associated with bottom tracking, therefore, an instrument held in a fixed location will show small random movements based on bottom tracking. This test evaluates the random noise in the bottom tracking algorithms. This test should be completed for both bottom mode 5 and 7 to compare the results. It should also be completed with different bed conditions (see table in Test section below). To complete this test, the instrument must be deployed in a fixed location. This could be a temporary mount on some fixed platform. It could be a boat securely anchored from the bow and two points on the stern. It is important to document the deployment and how much actual movement the deployment may have experienced. This test like a moving bed test should be conducted for no less than 10 minutes. A duration of 30-60 minutes would be preferred. Assuming the instrument did not move, the values to be compared would be the mean velocity computed from the ADCP and the standard deviation associated with the mean.

TESTS

The table below outlines tests that will help evaluate the capabilities and robustness of the bottom modes 5 and 7. The 30 tests are not necessarily independent tests. Measurements made for tests 1-7 may also be used for 23-29, etc. No priority has been assigned to the tests and hopefully contributions from various users in different parts of the country will allow us to cover the full range of conditions. If you experience bottom tracking problems during testing insert &O0000 0100 0000 0000, &N0100 0000 1110 0000 into the user commands to collect engineering data that can be used by RDI to evaluate the problem.

Test No.	Type	Depth	Bed Material	Terrain Variability or Slope
1	Discharge Comparison Measurements (1, 2, and 4)	Any	Mud / Silt	Smooth
2			Sand	Smooth
3			Sand	Dunes, Moderate changes
4			Gravel	Moderate changes
5			Gravel	Rapid changes
6			Cobble/Boulders	Moderate changes
7			Cobble/Boulders	Rapid changes
8	GPS Comparison Measurements (3)		Mud / Silt	Smooth
9			Sand	Smooth
10			Sand	Dunes, Moderate changes
11			Gravel	Moderate changes
12			Gravel	Rapid changes
13			Cobble/Boulders	Moderate changes
14			Cobble/Boulders	Rapid changes
15	Bottom Track Capability and Stationary Comparisons (5,6)	< 2 ft	Mud / Silt	Mild Slope
16			Mud / Silt	Steep Slope
17			Sand	Mild Slope
18			Sand	Steep Slope
19			Gravel	Mild Slope
20			Gravel	Steep Slope
21			Cobble/Boulders	Mild Slope
22			Cobble/Boulders	Steep Slope
23		Any	Mud / Silt	Smooth
24			Sand	Smooth
25			Sand	Dunes, Moderate changes
26			Gravel	Moderate changes
27			Gravel	Rapid changes
28			Cobble/Boulders	Moderate changes
29			Cobble/Boulders	Rapid changes
30			Any	Wood debris on bottom

SITE CONDITIONS

The site conditions should be completely documented, for completeness and to facilitate use of these data by others. Video or digital pictures are encouraged. The flow, bed conditions, weather, mounts, boats, and other equipment should be documented. If necessary use a tape recorder to ensure detailed notes and then transcribe them back in the office.

SUBMITTING DATA

Data submitted for the comparisons described herein should be sent via FedEx or a note to dmueller@usgs.gov with information as where the data can be downloaded. This submission should include all raw data, supporting information used to make the comparison, documentation of any deviation from standard procedures, and documentation of site conditions. Please do not email large data sets without prior notification and approval.

FedEx address:

David Mueller
U.S. Geological Survey
9818 Bluegrass Parkway
Louisville, KY 40299
(502) 493-1935
dmueller@usgs.gov

Standard Procedures for Collection of Discharge Data

- Follow all OSW recommended procedures for making a discharge measurement except as noted in test plan.
- Use standard USGS Acoustic Profiler Discharge Measurement Notes (Form 9-275-I), if possible.
- Use WinRiver 10.06
- If possible, collect 12 transects to get a better estimate of the instrument / river variability and to allow evaluation of 2, 4, 6, and 8 transect averages.
- Record air temperature and water temperature
- Document speed and direction of wind.
- Calibrate compasses prior to data collection using CompCal or AF and AX.
- Run RGTest prior to measurements
- Configure ADCP using the ConfigWizard and document any user commands that may be recommended by the test procedure.
- Set time on PC and ADCP.
- Accurately measure draft, particularly on shallow streams. Be sure to compensate for pitch or roll of the boat during this measurement. If a pressure sensor is used, be sure and zero it and check for reasonableness of the draft measurement.
- Locate a section with uniform flow, if possible.
- Document any observed reverse flow at the edges.
- Set starting and stopping edge to allow two good depth cells at each edge. If this is not possible, document why.
- Collect at least 10 ensembles in a stationary position at the beginning and end of each transect.
- Use buoys to ensure consistent starting and stopping points, if possible. Measure distance to shore from each buoy.
- Always *measure* distance to shore for each transect, if buoys are not used.
- Maintain a boat speed equal to or less than the water speed, if at all practical. Document reasons for deviation.
- When possible, collect at least one and preferably 2 cup meter measurements. Where there is changing flow conditions, it will be important to identify which transects were collected during the cup meter measurement.