Mode 11 Test Plan

Prepared by
David S. Mueller, OSW
February 4, 2004

INTRODUCTION

RD Instruments (RDI) has introduced a new pulse-coherent mode (Mode 11) that promises to expand the capability of the Rio Grande instruments in both shallow and deep slow moving water. The deep slow moving water portion of this mode is not yet well understood by USGS personnel and will not be covered in this test plan.

Water mode 11 is much like water mode 5 with three exceptions.

1. Water mode 5 is limited to a WZ of 5 that limits the maximum depth for water mode 5 to 8 m for a 600 kHz Rio Grande and 4 m for a 1200 kHz Rio Grande. Water mode 11 allows a manual input of WZ3, which allows mode 11 to operate 5/3 deeper (13.3 m for a 600 kHz Rio Grande and 6.7 m for a 1200 kHz Rio Grande). The price to be paid for this extra depth is that the speed of the water must be slower because the lag (equal to the depth of flow) is longer and the residence time of the scatters must be maintained for the two pulses to correlate.

2. Water mode 5 always required an ambiguity-resolving bin (ARB) with a minimum length of 30 cm. If the depth was insufficient for this ARB, mode 5 would simply stop working. Mode 11 does not require an ARB. For depths of flow less than 30 cm model 11 recognizes that the ambiguity velocity for a 30 cm lag is greater than 1 m/s, which is beyond the horizontal operational velocity for mode 11, and mode 11 simply stops checking for ambiguity. Thus, mode 11 can profile in shallower water than mode 5.

3. The location of the ARB is also different in modes 5 and 11. In mode 5, the ARB was located just below the blank and extended a maximum of 0.6 m or 85% of the shallowest beam. The ARB for water mode 11 has a maximum size of 2.3 m and is centered between the end of the blank and 85% of the shallowest beam. Thus, mode 5 always resolved ambiguity near the surface while mode 11 resolves ambiguity near the center of the water column.

COMPARISON MEASUREMENTS

Defining absolute truth in the field is difficult, if not impossible. However, our standard over the years has been a Price AA or Pygmy meter measurement made in accordance with the standards defined in Water-Supply Paper 2175. Due to unsteady flow a direct comparison may not be possible so we will define four types of comparisons that could be made in descending order of confidence. You must provide all the documentation to

support the comparison with your submission of comparison data. All 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.

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 water modes 1 or 5 as determined by site conditions. 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 mode 11 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 other simultaneous ADCP measurements.** Where two ADCP's can be used concurrently (usually a 600 kHz and a 1200 kHz) one of the instruments can be operated in water mode 1 or 5 and the other in water mode 11. Positional and other sources bias of the instruments should be evaluated to ensure that any differences in discharge are attributed to the difference in water mode configurations. Individual comparison measurements can contain as few as 4 transects that fall within 5 percent of the mean of those 4 transects. However, for the water mode 11 measurements 8 transects are preferred. By collecting more transects, statistics on the variability of a particular configuration can be computed more accurately.

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 water mode 1 or 5 measurement using standard procedures and then making water mode 11 measurements. In this comparison we are assuming that the flow is not changing between the measurements, which is seldom absolutely true but may be an acceptable assumption at some sites. The mode 1 or 5 measurements can contain as few as four transects that fall within 5 percent of the mean of those 4 transects. However, for the water mode 11 measurements 8 transects are preferred. By collecting more transects, statistics on the variability of a particular configuration can be computed more accurately.

TESTS

The effect of the three differences between mode 5 and 11 identified in the introduction dictate the site conditions for testing. The following table lists the conditions for which mode 11 should be tested.

1200 kHz Rio Grande

Minimum Water Depth in Meters	Maximum Water Depth in Meters	WZ	Acceptable comparison			
			Cup Meter	Rating Curve	Mode 1	Mode 5
0.4	1	3 or 5	X	X		
0.4	4	3 or 5	X	X	X	X
0.4	6.7	3	X	X	X	

600 kHz Rio Grande

Minimum Water Depth in Meters	Maximum Water Depth in Meters	WZ	Acceptable comparison			
			Cup Meter	Rating Curve	Mode 1	Mode 5
0.6	1	3 or 5	X	X		
0.6	8	3 or 5	X	X	X	X
0.6	13.3	3	X	X	X	

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.