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September 19, 2011

Memorandum

OFFICE OF SURFACE WATER TECHNICAL MEMORANDUM 2011.08

SUBJECT: Exposure time for ADCP moving-boat discharge measurements made during steady flow conditions

The purpose of this memorandum is to establish U.S. Geological Survey (USGS) policy regarding exposure time for discharge measurements from moving boats with acoustic Doppler current profilers (ADCPs) under steady flow conditions. Exposure time refers to the total amount of time spent sampling (or measuring) the flow during a discharge measurement and does not include time between transects nor time spent doing moving bed tests or other tasks. The policy established in this memorandum supersedes previous policy documented in OSW Technical Memoranda 2002.02 and 2005.04 and in Mueller and Wagner (2009). Previous policy (a) required the collection of 4 transects and the discharge for each transect to be within 5 percent of the mean or 8 transects if one or more of the original 4 transects exceeded 5 percent of the mean and (b) required 8 transects for StreamPro measurements having a mean velocity less than 0.8 feet per second. Policy for discharge measurements made during rapidly changing flow is unchanged.

Effective October 1, 2011, discharge measurements made from a moving boat under approximately steady flow conditions will consist of an even number of transects (at least 2) having a total exposure time of 720 seconds (s) or greater. An even number of transects with reciprocal courses is required to minimize directional biases in measured discharges. The exposure time for the discharge measurement should be at least 720 s (12 minutes), even if that requires the hydrographer to make more than 4 transects. This requirement applies to all ADCPs used for moving-boat discharge measurements and also applies when using differential GPS (GGA, VTG, and RTK) as a reference for boat velocity. The quality of each transect included in the average is important. Therefore the user should verify the data in the field and replace transects with identifiable problems (improper boat operation, significant loss of bottom track, another boat passed, etc.) with transects collected in the same direction.

This new policy (described above) means that it is possible for a transect discharge to be more than 5 percent different from the mean discharge of 2, 4, 6, ..., n transects, even if the exposure time for the measurement is greater than 720 s. Analyses of data from Oberg and Mueller (2007) and Czuba and Oberg (2008) have confirmed that no other requirement is necessary. However, even if the exposure time for a measurement is 720 s or greater, it may still be necessary to make a check discharge measurement. The requirement for check measurements as described in Mueller and Wagner (2009) by Rantz and others (1982, p. 346), and Turnipseed and Sauer (2010, p. 81) is still valid.
“If the measurement does not plot within 5 percent (or other specified percentage) of the rating curve in use, or if it is not in line with the previous trend of measurements, try to find an explanation .... If a satisfactory explanation cannot be found, then make a check measurement.”

BACKGROUND

Previous USGS policy required that at least four transects be averaged for a complete moving-boat ADCP discharge measurement, except in rapidly changing flow, according to OSW Technical Memorandum 2002.02 and Mueller and Wagner (2009, p. 21-22). When using an ADCP, a complete transect (single pass across the stream) can be made in less than 2 minutes. Therefore, it is possible to complete a discharge measurement using an ADCP with less than 8 minutes of exposure time.

Previous work (Oberg and Mueller, 2007a) suggested that the uncertainty of a moving boat ADCP discharge measurement under steady-flow conditions, is more dependent on exposure time, than on the number of transects collected. Oberg and Mueller’s (2007a) results were based on 29 measurements made with Rio Grande ADCPs using bottom tracking as the boat velocity reference, with varying widths, depths, water speeds, and boat speeds. Subsequent work (Oberg and Mueller, 2007b; Czuba and Oberg, 2008) has validated the conclusions from Oberg and Mueller (2007a) for ADCP discharge measurements made with Rio Grande and StreamPro ADCPs. Czuba and Oberg (2008) made measurements at 4 sites with the goal of independently validating the exposure time concept using both Rio Grande and StreamPro ADCPs. Analysis of these validation measurements confirms that exposure time is a critical factor in reducing measurement uncertainty and is independent of stream width, depth, and range of boat speeds.

SUMMARY

Thus, work completed by the OSW to-date (2011) suggests that a 720 s exposure time with a minimum of two transects, is appropriate for moving boat ADCP discharge measurements under steady flow conditions. As additional evaluations of instruments are completed, we will confirm or revise this policy as needed. When measuring rapidly-changing flows, policies discussed in OSW Technical Memo 2002.02 and Mueller and Wagner (2009) still apply.

If you have any questions regarding this policy, please contact Kevin Oberg (kaoberg@usgs.gov) or the Hydroacoustics Work Group (hawg@simon.er.usgs.gov).

/signed/

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Acting Chief, Office of Surface Water
SELECTED REFERENCES


**EXPOSURE TIME FROM EXAMPLE MEASUREMENT DATA**

*Exposure time from WinRiver II Measurements*

Exposure time for ADCP discharge measurements collected using Teledyne RD Instrument’s WinRiver II software is computed by summing the values shown in the Duration column shown in the Discharge Summary Tabular view (F12). For the example below, the exposure time for this measurement is 789 sec (13 min and 7 sec).

Do **NOT** use the total time shown in the Q Measurement Summary output as this is the total elapsed time from beginning to end of the measurement, and **NOT** the exposure time for the measurement.

*Exposure time from RiverSurveyor Live Measurements*

Exposure time for ADCP discharge measurements collected using SonTek/YSI’s RiverSurveyor Live software is shown in the Discharge Measurement Summary output at the bottom of the Measurement Results table. In the example below the exposure time for the measurement was 1,419 sec (23 min and 39 sec).