Nortek Technical Note No: *0010*
Title: *Test of an Aquadopp Current Meter near Sydney B.C.*
Last Edited: *June 13, 1999*
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No. of Pages: *4*

Test of an Aquadopp Current Meter near Sydney B.C.

This report summarizes results of a 3-day deployment of an Aquadopp current meter (Figure 1), deployed just above a 300 kHz Workhorse ADCP. The instruments were deployed midday of 4 June 1999 and recovered midday of 7 June, 71 hours later.

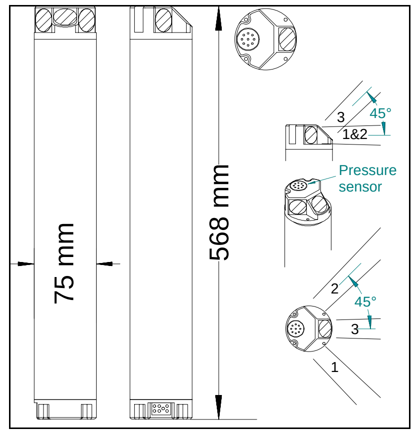

Figure 1 - Aquadopp drawing and beam configuration.

The deployment consisted of a gimbaled, bottom-mounted 300 kHz Workhorse ADCP (RD Instruments) with the Aquadopp moored directly above it (Figure 2). The Aquadopp was centered roughly in the center of the first ADCP bin, and its velocity-sensing bin was displaced horizontally about 3.5 m away from the Aquadopp. Given the small observed tilts, the horizontal velocity was nearly entirely a function of the velocities measured by the two horizontal beams. The ADCP was set to collect data in five 2-m cells, starting at an elevation of 4.5 m above the bottom. Both instruments were set to record data with 10-s intervals.

Velocity time series

Figure 3 compares Aquadopp horizontal velocity time series with velocities from the lowest three ADCP bins. All data have been averaged into 10 minute increments. The Aquadopp compares best with the second and third bins of the ADCP, and not the lowest bin, even though it was certainly at the same level as the lowest bin. The mean and standard deviation of the differences between the Aquadopp and ADCP bin 2 hourly velocities are given in Table 1.

	East-West	North-South
Mean (V_{ADCP2} - V_{Aqd})	-0.3 mm/s	-0.02 mm/s
STD (V_{ADCP2} - V_{Aqd})	1.3 mm/s	1.8 mm/s

Table 1

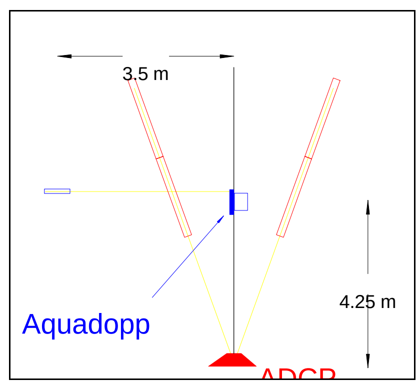

Figure 2 - Mooring diagram.

Mounting the Aquadopp at the level of the first bin was a mistake, in retrospect. The first bin of ADCP data is commonly rejected—the instruments are often unable to recover from the transmit transient in time to produce good data in the first bin (note that this is based on setting the ADCP up according to manufacturer's recommendations). A closer examination of the data further supports that the first ADCP bin is bad. Figure 4 shows an ADCP north-south velocity profile, and compares it with a standard hydraulic river profile (1/6 power law). ADCP bins 2-5 follow the river profile closely, while the first bin is significantly smaller. The dominant tidal flow and shallow water in the strait could reasonably be expected to mix the water, producing turbulent flow much like flow in a river.

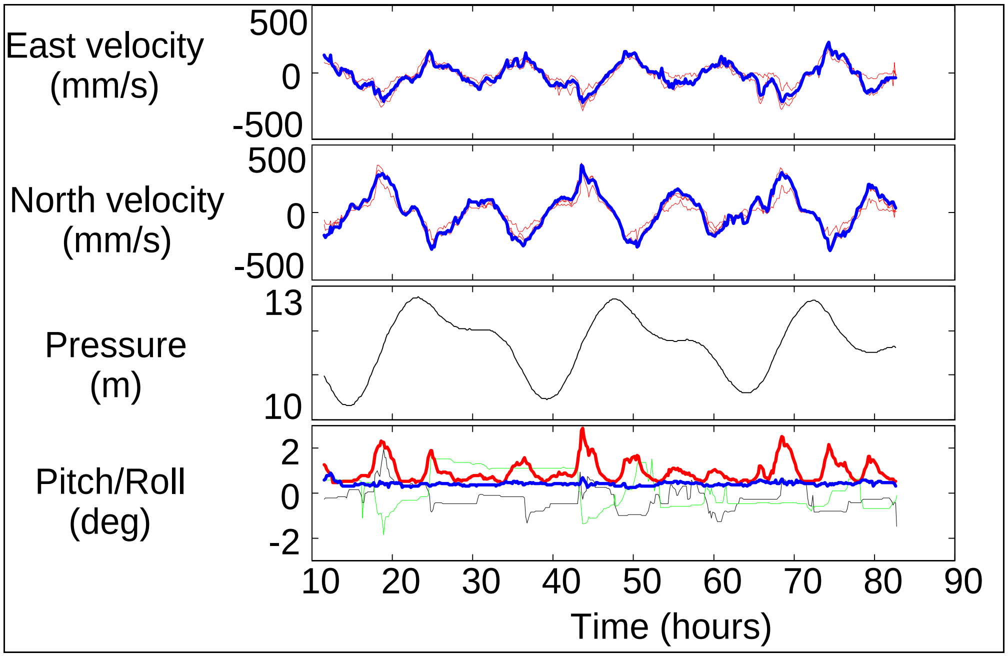

Figure 3. Currents, pressure and tilts. The ADCP data include currents from bins 1-3—velocities increase monotonically with height above the bottom.

Thus we conclude that the first ADCP bin is contaminated and that the second bin is a better representation of what the Aquadopp is measuring. The close match between the Aquadopp and ADCP bin 2 is consistent with the Aquadopp measuring currents accurately. However, given the separation between the ADCP and Aquadopp measurement volumes, the statistical results given in Table 1 can only be considered approximate.

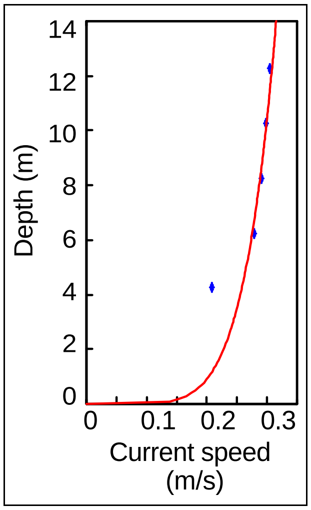

Figure 4. Velocity profile comparison

Velocity Spectra

Figure 5 compares velocity spectra for the north components of both the Aquadopp and ADCP. The spectra show peaks at the tidal frequencies (1-2 x 10^{-5} Hz), and a red spectrum after that. The red spectrum is consistent with fully developed turbulent flow. The spectra match closely at time scales longer than around 300 s (5 minutes). At shorter time scales, the ADCP spectrum rises above the Aquadopp spectrum. This is consistent with expected instrumental uncertainties (Table 2).

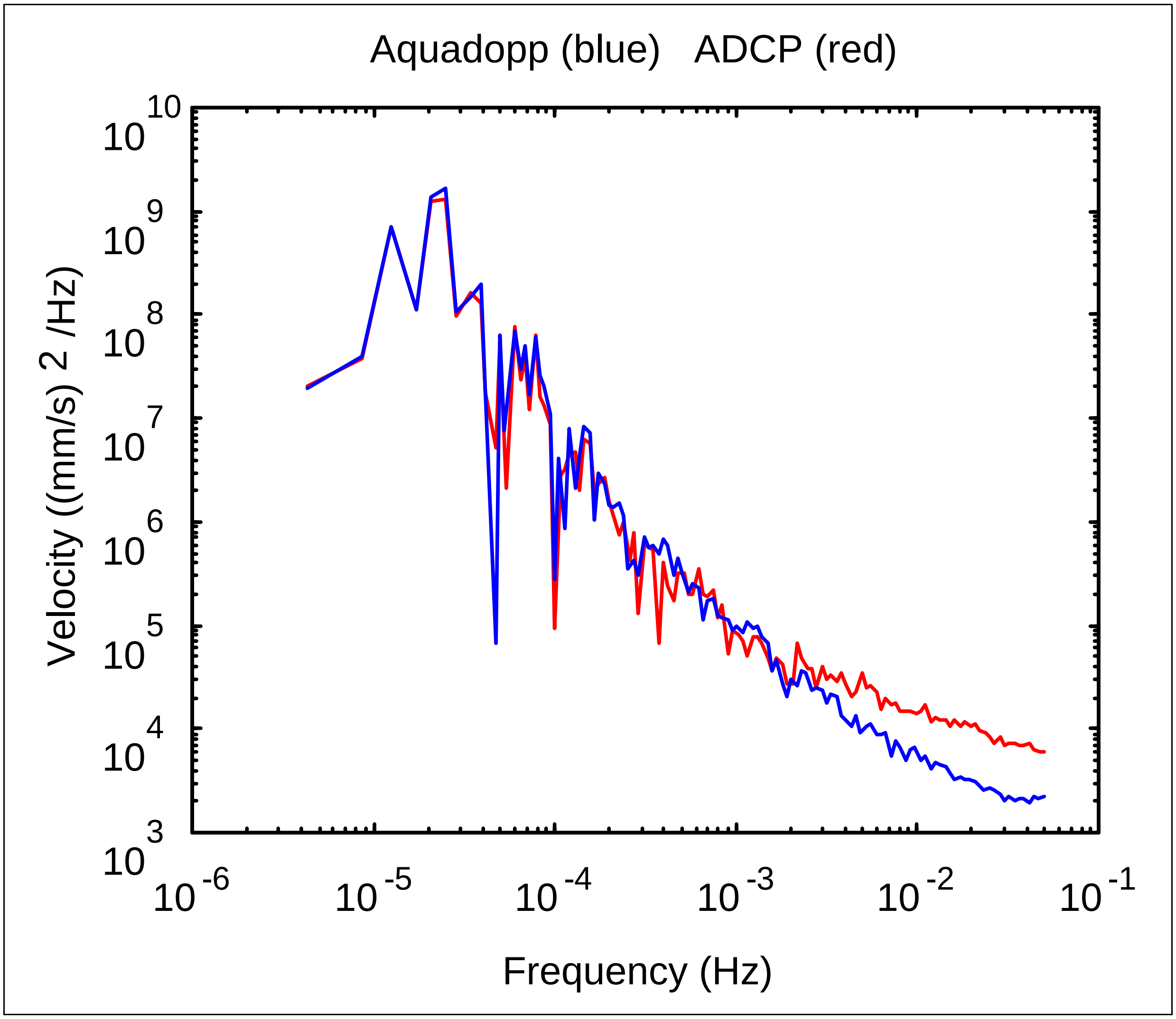

Figure 5. Spectra of the north-south velocity component.

	Predicted standard deviation	Computed standard deviation
Aquadopp	6 mm/s	10 mm/s
ADCP	11 mm/s	18 mm/s

Table 2 - Predicted and computed velocity standard deviations. Predicted standard deviations are manufacturer's predictions, and observed standard deviations are computed based on the observed noise level in the spectra.

Predicted standard deviations assume purely instrumental uncertainty, and would thus represent a lower bound for observed noise levels. Hence, the observed and computed standard deviations are reasonably consistent with one another.

Other observations

The observed tilts (Figure 3) are consistent with how the instruments were moored. The Aquadopp was moored with an attached 30-cm square fin to keep the beams pointed into the flow (hence minimizing flow disturbance). As a result, roll was small and steady while pitch was always in one direction, and correlated with the flow speed. ADCP tilts, in contrast, were characteristic of its gimbaled mount. Tilt stayed steady for relatively long periods, changing suddenly when currents were large, and overshooting before settling on new values.

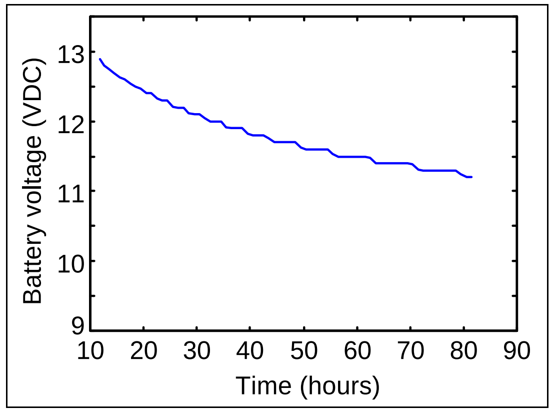

Figure 6. Aquadopp battery voltage.

The Aquadopp pressure (Figure 3) shows an approximately 2.5 m semidiurnal tide closely synchronized with the tidal currents. Given maximum tilts of 3°, the depth of the Aquadopp changed less than 1 cm as a result of mooring motion.

Figure 6 shows the Aquadopp battery voltage. Predicted energy usage in the Aquadopp setup program was 62% of the battery. A fresh battery pack has a voltage of 13.5 VDC, and a depleted pack has a voltage of 9 VDC. The voltage at the end of the deployment was around halfway between these two limits, so it appears that about half the battery capacity was depleted during the deployment. Figure 7 compares Aquadopp and ADCP temperature time series. Because the Aquadopp's production temperature calibration is not complete, the Aquadopp's mean temperature was lower than the ADCP's by about 0.66 °C. The Aquadopp's temperature was offset by this amount in Figure 7. The Aquadopp and ADCP then read much the same temperature, except that the Aquadopp responds more quickly to temperature changes.

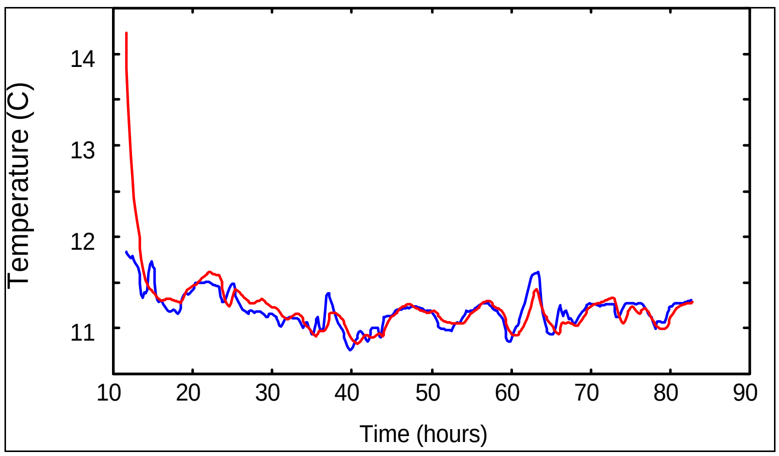

Figure 7. Aquadopp (blue) and ADCP (red) temperature time series.

Document no.: N4001-101	Rev.: -
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