Aqua-Data RV2 and RV4 Calibration

November 2015 Procedure

Each flow sensor is calibrated at an 80m hydrological tank in Southampton Solent University or another suitable facility. We use a specific RC2 measuring unit that is dedicated to the measurement of the sensor, and this has previously been calibrated against a fixed precision unit that generates electrical signals in direct proportion to the current excitation, so as to simulate an ideal sensor with a fixed flow of 3.64m/s. This precision calibration unit uses ultra-stable 0.01% precision parts for the critical components, and we check this annually using a calibrated current source and a verified voltmeter (the voltmeter is verified internally against a calibrated voltage source).

Having calibrated the RC2 display unit so it displays the 'nominally' correct speed (as per design criteria) then a number of measurements are made at various speeds, and these are logged every 0.5 seconds from the RC2 onto a disc, and assigned against the unique serial number previously assigned to the flow sensor. The flow sensor is rigidly bolted to a heavy trolley that is moved by a regulated electric motor and gearing at a constant speed, parallel to the side of an 80 metre tank of depth 2 metres. The sensor is held at a depth of 1 metre. The depth is not a calibrated value; it is nominal, so as to reduce side effects to a negligible level.

The trolley is moved at the desired nominal speed, and the actual speed of movement is measured by timing the travel between various fixed points at the side of the tank. For low speeds the separation of the fixed points is either 3m or 4m depending on the selected speed. For higher speeds the separation is 50 feet. The Imperial (feet) measurements are used for historical reasons, and these are converted to precise metres using the correct scaling factors. The trolley has its own timer system which displays the velocity between two fixed sensors built into the tank structure.

The distance between the marker posts is fixed and confirmed with a precision steel rule; the ambient temperature is fairly constant at a nominal 20 C, and even allowing for worst case thermal effects on the steel rule, a length error of more than 0.03% cannot occur over a 20C temperature variation. The timing interval is measured by a precision timer/counter Fluke model 1953A, which is independently verified against a TTi counter model TF930 and a TTi pulse generator model TG4001. These instruments are not currently NPL calibrated, but are checked to agree with each other to within 1 ppm. Hence we have a high level of confidence that the timing is extremely accurate.

Readings are taken at various nominal speeds as follows (the number of readings at the higher speeds is limited by the tank length):

0.00 m/s	100 readings
0.02 m/s	200 readings
0.05 m/s	120 readings
0.10 m/s	60 readings
0.18 m/s	40 readings
0.25 m/s	100 readings
0.50 m/s	40 readings
1.00 m/s	24 readings
1.50 m/s	16 readings
1.80 m/s	14 readings
2.30 m/s	10 readings
2.80 m/s	10 readings

3.30 m/s	7 readings
3.80 m/s	6 readings

These readings are converted into a table of 14 data pairs of actual speed (as measured by the distance/time method outlined above) versus instrument displayed speed. These pairs in turn are used to create a piecewise linear curve that corrects the sensor readings to be correct at the given sample points, and linearly interpolates in between. The graph being interpolated is very nearly linear in any case, so the interpolation is very precise. For speeds from 3.8 m/s to 4.0 m/s the above data is extrapolated upwards.

Since the sensor contains no moving parts, and the sensitivity is a function only of the magnetic field generated (in turn only a function of the excitation current) and the hydrodynamic effects of the geometry, then provided the sensor is clean and no physical damage has occurred there is no mechanism whereby drift can occur, except in the drift of internal gain setting resistors potted inside the sensor. These are all precise and high stability parts, and are guaranteed free from significant drift by the manufacturer. The combination of all the possible errors mentioned above is such that the precision can be guaranteed within its working range to +/- 0.5% of range, and +/- 15mm/s over a temperature range of -10 C to + 60 C. Special calibration is possible for units that are intended to be used in more extreme temperature environments.