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To Whom It May Concern:

**The following are the accuracy test results of the MGD Technologies Inc. (MGD) ADFM Velocity Profiler™ Model Pro-20 (ADFM).** The ADFM was tested in the Hydraulics Laboratory at the Utah Water Research Laboratory at Utah State University in Logan, Utah.

The accuracy tests were performed in accordance with the Pima County RFP#1090 – 2000 Remote Monitoring Specification (Spec), Addendum #1 (A1), Addendum #2 (A2) and Addendum #3 (A3).

### **TEST RESULTS**

Four complete accuracy tests were run for the ADFM (**per Spec**). Each of the tests had depth and velocity ranges associated with it (**per Spec and A1**). Each of the four tests lasted at least 1 day (**per A3**). Each of the tests had a minimum of four (4) sets of parameters to be tested – top half of velocity range and top half of depth range, top half of velocity range and bottom half of depth range, bottom half of velocity range and top half of depth range, bottom half of velocity range and bottom half of depth range (**per A2**). Each of these sets of parameters was run at a minimum of two (2) hours (**per A2 and A3**).

The meter was set to collect data every 5 minutes (**per Spec**).

The velocity and depth ranges were as follows (**per Spec and A2**):

<b>Test Number</b>	<b>Depth of Flow Range</b>	<b>Velocity of Flow Range</b>
1	2 inches to 24 inches	7 feet per second to 12 feet per second
2	2 inches to 24 inches	1 foot per second to 6.9 feet per second
3	2 inches to 60 inches	0 feet per second to 0.9 feet per second
4	2 inches to 60 inches	-3.5 feet per second to -0.1 feet per second

The ADFM's percent error (rounded to the nearest 0.01 percent) for flow velocity, flow depth and volume of flow is reported here for each test. The flow velocity error is computed by comparing the meter's reported velocity against the velocity computed by using the volume of flow reported by the laboratory meter and the manually measured depth of flow in the area velocity formula. As the ADFM does not report an average velocity, but uses the measured velocity profiles to determine a flow rate, the velocity used for comparison was generated by using the volume of flow reported by the ADFM

and the ADFM measured depth of flow in the area velocity formula. This is the same procedure as stipulated for the laboratory meter (**per Spec**). The depth of flow percent error was computed by comparing the ADFM's depth of flow against the manually measured depth of flow. The flow depth was measured frequently during the test. The ADFM's volume of flow measurements were compared directly against the laboratory flow measurements. The three "percent error" computations from each of the four (4) tests were combined and average to produce an overall percent error (rounded to the nearest 0.1 percent) for the ADFM (**per Spec, A2 and A3**).

Results of the ADFM accuracy tests are given in the following table and were computed per the instructions given in the RFP (**per Spec**).

#### Test Average Errors

Test Number	Flow	Depth	Avg. Velocity	Total Average Error
1	0.00%	0.49%	-0.28%	0.07%
2	0.43%	0.63%	0.69%	0.58%
3	-2.63%	0.33%	-2.44%	-1.58%
4	1.52%	0.10%	2.00%	1.21%
<b>Average all Tests</b>	<b>-0.17%</b>	<b>0.39%</b>	<b>-.03%</b>	<b>0.07%</b>

**Final Test Result = 0.1% (rounded to nearest tenth per Spec)**

#### TEST PROTOCOL

All tests were run in a 48-inch circular pipe, a 36-inch wide rectangular channel or an 84-inch wide rectangular channel. The choice of pipe or channel was dependent on prior laboratory commitments and facility availability. The same pipe or channel could have been used for all tests, but was not required by the specification (**per A2**).

The ADFM was positioned approximately 10 feet from the discharge end of the test line. For those tests requiring measurement of reverse flows, the ADFM was mounted "backwards".

The test loop consisted of water drawn from the laboratory reservoir that feeds the test facility through a 48-inch gravity line. The water is transferred to the test line where the ADFM is installed. Flows through the test line are controlled by butterfly valves that allow selection of the desired laboratory reference meter and flow rate. Two laboratory reference meters were used for these tests. One was a 20-inch Venturi meter and the other was a 48-inch Venturi meter. Both meters have a nominal accuracy of 0.2 percent. They are regularly calibrated against NIST traceable weight and volumetric tanks. The weight and volumetric tanks can allow a flow rate measurement of better than 0.1 percent. The test loop has a superior accuracy to the 0.25 percent required by the specification (**per Spec**).

For each test, a steady flow was established for a particular set of parameters for the test (e.g., top half of the velocity range and bottom half of the depth range). Once a steady flow was established, the laboratory meter's flow readings were recorded at 5-minute intervals. During this time, the ADFM recoded its own readings internally at 5-minute intervals (**per Spec**).

Manual depth measurements were obtained by inserting a thin steel rod through a hole in the top of the pipe or from above the rectangular channel until it reached the water surface. This distance was then subtracted from the total vertical height to obtain the depth of flow.

Various combinations of pipe slope, number of stop logs on the downstream end of the test line and appropriate butterfly valve settings were used to create the different flow conditions required by the RFP (**per Spec and A2**).

Please contact me if you have any questions concerning these tests and results, or if you require further information.

Sincerely,

A handwritten signature in black ink that reads "Michael C. Johnson". The signature is written in a cursive style with a long, sweeping horizontal line extending to the right.

Michael C. Johnson, Ph.D., P.E.

Research Scientist, Utah State University Research Foundation

Adjunct Professor, Department of Civil and Environmental Engineering