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WHITE PAPER

A New Approach to Accurate Water Flow Measurement - The Study of the FPI Mag® Accuracy

FPI Mag®

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A New Approach to Accurate Water Flow Measurement - The Study of the FPI Mag® Accuracy

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Abstract:

Electromagnetic Flow Meters, or "Mag Meters," are the most widely used meter technology to measure the flow of water in the world today. As populations expand, water measurement and management is becoming increasingly critical to preserve our water resources. To complicate the equation further, many existing water treatment and distribution systems that need to upgrade their technology cannot shut down or stop service to the communities they serve. The result is unmetered lines or inaccurately metered systems which leads to costly water loss.

In 2011, McCrometer Inc., an innovator in flow measurement technology for over 55 years introduced the FPI Mag Electromagnetic Flow Meter. The FPI Mag promised to give the same specified accuracy of traditional "full bore" or "flanged" mag meters but with the ease of installation of insertion type meters. In addition, the FPI Mag promised to be "hot tapped" or installed while the system was running at normal capacity, preventing costly shut downs and the loss of service. While the hot tapped feature of the meter has been proven and documented in customer experiences (see McCrometer Case Study 30121-00 – *Next Generation Mag Meter Helps Davidson with Non-Revenue Water*), the 3rd party proven testing had not previously been published. This paper will examine the accuracy claims for the FPI Mag and present testing performed. All testing presented in this paper was done at an independent 3rd party test lab.

Terminology:

- GPM – Volumetric flow rate in Gallons Per Minute
- FPI Mag – Full Profile Insertion electromagnetic flow meter
- ft/s – Velocity in Feet per second
- Full Bore Mag – Traditional in-line electromagnetic flow meter
- m/s – Velocity in meters per second
- Pipe Diameters – A measure of upstream or downstream piping where the length of the pipe in inches is divided by the diameter of the meter
- Turndown – The range of flow where the max flow rate is divided by the min flow rate
- Accuracy – Synonymous with error, expressed as a % deviation from actual flow rate

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FPI Mag Test Protocol:

The claimed accuracy for a calibrated FPI Mag meter is as follows:
+/- 0.5% for Velocity 1ft/s (0.3m/s) to 32ft/s (9.8m/s)
+/- 1.0% from 0.3ft/s (0.1m/s) to 1ft/s (0.3m/s)

Testing was done at Utah State Water Research Laboratory (USWRL) in Logan, Utah. USWRL was chosen to perform these tests because they are a well-known, reputable water lab and because they have a very large range of line sizes and flow rates they can achieve.

McCrometer chose to test the accuracy of a 30" FPI Mag at USWRL. This size was chosen instead of a smaller size due to the sheer volume of water a 30" line carries. In service, accuracy matters more in larger pipe sizes: in a smaller line in the 4" to 10" range, if the measurement is off by 1% at high flows, the meter would be off by a few hundred gallons, which represents a low cost in lost revenue. In a 30" line or larger, the amount of water flowing is much greater, so a 1% error can mean thousands of gallons of water unaccounted for, leading to significantly more lost revenue to the plant or district.

Testing was done over a wide 22:1 turndown with 23D upstream piping and 14D downstream piping. The long upstream and downstream pipe lengths simulate an infinite straight pipe section to establish the baseline performance of the meter without obstructions. Flow rates reported by the FPI Mag were compared against the flow rates reported by a 20" master Venturi flow meter owned by USWRL for the moderate and high flows. Flow rates reported by the FPI Mag were compared against a traditional 12" full bore mag master meter owned by USWRL for the low flow rates.

The complete detail of the accuracy test is found in table 1 below:

FPI Size (in)	Min Flow Rate (gpm)	Max Flow Rate (gpm)	Min Velocity (ft/s)	Max Velocity (ft/s)	Turndown	Upstream Pipe Diameters	Downstream Pipe Diameters
30"	503.1	10900.3	0.24	5.2	22:1	23	14

Table 1: FPI Mag Test Protocol Parameters

Results:

The results of the tests are best summarized in the accuracy plot below. The accuracy is expressed as the difference in the reading reported by the FPI Mag compared against the actual flow rate. The actual flow rate was established by the venturi and full bore mag meter as described above. The orange bars represent the accuracy of the complete measurement system. For details on the complete system accuracy, please see the Appendix.

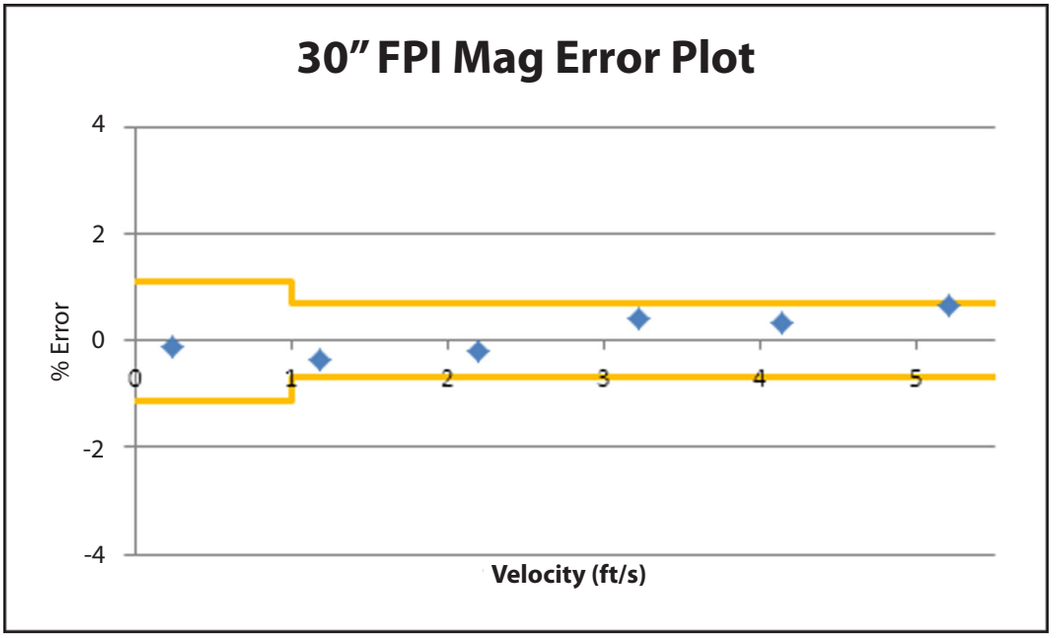

Figure 1: 30” FPI Mag Error Plot

Tested accuracy of the 30” FPI Mag compared against the master flow meter is better than +/- 1.0% for velocities between 0.3ft/s to 1ft/s. Tested accuracy above 1ft/s was better than +/-0.5% within uncertainty of the system. For the test point at 5.2ft/s, the tested FPI Mag accuracy was 0.66%. This is less than the total accuracy of measurement of 0.71% for the combined system.

Conclusion:

Results of the 30” FPI Mag test prove the FPI Mag meets the accuracy claims. The measured error of the 30” meter was equal to or better than the specified accuracies for a wide range of flow. Not only was the meter accurate at low flow rates where accuracy is often difficult to achieve, but it was also very accurate at high flow rates where inaccuracy equals lost revenue.

The author would like to highlight that two reference meters were necessary to measure the reference flow rate of one FPI Mag meter. In addition, one of the pipe systems had to be reduced from 30” to 20” to employ the Venturi, and again reduced to 12” to employ the full bore mag. Not only did the FPI Mag measure the full range of the Venturi and full bore mag, it did so without needing to reduce or change the pipe system. The FPI Mag allows operators to put the meter where they need it without making modifications to the piping system. Given the ease of installation presented in McCrometer Case Study 30121-00 – *Next Generation Mag Meter Helps Davidson with Non-Revenue Water,* and the testing presented here, the FPI Mag meter is the next generation in water flow measurement.

Learn More

Appendix

Accuracy of Measurement:

When evaluating the accuracy of a flow meter, we must take into account the uncertainty of both the test meter and the system determining the actual flow rate. For the moderate and high flow rates of the 30" FPI Mag, the reported flow was compared against the flow rate of a USWRL Master Venturi flow meter. Venturi flow meters are a differential pressure type flow meter. Differential pressure (DP) type flow meters use a pressure drop across the primary element to determine a volumetric flow rate. The stated uncertainty of the Venturi master flow meter is +/-0.25% of flow rate.

For the low flows, the 30" FPI Mag was compared against the flow rate of a traditional full bore mag meter. The stated accuracy of the full bore mag is +/-0.15% of flow rate.

Using the root-sum-squared method; we determine the total uncertainty of test measurement to be as follows:

Device Uncertainty	Velocity	
	0.3ft/s to 1ft/s	> 1ft/s
Full Bore Mag	+/- 0.15%	---
Venturi	---	+/- 0.25%
FPI Mag	+/- 1.0%	+/- 0.5%
Total Test Uncertainty	+/- 1.12%	+/- 0.71%

Table 2: 30" FPI Mag Test System Uncertainty