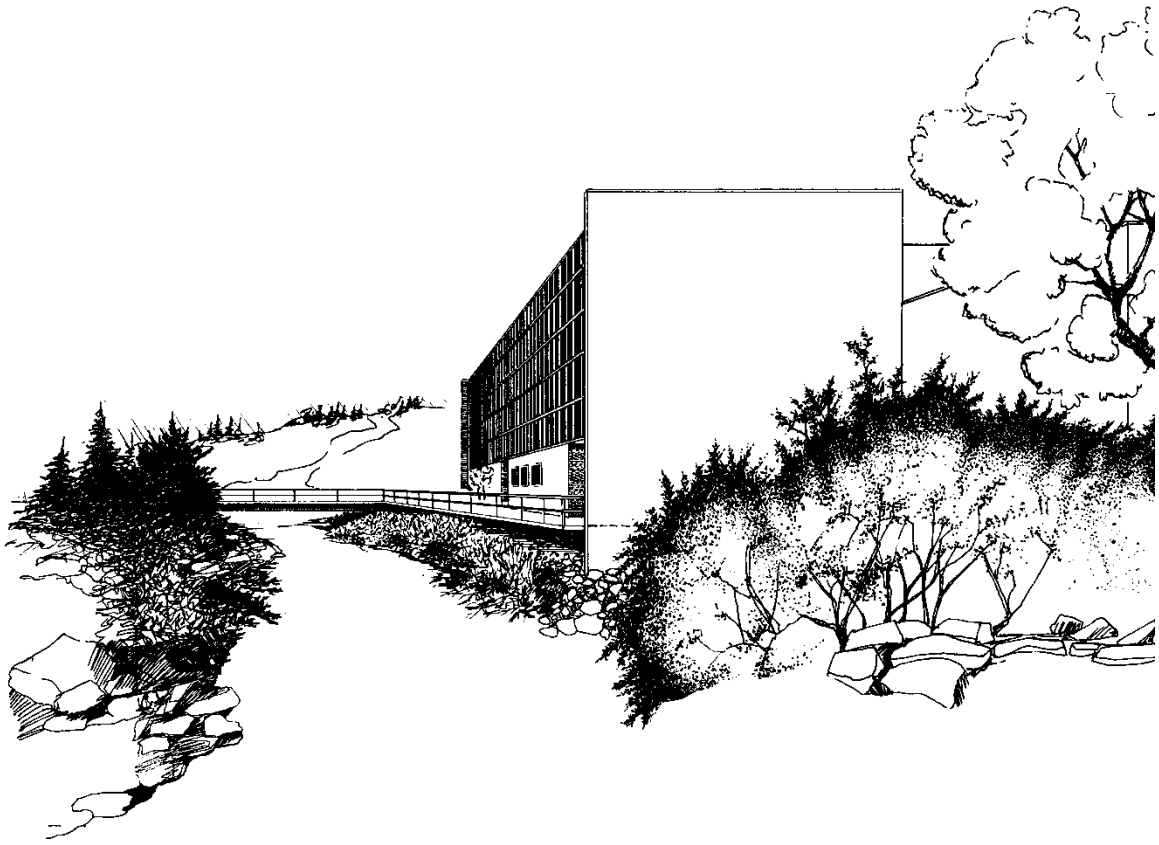
CALIBRATION OF A 10-INCH ULTRASONIC FLOW METER

Meter Serial Number 37516452

Prepared for

Master Meter, Inc.

March 2013



UTAH WATER RESEARCH LABORATORY

Utah State University
Logan, Utah

Report No. 2791

CALIBRATION OF A 10-INCH ULTRASONIC FLOW METER

Meter Serial Number 37516452

Submitted to:

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March 2013

Hydraulics Report No. 2791

INTRODUCTION

Utah State University was contracted by Master Meter to perform a flow calibration at the Utah Water Research Laboratory (UWRL) in Logan, Utah on a 10-inch ultrasonic flow meter (Octave Serial Number 37516452). The meter was tested in straight 10-inch pipe and also downstream of a 90 degree elbow. The cold-water tests were performed to determine the meter's discharge coefficient and flow measurement accuracy over a wide range of flow rates in the two different pipe setups.

EXPERIMENT SETUP

Two separate piping configurations were installed in the laboratory for these tests. The first pipe setup consisted of thirty-four feet of straight 10-inch pipe upstream of the meter location and eight feet of straight 10-inch pipe downstream of the meter location. In addition, over twenty feet of straight 12-inch pipe was also installed upstream of the 10-inch pipe as part of this test setup (Figure 1). The second pipe setup included a short radius 90-degree, 10-inch horizontal elbow, located upstream of the meter (see Figure 2). For this pipe setup, the upstream flange of the meter was installed 30 inches downstream of the elbow flange. Ten feet of 10-inch pipe was installed downstream of the meter for the elbow test. The 10-inch Octave meter was tested in each of the two piping configurations.

FLOW COEFFICIENT

The coefficient C for this meter calibration was calculated using the following equation:

$$C = \frac{Q_a}{Q_i}$$

in which Q_i is the indicated flow rate from the ultrasonic flow meter in gallons per minute and Q_a is the actual laboratory reference flow rate in gallons per minute. A C value of 1.0 would indicate that the ultrasonic flow meter had a 0% deviation from the reference laboratory flow rate.

Figure 1 – Pipe Setup for Straight Pipe Test (flow goes left to right)

Figure 2 – Pipe Setup for Elbow Test (flow goes left to right)

PROCEDURE

Water was supplied to each test line from a reservoir near the hydraulics laboratory. The reference flow rate from the laboratory weight tanks and the indicated flow rate from the 10-inch Master Meter ultrasonic flow meter were measured for each run. The water temperature was also measured.

All reference flow measurements were made using the laboratory weight tanks. The weight tanks are regularly calibrated and are traceable to the National Institute of Standards and Technology. Discharge during the test was controlled using a 12-inch butterfly valve downstream of each test section.

The meter pulses were counted during the flow measurement period from the Master Meter ultrasonic flow meter. The pulse ratio was set at one pulse per one gallon for the entire test series.

Measurements were immediately fed into a computer to display deviations in test results before any flow change was made. Five different target flow rates were tested during the straight meter test series. Fifteen different target flow rates were tested during the elbow test series. Two sets of five data points were also repeated to validate the original elbow test data.

RESULTS

Table 1 summarizes the test results for the Master Meter ultrasonic flow meter calibration when it was tested in straight pipe. Table 2 summarizes the test results for the Master Meter ultrasonic flow meter calibration when it was installed 30 inches downstream of the short radius elbow.

Figure 3 is a plot of pipe velocity versus the percent deviation of flow rate for the Master Meter ultrasonic flow meter tests. The legend in Figure 3 has been annotated to describe the specific testing configurations as shown in the tables.

Table 1. Utah Water Research Laboratory Flow Meter Calibration Data

Manufacturer:	Master Meter	Meter Bore Diameter (in.) =	7.5000
Calibration Date:	3/6/13		
Calibration Location:	12 North		
Meter Serial Number:	37516452	Pipe Diameter (in.) =	10.020
		Pipe Area (ft^2) =	0.55
		Water Temp. (F) =	38.0
Pipe Setup	Straight Pipe Test	Unit Weight (lb/ft^3) =	62.43
Upstream:	34 feet of Straight Pipe	Kin. Visc. (ft^2/s) =	1.72E-05
Downstream:	8 feet of Straight Pipe		

Calibration Performed by: Z. Sharp, J. Prettyman
Calibration Witnessed by: Avi Barak, Greg Land

Run No.	UWRL Flow (gpm)	Indicated Flow (gpm)	Inlet Reynolds Number	C UWRL Flow / Ind. Flow	Dev from mean C (%)	Dev of Flow (%)
1	2	3	4	5	6	7
This Data was taken using the Pulse output (Straight)						
1	245.2	243.75	48,349	1.0058	0.20%	-0.574%
2	1008.0	999.30	198,795	1.0087	0.50%	-0.864%
3	1979.3	1969.80	390,348	1.0048	0.11%	-0.480%
4	2983.8	2981.40	588,445	1.0008	-0.29%	-0.079%
5	3928.5	3934.20	774,762	0.9986	-0.52%	0.145%
			Avg. coefficient :	**1.0037**	Avg. Deviation:	**-0.370%**
			Std. deviation :	**0.0041**		

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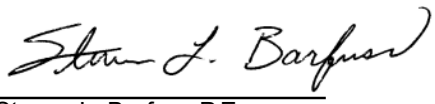

Steven L. Barfuss P.E.
Research Assistant Professor

Table 2. Utah Water Research Laboratory Flow Meter Calibration Data

Manufacturer:	Master Meter	Meter Bore Diameter (in.) =	7.5000
Calibration Date:	3/6/13		
Calibration Location:	12 North		
Meter Serial Number:	37516452	Pipe Diameter (in.) =	10.020
		Pipe Area (ft2) =	0.55
		Water Temp. (F) =	38.0
Pipe Setup	Elbow Test	Unit Weight (lb/ft3) =	62.43
Upstream:	30 inches of Straight Std. wall 10-inch Pipe	Kin. Visc. (ft2/s) =	1.72E-05
Downstream:	6 ft of Straight Std. wall 10-inch Pipe		

Calibration Performed by: Z. Sharp, J. Prettyman
Calibration Witnessed by: Avi Barak, Greg Land

Run No.	UWRL Flow (gpm)	Indicated Flow (gpm)	Inlet Reynolds Number	C UWRL Flow / Ind. Flow	Dev from mean C (%)	Dev of Flow (%)
1	2	3	4	5	6	7
This Data was taken using the Pulse output (Elbow 1 on Chart)						
1	116.5	118.03	22,980	0.9873	-0.96%	1.290%
2	411.8	414.79	81,206	0.9927	-0.41%	0.734%
3	716.8	716.70	141,369	1.0002	0.34%	-0.017%
4	1005.1	1008.30	198,228	0.9969	0.01%	0.315%
5	1328.0	1336.20	261,893	0.9938	-0.30%	0.621%
6	1597.6	1598.10	315,066	0.9997	0.29%	0.033%
7	1931.9	1933.50	381,000	0.9992	0.24%	0.083%
8	2174.2	2178.60	428,785	0.9980	0.12%	0.202%
9	2477.6	2489.70	488,622	0.9951	-0.17%	0.488%
10	2786.1	2754.30	549,452	1.0115	1.48%	-1.140%
11	2772.4	2754.00	546,758	1.0067	0.99%	-0.663%
12	2781.0	2748.60	548,459	1.0118	1.50%	-1.166%
11	3001.0	3014.10	591,848	0.9957	-0.11%	0.436%
12	3351.9	3375.90	661,044	0.9929	-0.39%	0.716%
13	3670.4	3699.90	723,858	0.9920	-0.48%	0.804%
14	3937.1	3963.00	776,464	0.9935	-0.33%	0.657%
15	4996.2	5042.70	985,326	0.9908	-0.60%	0.931%
This Data was taken using the Pulse output (Elbow 2 on Chart)						
1	239.8	241.36	47,300	0.9937	-0.31%	0.635%
2	998.7	1000.50	196,952	0.9982	0.14%	0.184%
3	1964.3	1974.90	387,381	0.9946	-0.22%	0.542%
4	3003.9	3011.40	592,415	0.9975	0.07%	0.250%
5	3912.0	3937.20	771,501	0.9936	-0.32%	0.645%
This Data was taken using the Pulse output (Elbow 3 on Chart)						
1	245.2	247.63	48,356	0.9902	-0.67%	0.992%
2	1005.1	1008.00	198,228	0.9972	0.04%	0.285%
3	1997.3	2003.70	393,904	0.9968	0.00%	0.319%
4	2975.1	2995.50	586,743	0.9932	-0.36%	0.684%
5	3975.2	4008.60	783,979	0.9917	-0.51%	0.839%
		Avg. coefficient :		**0.9968**	Avg. Deviation:	**0.323%**
		Std. deviation :		**0.0056**		

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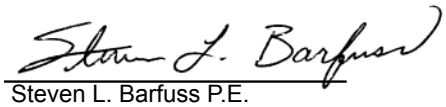

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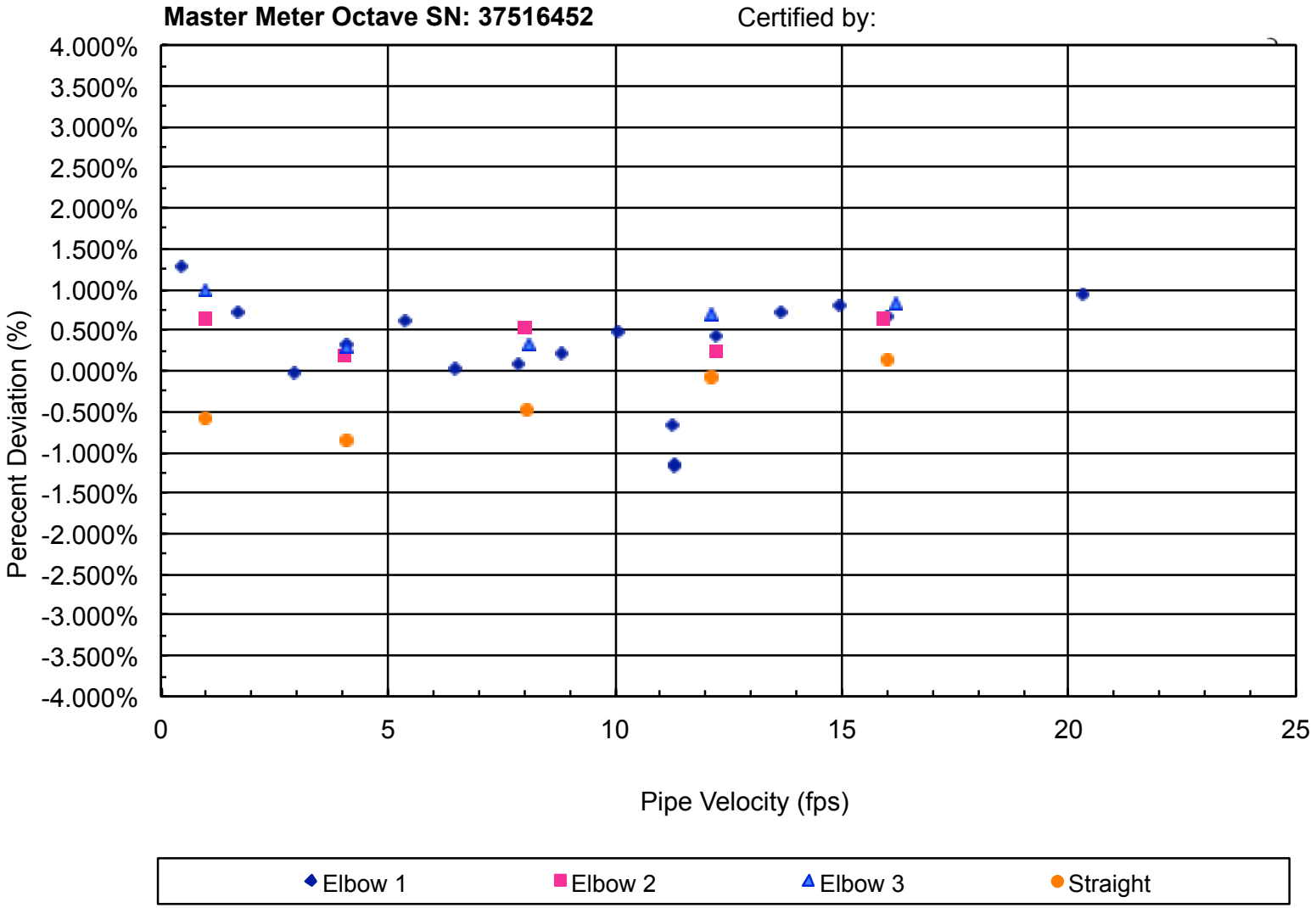

Figure 3. Pipe velocity versus percent deviation of flow rate for Master Meter ultrasonic flow meter tests