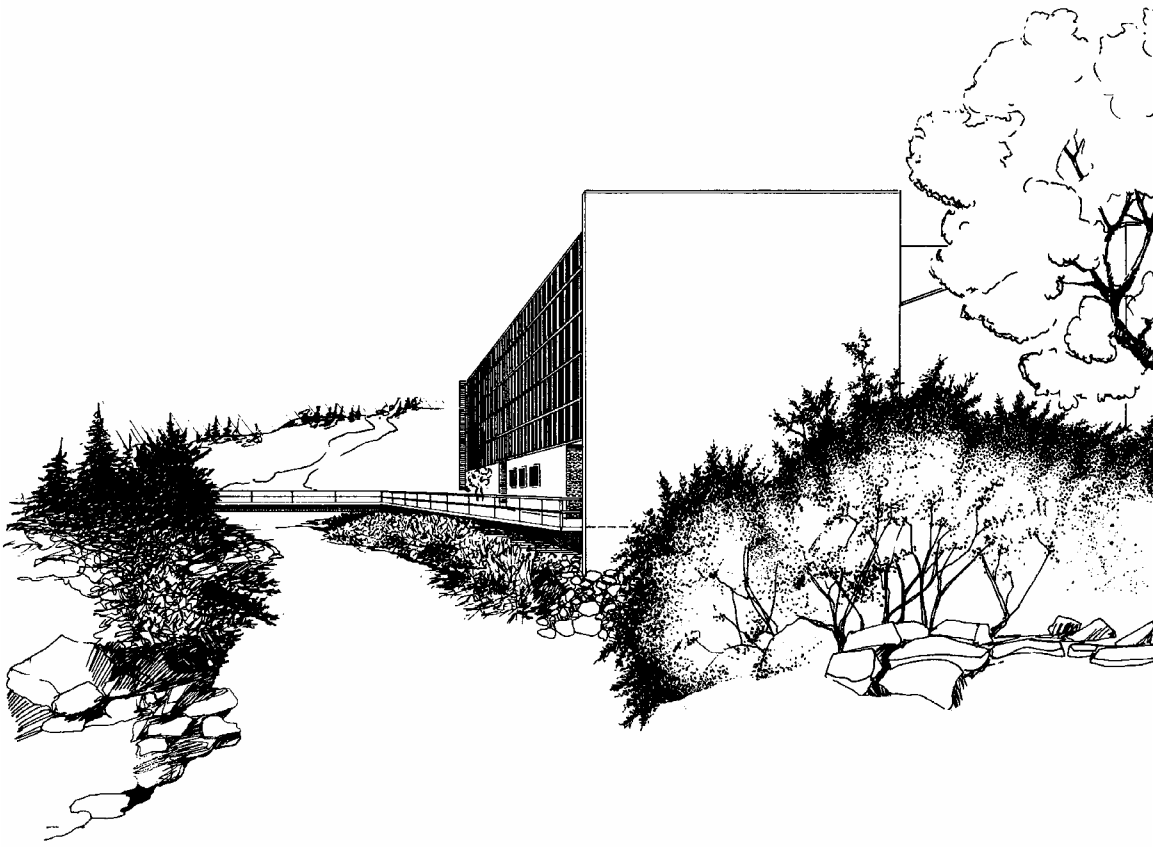
VENTURI FLOW METER CALIBRATIONS

SERIAL NUMBERS: 23034-1, 23034-2,
23034-3, 23034-4

Prepared for

Imperial Flange and Fitting

January 2007



UTAH WATER RESEARCH LABORATORY

Utah State University
Logan, Utah

Report No. 1734

VENTURI FLOW METER CALIBRATIONS

SERIAL NUMBERS: 23034-1, 23034-2, 23034-3, 23034-4

Submitted to:

Imperial Flange and Fitting
2688 S La Cienega Boulevard
Los Angles, CA 90034

By:

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

Utah Water Research Laboratory
8200 Old Main Hill
Logan, UT 84322-8200

January 2007

Hydraulics Report No. 1734

INTRODUCTION

Utah State University was contracted by Imperial Flange and Fitting to perform flow calibrations at the Utah Water Research Laboratory (UWRL) in Logan, Utah on 4-inch, 6-inch, 10-inch, and 14-inch fabricated venturi flow meters. The flow meters, one of each size, were manufactured by Imperial Flange and Fitting using steel with each having a stainless steel throat section. The meters were calibrated in straight steel piping over the ranges of flow specified by Imperial Flange and Fitting. The discharge coefficients were experimentally determined for each meter.

CALIBRATION INSTALLATIONS

The flow meters were installed in the laboratory's 12-inch test line. Upstream from each meter were a minimum of 20 diameters of straight standard steel pipe and downstream from each meter were a minimum of 6 diameters of straight standard steel pipe. Figures 1 through 4 show the calibration installations used.

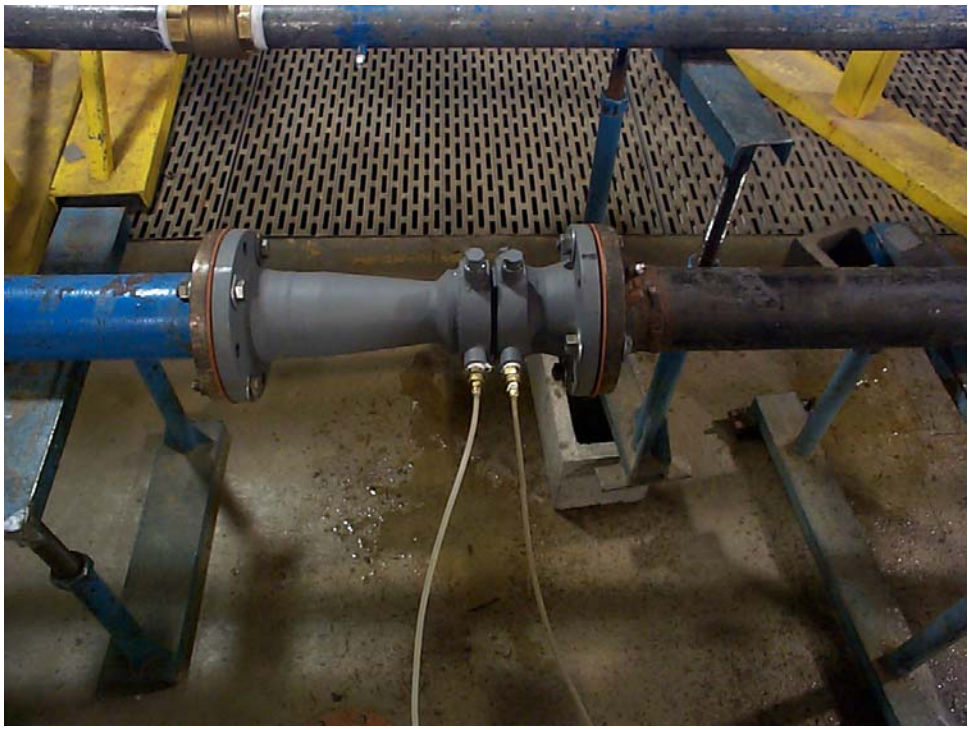


Figure 1. Installation of the 4-inch flow meter.

Figure 2. Installation of the 6-inch flow meter.

Figure 3. Installation of the 10-inch flow meter.

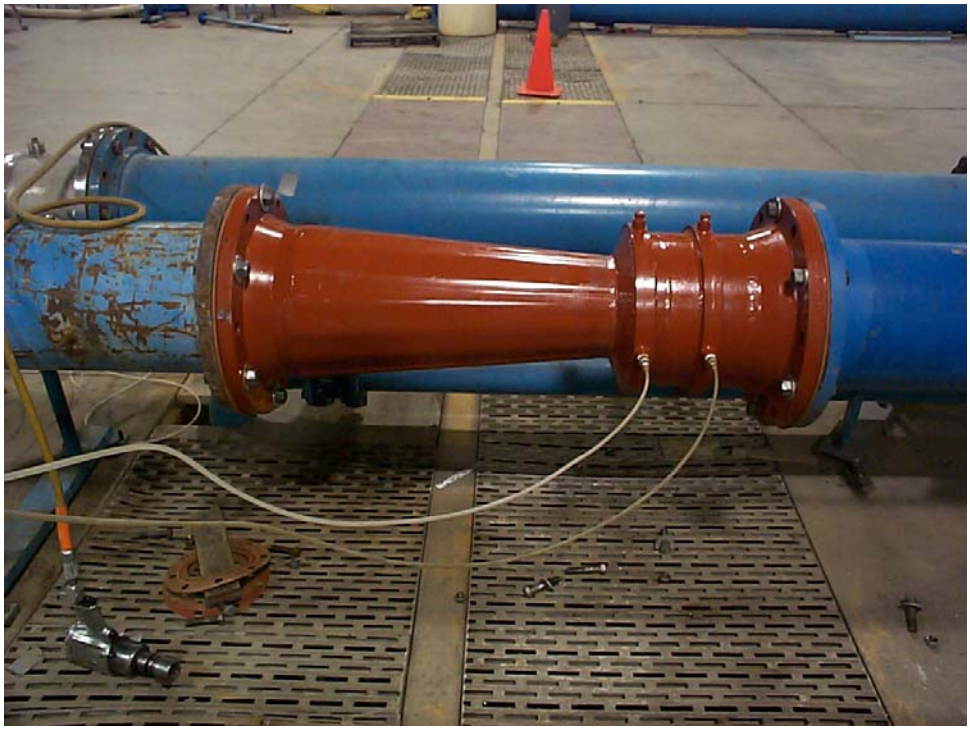


Figure 4. Installation of the 14-inch flow meter.

DISCHARGE COEFFICIENT

The flow meter coefficient (C) was calculated using the following equation:

$$C = \frac{Q\sqrt{1-\beta^4}}{A_\circ\sqrt{(2g\Delta H)}}$$

in which Q is the actual flow rate in cubic feet per second, A_o is the area of the meter's throat in square feet, g is the acceleration of gravity (32.17 feet per second per second), and ΔH is the differential pressure reading in feet of water across the inlet and throat taps. The beta ratio (β) is defined as the ratio of the meter's throat diameter to the meter's inlet diameter.

PROCEDURE

Water was supplied under gravity from First Dam located on the Logan River. Ten different flow rates were established for each meter. The flow, water temperature, and differential pressure were measured.

Flow measurements were made using the laboratory's weight tanks which are primary flow measurement devices that are regularly calibrated and are traceable to the National Institute of Standards and Technology.

Venturi meter differential measurements were made using Rosemount transmitters. The transmitters were referenced to zero at a no flow condition prior to any data collection. The transmitter output was averaged over each individual run and was used to obtain the discharge coefficient.

RESULTS

Tables 1 through 4 summarize the test results and Figures 5 and 14 show the discharge coefficient plotted against the inlet Reynolds number. The Reynolds number was computed using:

$$R = \frac{VD}{\upsilon}$$

Where V is the average velocity at the inlet, D is the diameter of the inlet, and υ is the kinematic viscosity of the test fluid.

Table 1. Utah Water Research Laboratory Flow Meter Calibration Data

Manufacturer:	Imperial Flange and Fitting	Throat Diameter (in.) =	2.416
Calibration Date:	1/10/2007	Beta Ratio (d/D) =	0.6000
Calibration Location:	4" Line	Inlet Diameter (in.) =	4.027
		Nominal Pipe dia. =	4-inch
Serial Number:	23034-1	Pipe Diameter (in.) =	4.027
Model Number:	4" Venturi Tube	Pipe Area (ft^2) =	0.09
		Water Temp. (F) =	43.4
Pipe Setup		Unit Weight(pcf) =	62.42
Upstream:	4" std wall	Kin. Visc. (ft^2/s) =	1.58E-05
Downstream:	4" std wall	Vapor Pres. (psia) =	0.14

Calibration Performed by: N.Smith
Calibration Witnessed by: -

Run No.	Flow (gpm)	ΔH (in. H_2O)	Inlet Reynolds Number	C	Dev from mean (%)
1	2	3	4	5	6
1	57.7	3.18	30,912	0.9122	-4.60%
2	115.3	11.99	61,769	0.9387	-1.83%
3	173.0	26.44	92,692	0.9487	-0.78%
4	229.9	46.06	123,173	**0.9551**	-0.12%
5	286.8	71.81	153,668	**0.9543**	-0.20%
6	346.5	104.44	185,652	**0.9560**	-0.02%
7	402.5	140.63	215,651	**0.9570**	0.09%
8	455.8	180.38	244,229	**0.9570**	0.08%
9	516.6	231.75	276,800	**0.9569**	0.07%
10	574.9	286.88	308,032	**0.9571**	0.09%

Certified by:

Avg. coefficient :	**0.9562**	Re > 123,100
Std. deviation :	**0.0142**	Re > 123,100

Table 2. Utah Water Research Laboratory Flow Meter Calibration Data

Manufacturer:	Imperial Flange and Fitting	Throat Diameter (in.) =	3.639
Calibration Date:	1/9/2007	Beta Ratio (d/D) =	0.6000
Calibration Location:	12" Line	Inlet Diameter (in.) =	6.065
		Nominal Pipe dia. =	6-inch
Serial Number:	23034-2	Pipe Diameter (in.) =	6.065
Model Number:	6" Venturi Tube	Pipe Area (ft^2) =	0.20
		Water Temp. (F) =	42.0
Pipe Setup		Unit Weight(pcf) =	62.43
Upstream:	6" std wall	Kin. Visc. (ft^2/s) =	1.61E-05
Downstream:	6" std wall	Vapor Pres. (psia) =	0.13

Calibration Performed by: B. Heiner, N. Smith
Calibration Witnessed by: -

Run No.	Flow (gpm)	ΔH (in. H_2O)	Inlet Reynolds Number	C	Dev from mean (%)
1	2	3	4	5	6
1	127.1	2.72	44,226	**0.9582**	0.34%
2	269.2	12.34	93,650	**0.9522**	-0.28%
3	394.1	26.44	137,129	**0.9527**	-0.23%
4	522.1	46.31	181,658	**0.9536**	-0.14%
5	650.5	71.88	226,335	**0.9537**	-0.13%
6	806.8	110.06	280,709	**0.9558**	0.10%
7	910.4	140.25	316,768	**0.9555**	0.06%
8	1056.5	189.00	367,601	**0.9552**	0.03%
9	1186.1	237.94	412,675	**0.9557**	0.08%
10	1320.7	294.56	459,502	**0.9564**	0.16%

Certified by:

Avg. coefficient :	**0.9549**	Re > 44,200
Std. deviation :	**0.0018**	Re > 44,200

Table 3. Utah Water Research Laboratory Flow Meter Calibration Data

Manufacturer:	Imperial Flange and Fitting	Throat Diameter (in.) =	6.012
Calibration Date:	1/17/2007	Beta Ratio (d/D) =	0.6000
Calibration Location:	12" Line	Inlet Diameter (in.) =	10.020
		Nominal Pipe dia. =	10-inch
Serial Number:	23034-3	Pipe Diameter (in.) =	10.020
Model Number:	10" Venturi Tube	Pipe Area (ft^2) =	0.55
		Water Temp. (F) =	34.3
Pipe Setup		Unit Weight(pcf) =	62.42
Upstream:	10" std wall	Kin. Visc. (ft^2/s) =	1.85E-05
Downstream:	10" std wall	Vapor Pres. (psia) =	0.10

Calibration Performed by: M. Johnson
Calibration Witnessed by: -

Run No.	Flow (gpm)	ΔH (in. H_2O)	Inlet Reynolds Number	C	Dev from mean (%)
1	2	3	4	5	6
1	338.9	2.87	62,102	0.9113	-1.62%
2	664.3	10.73	121,720	**0.9233**	-0.32%
3	1006.2	24.38	184,360	**0.9281**	0.19%
4	1335.1	43.00	244,626	**0.9272**	0.09%
5	1669.1	67.25	305,815	**0.9268**	0.06%
6	1982.9	94.88	363,312	**0.9270**	0.08%
7	2314.7	129.75	424,106	**0.9254**	-0.10%
8	2645.8	169.13	484,768	**0.9264**	0.01%
9	2974.7	213.75	545,035	**0.9265**	0.02%
10	3315.9	265.88	607,543	**0.9260**	-0.03%

Certified by:

Avg. coefficient :	**0.9263**	Re > 121,700
Std. deviation :	**0.0049**	Re > 121,700

Table 4. Utah Water Research Laboratory Flow Meter Calibration Data

Manufacturer:	Imperial Flange and Fitting	Throat Diameter (in.) =	7.950
Calibration Date:	1/17/2007	Beta Ratio (d/D) =	0.6000
Calibration Location:	12" Line	Inlet Diameter (in.) =	13.250
		Nominal Pipe dia. =	14-inch
Serial Number:	23034-4	Pipe Diameter (in.) =	13.250
Model Number:	14" Venturi Tube	Pipe Area (ft^2) =	0.96
		Water Temp. (F) =	34.6
Pipe Setup		Unit Weight(pcf) =	62.42
Upstream:	14" std wall	Kin. Visc. (ft^2/s) =	1.84E-05
Downstream:	14" std wall	Vapor Pres. (psia) =	0.10

Calibration Performed by: N. Smith
Calibration Witnessed by: -

Run No.	Flow (gpm)	ΔH (in. H_2O)	Inlet Reynolds Number	C	Dev from mean (%)
1	2	3	4	5	6
1	579.4	2.84	80,715	0.8947	-1.58%
2	1189.7	11.66	165,742	**0.9075**	-0.18%
3	1819.5	27.06	253,476	**0.9108**	0.19%
4	2380.2	46.25	331,584	**0.9114**	0.26%
5	2963.9	71.94	412,901	**0.9100**	0.10%
6	3565.6	104.25	496,724	**0.9094**	0.03%
7	4150.8	141.56	578,241	**0.9085**	-0.07%
8	4735.9	184.50	659,759	**0.9080**	-0.13%
9	5323.3	232.88	741,577	**0.9084**	-0.08%
10	5914.9	287.81	823,997	**0.9079**	-0.13%

Certified by:

Avg. coefficient :	**0.9091**	Re > 165,700
Std. deviation :	**0.0014**	Re > 165,700

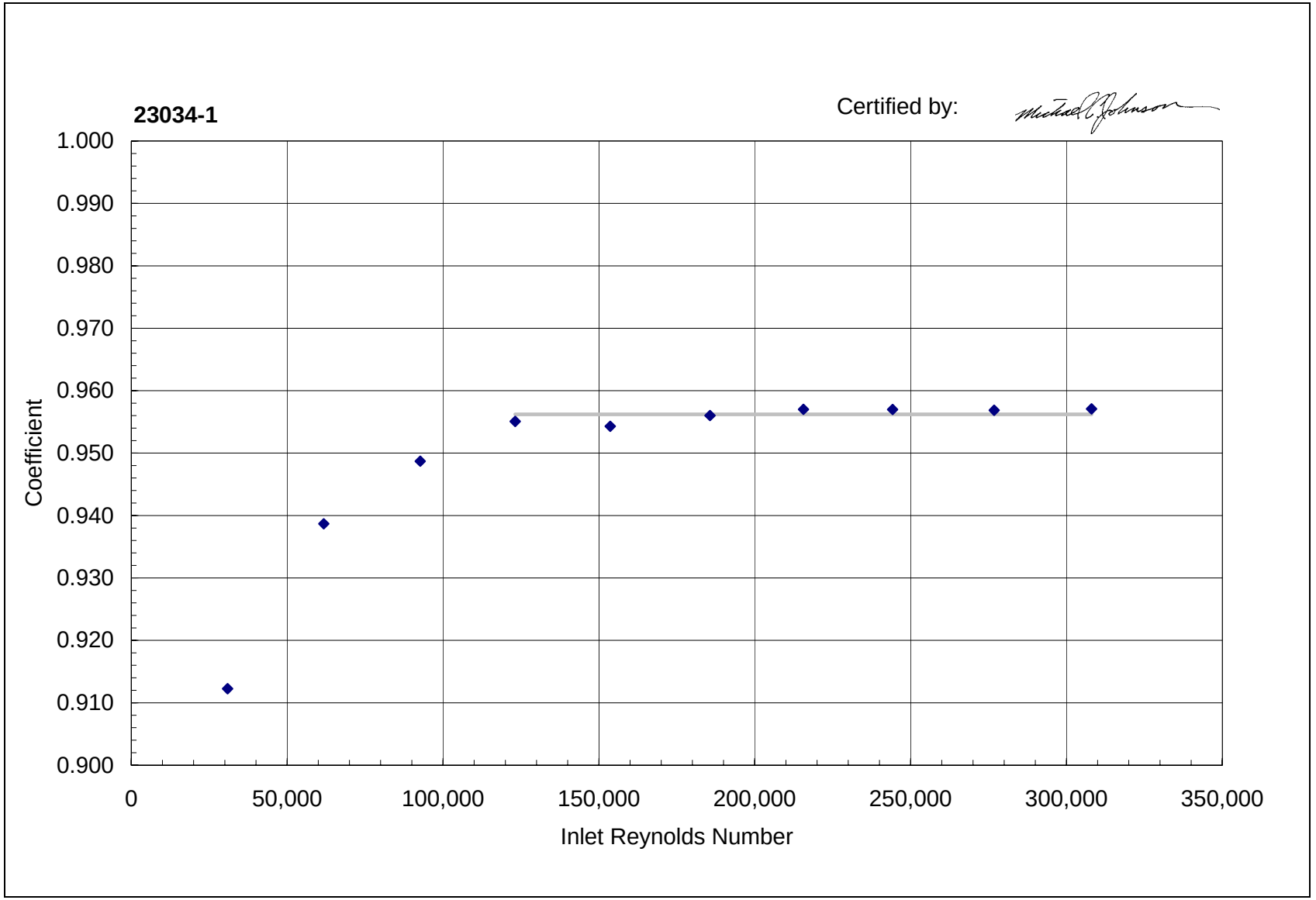


Figure 5. Discharge coefficient versus inlet Reynolds Number for meter 23034-1.

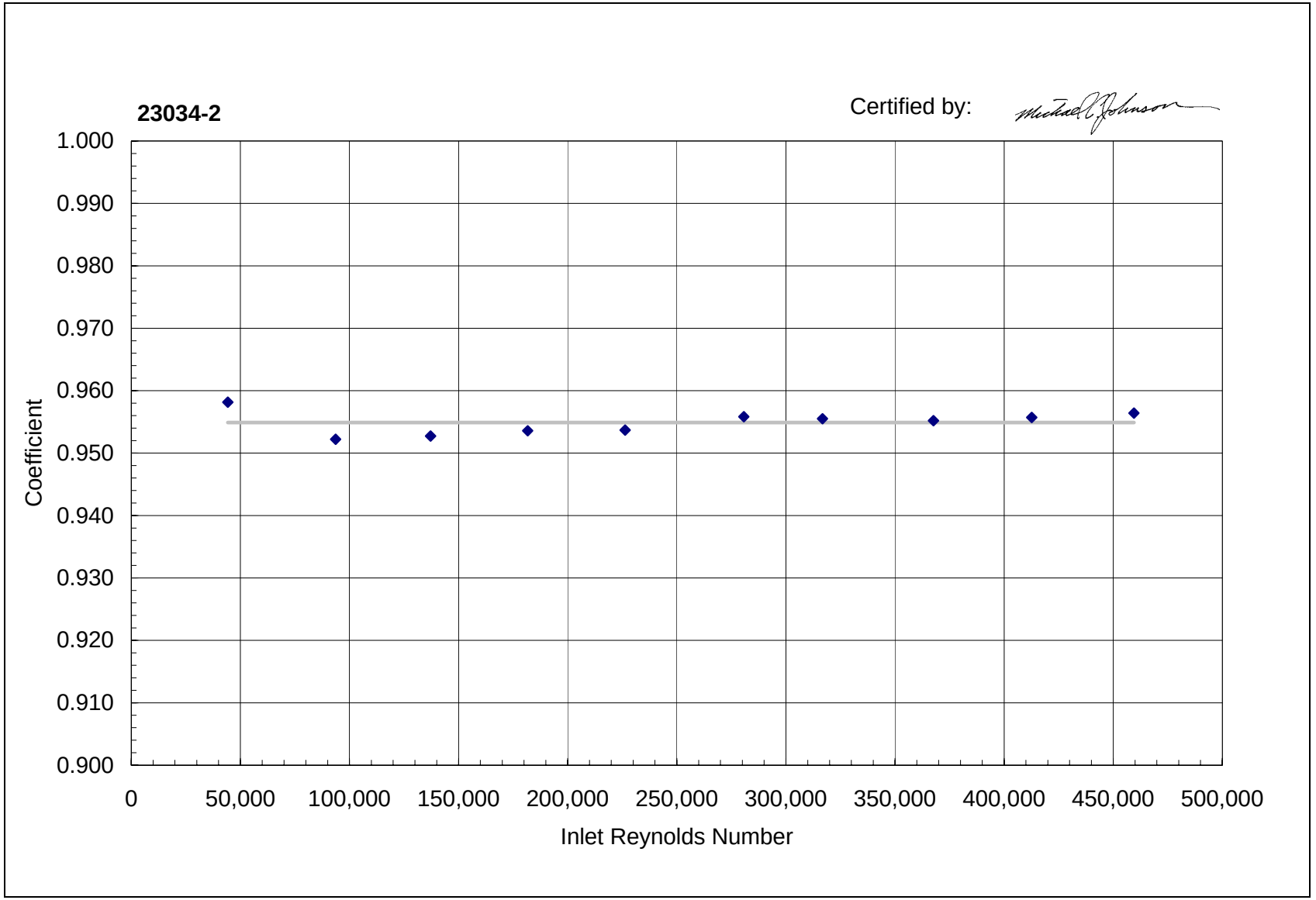


Figure 6. Discharge coefficient versus inlet Reynolds Number for meter 23034-2.

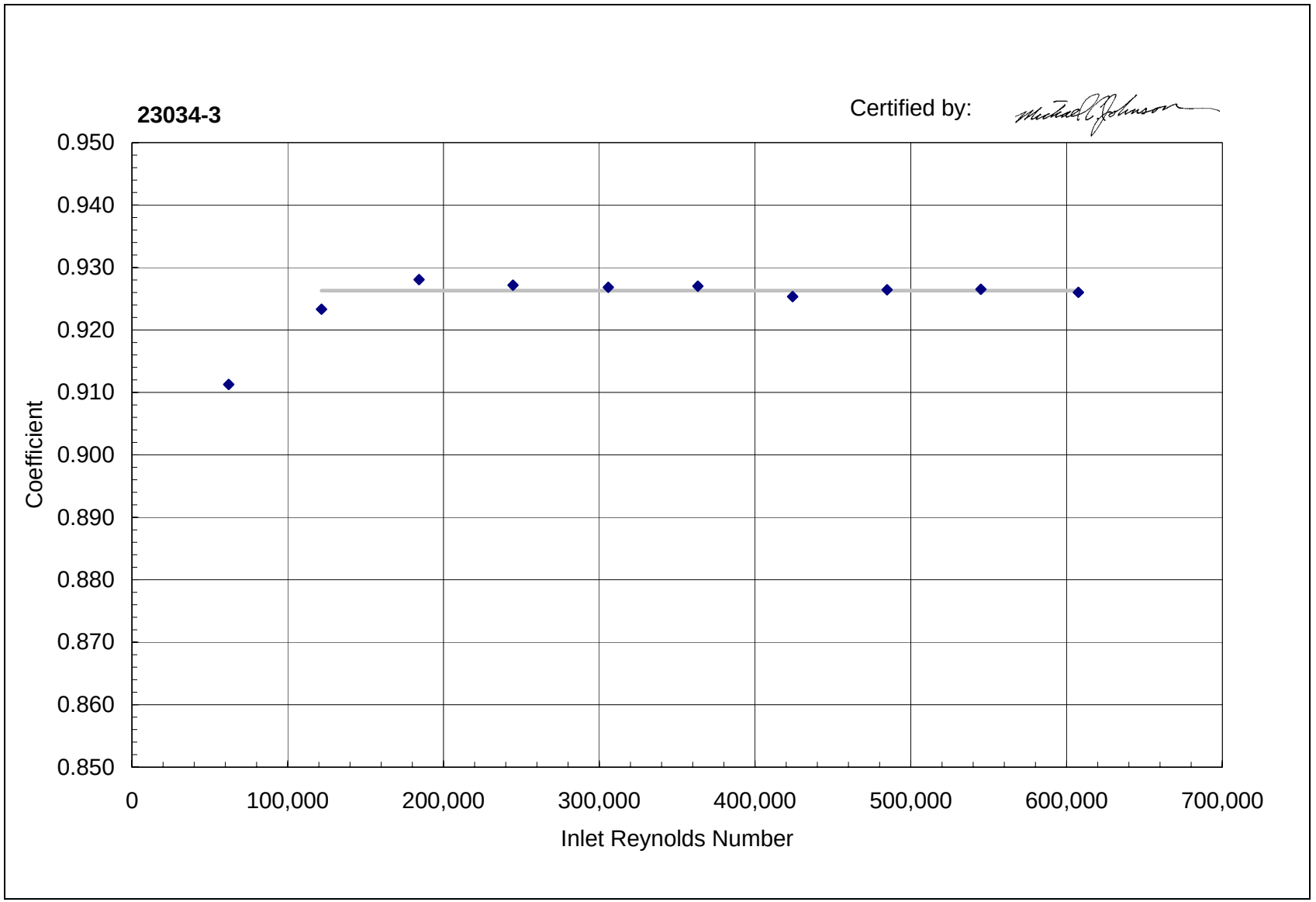


Figure 7. Discharge coefficient versus inlet Reynolds Number for meter 23034-3.

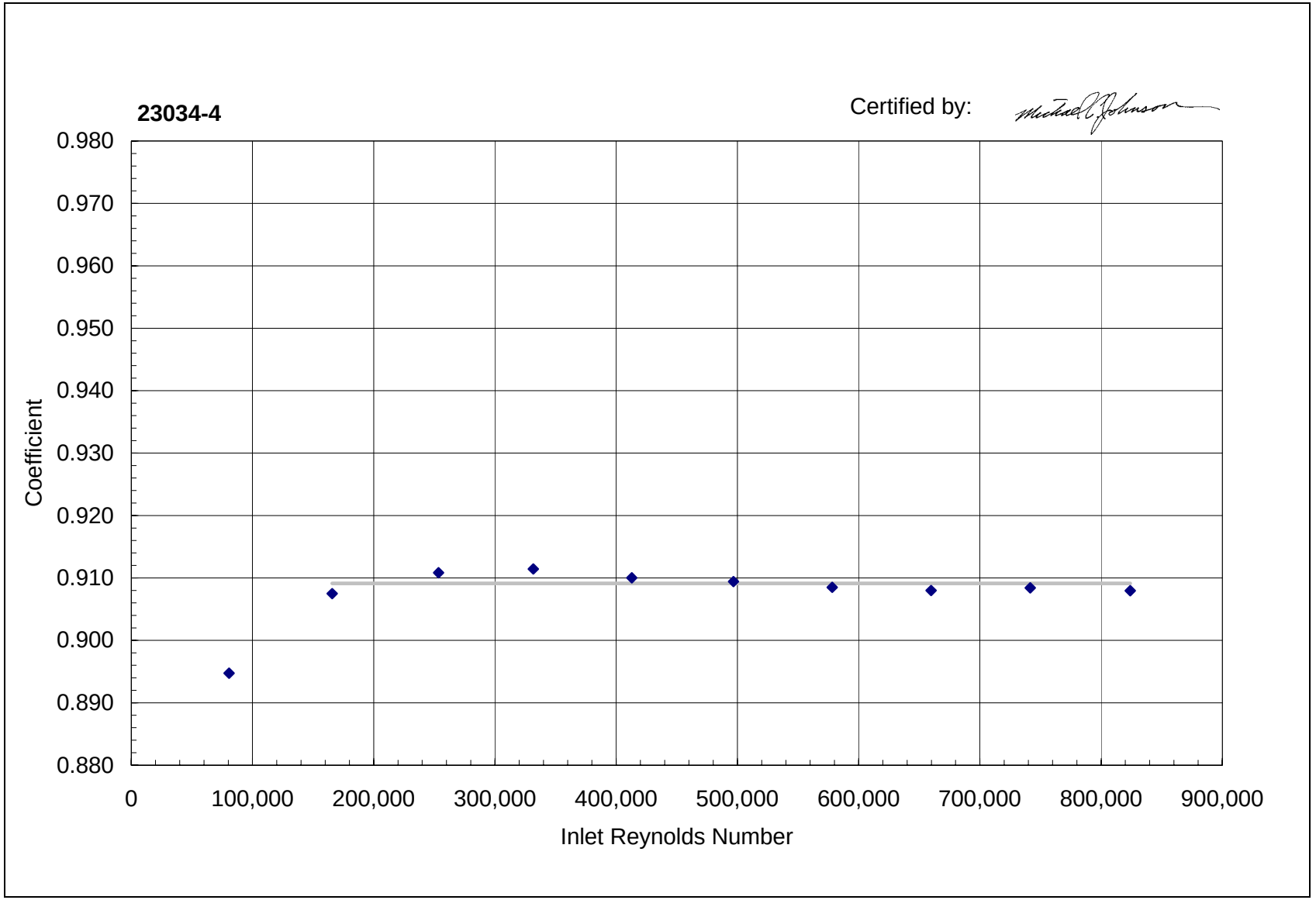


Figure 8. Discharge coefficient versus inlet Reynolds Number for meter 23034-4.