FINAL REPORT

BASELINE AND INSTALLATION EFFECTS TESTS OF THE V-CONE METER

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EXECUTIVE SUMMARY

A 4-inch McCrometer V-Cone flow meter having a beta ratio of 0.67 was tested in the Interim Low Pressure Loop of the GRI Metering Research Facility at Southwest Research Institute. All tests were conducted using dry nitrogen gas at a pressure of 115 psia. Flow rates ranged from 40 to 400 acfm, which corresponded to Reynolds numbers from 125,000 to 1,245,000.

The objectives of the tests were to establish a baseline meter discharge coefficient as a function of Reynolds number and then assess the affect of various upstream installation configurations on the discharge coefficient. A total of seven tests were conducted.

- Baseline discharge coefficient plus permanent head loss
- Installation effect of a 90° elbow
- Installation effect of a 90’ elbow and an inline full open plug valve
- Installation effect of short-coupling to a 90° elbow
- Effect of flow static pressure tap location
- Modified baseline configuration
- Rerun baseline discharge coefficient

The test report documents the test plan, test conditions, facility configuration per test, the instruments used and their calibration accuracies plus graphs and tables depicting the results of the tests and the total uncertainty in measured discharge coefficient and Reynolds number. The main conclusions from the testing are as follows.

- The baseline discharge coefficient is a slowly increasing function of Reynolds number. The average V-Cone discharge coefficient at 400 acfm was 1.5% higher than the average coefficient at 40 acfm.
- With one exception, upstream installation configurations, e.g. elbow, elbow plus plug valve, short coupled to a 90° elbow, flow static pressure tap location, and V-Cone orientation, had negligible affect on the V-Cone discharge coefficient as compared to the baseline values. The exception resulted when the V-Cone was short coupled to a 90’ elbow, but the V-Cone was oriented such that the high and low pressure taps were in the plane of the elbow and directed toward the outside of the elbow.
- The data indicates that a flow conditioner may not be needed upstream of the V-Cone for most of the test conditions that were considered.
- The baseline V-Cone discharge coefficients were quite reproducible. Reproducible Cd versus Reynolds number curves were obtained from two runs separated by 15 days and 10 intervening facility configuration changes.

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ACKNOWLEDGEMENTS

The research, development, test and evaluation activities at the GRI Metering Research Facility are a team effort. Therefore, it is appropriate that the members of the team are acknowledged for their contribution to this project.

Mr. Kenneth Nickle and Mr. Rolando Martinez operated the Interim Low Pressure Loop (ILPL) of the GRI Metering Research Facility, which included test setup, data acquisition and data post processing. Ms. Linda Montez converted the post processed data files into final spreadsheet format. This report manuscript was edited and processed by Ms. Rose Alvizo.

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1.0 INTRODUCTION

This report documents a test program conducted in the Interim Low Pressure Loop (ILPL) of the GRI Metering Research Facility located at Southwest Research Institute (SwRI) in San Antonio, Texas. The test program was conducted for the McCrometer Division of Ketema, Inc.

The V-Cone flowmeter is a patented design, differential pressure flowmeter that uses the same basic principles of measurement as the orifice plate. McCrometer has conducted extensive performance testing of the V-Cone in water. The objectives of the tests conducted in the ILPL on nitrogen gas were to establish the baseline meter discharge coefficient as a function of Reynolds number and then assess the variation of discharge coefficient from the baseline due to various upstream installation configurations.

2.0 TEST ARTICLE

The test article provided by McCrometer was a 4-inch, Model V5104 V-Cone primary flow element in a spoolpiece having ANSI 150 Lb flanges and two-hole up bolt pattern. The V-Cone element had a beta ratio of 0.67. This line size and beta ratio have been used in previous ILPL baseline and installation effects research on orifice meters, and they have been used exclusively in flow conditioner research. This meter size was selected to produce a differential pressure of nominally 50 inches of water at the highest flowrate. The beta ratio for the V-Cone flowmeter is defined in Appendix A. As with the orifice plate, the beta ratio is the ratio of meter flow area to pipe area. For the V-Cone, the flow area is distributed around the perimeter of the V-Cone body as opposed to the central core flow area of an orifice plate. A drawing of the V-Cone and spoolpiece is shown in Figure 1.

3.0 TEST PLAN

All tests were conducted at a nominal gas pressure of 115 psia. Flow rates ranged selectively from nominally 40 to 400 acfm. Within a given test, flow rate setpoints were repeated three times in order assess the repeatability of the discharge coefficient measurements. Seven tests were conducted, and each test is described below.

Test 1: Baseline Cd Plus Permanent Head Loss

The objective of Test la was to obtain a lo-point baseline calibration of the V-Cone meter using a physical installation that paralleled the configuration used by SwRI for its baseline and installation effects research on orifice meters. The configuration is shown in Figure 2. The 50D pipe length upstream of the V-Cone was the ILPL matched bored and pinned meter run. An orifice plate having a beta ratio

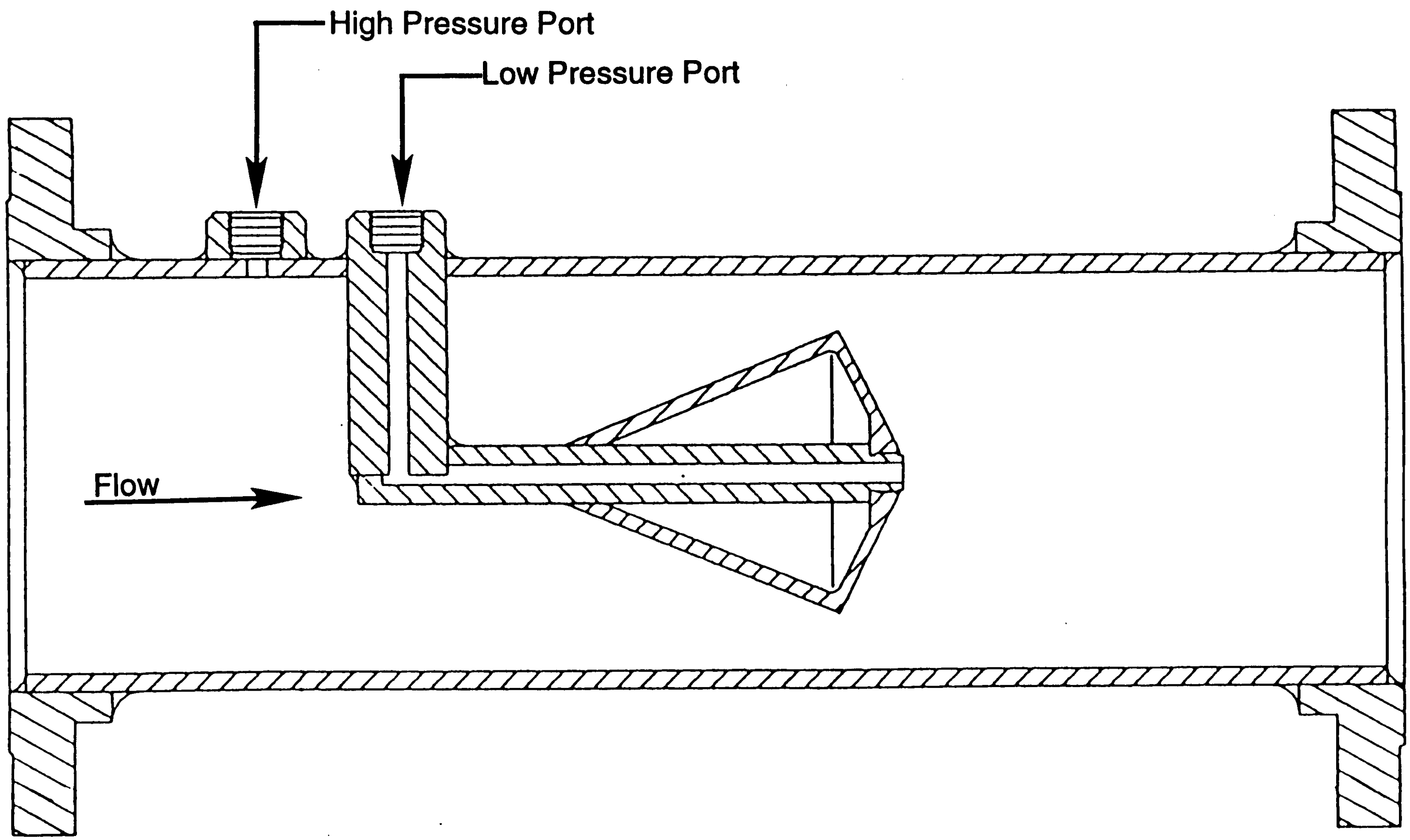

Figure 1. Cutaway Drawing of V-Cone Differential Pressure Flowmeter

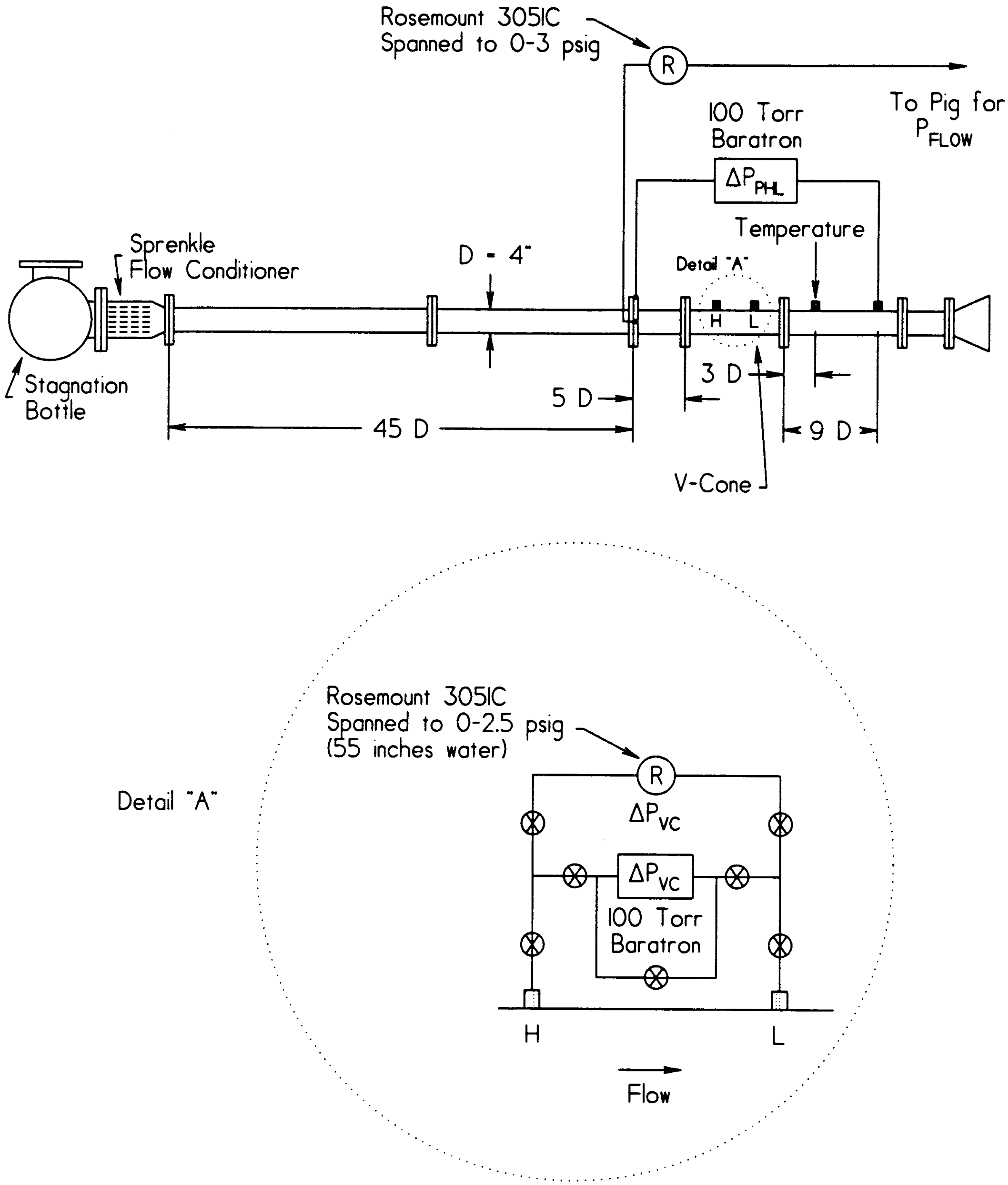

Figure 2. V-Cone Setup for Test 1a Calibration and Test 1b Permanent Head Loss Measurement

of one was inserted between the 45D and SD segments of the ILPL meter run in order to provide a sealing surface for the O-rings on the orifice flanges. In Test 1 b, the static head loss across the V-Cone was measured as shown if Figure 2. Nine pipe diameters were provided downstream of the V-Cone to allow for pressure recovery. Tests 1 a and 1 b were performed sequentially.

Test 2: Installation Effect of a 90’ Elbow

As shown in Figure 3, the configuration for Test 2 consisted of a horizontal 90” elbow and the ILPL 22D meter tube upstream of the V-Cone. The 50D meter tube of Test 1 was replaced with the 22D meter tube to be consistent with previous ILPL installation effects research on orifice meters. In three separate tests, 2a, 2b and 2c, the V-Cone was body was tested in three orientations with respect to the flow. The V-Cone was first tested with pressure taps vertical (Test 2a). In the next two tests, the V-Cone was rotated either +90 (Test 2b) or -90” (Test 2c) looking upstream with respect to the flow. All other piping components remained fixed during this test sequence.

Test 3: Installation Effect of a 90’ Elbow and Inline Full Open Plug Valve

To assess the affect of a valve upstream of the V-Cone, a full open 4-inch plug valve was inserted in the Test 2 setup between the discharge flange of the 90” elbow and 22D meter tube. The V-Cone was oriented vertically as was the valve stem.

Test 4: Installation Effect of Short Coupling

In this test, the V-Cone was short coupled to a 90” elbow. Following A.G.A. Report No. 7, a 4D pipe segment was inserted between the elbow and the V-Cone. The 4D section did not contain a flow conditioner. The piping configuration is shown in Figure 4. As in Test 2, three calibration runs, 4a, 4b and 4c, were made with the V-Cone oriented vertically and at ±90° with respect to the vertical. The upstream static pressure tap in the 4D section was located in the same plane as the V-Cone pressure taps. The 4D section was rotatated with the V-Cone.

Test 5: Effect of Flow Static Pressure Tap Location

The piping configuration for Test 5 was identical to the configuration of Test 4. In Test 4, the tap for flow static pressure measurement was located on the lead-in pipe 1.25D upstream of the V-Cone entry flange. In Test 5, the flow static pressure was obtained by teeing off of the high pressure port on the V-Cone. The V-Cone was oriented vertically. Whereas previous tests involved 10 flow rates, Test 5 included five flow rates: 80, 160, 240, 320 and 400 acfm.

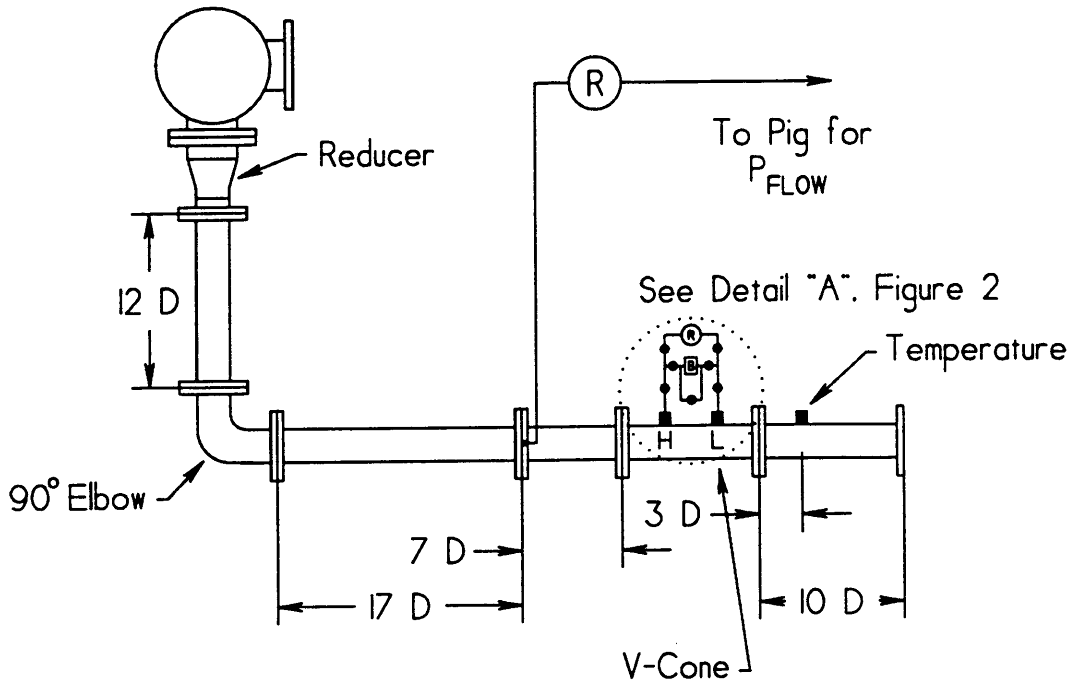

Figure 3. Physical Setup for Assessing the Installation Effects of a 90° Elbow Upstream of a V-Cone

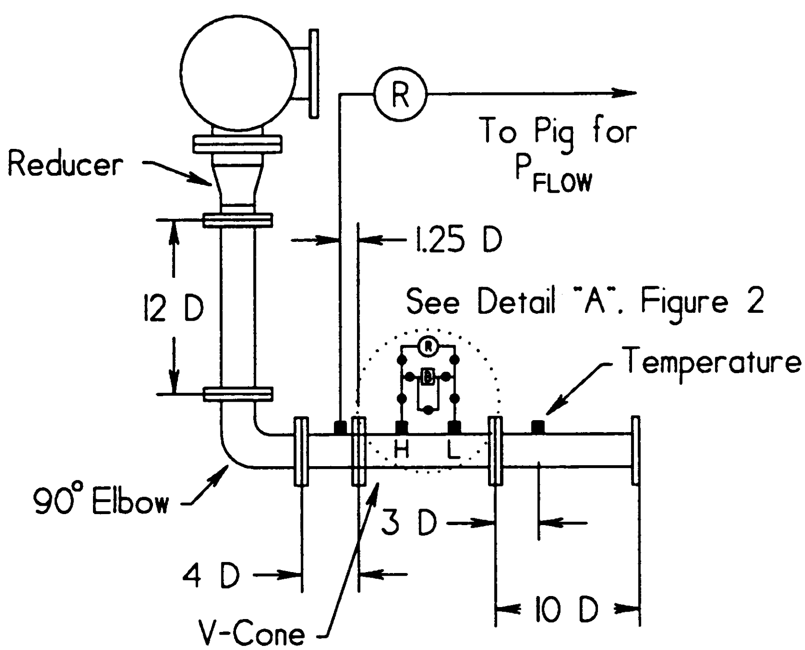

Figure 4. Physical Setup for Assessing the Performance of a V-Cone Short-Coupled to a 90° Elbow

Test 6: Modified Baseline Configuration

Test **6 was** identical to Test 1 with two exceptions. First, the **4D spool** piece that was used in Test 4 was inserted in Figure 2 between the 5D spool of the ILPL meter tube and the V-Cone. Second, the flow static pressure port on the 4D spool was used instead of the orifice flange pressure port that had been used in Test 1.

Test 7: Rerun Baseline Test 1

Test **7 was** a duplicate rerun of the baseline Test 1. Initially, in Test 7A, flow rates were 80, 160, 240,320, and 400 acfm. Then, the intermediate flow rates of 40,120,200,280, and 360 acfm were run under Test 7B.

4.0 TEST RESEARCH FACILITY — INTERIM LOW PRESSURE LOOP

The MRF is a unique world-class flow research center initiated by the Gas Research Institute (GRI). The facility is located at and is operated by Southwest Research Institute (SwRI). The MRF consists of an Interim Low Pressure Loop (ILPL) and a High Pressure Loop (HPL) in order to cover the wide range of flow conditions required by the gas industry.

The ILPL is a recirculating gas flow loop for pipe sizes up to 6 inches with a maximum operating pressure of 190 psig and flow rates up to 6 MMSCFD (250 MSCFH). A plan view of the ILPL illustrating the main components is shown in Figure 5. Acoustic filters are located upstream and downstream of a reference metering section so that measurements are isolated from any compressor disturbance, and pulsation research can be performed in the test section without influencing flow measurements in the reference section. A water-cooled heat exchanger controls gas temperature to stability of approximately ±l° F.

The configuration of the ILPL is flexible such that flow can enter the upstream end of the test section either directly from a vessel through a single elbow or through other arrangements of upstream piping. The test section has an overall length of over 33 feet, which is equivalent to approximately 100 diameters of 4-inch pipe.

Flow in the ILPL is controlled by compressor speed and by a critical flow venturi bank. There are currently nine different venturi sizes that can be installed in the four venturi runs to control flow rate. In the choked flow condition, critical flow venturi elements establish a stable flow rate and provide a secondary flow measurement standard.

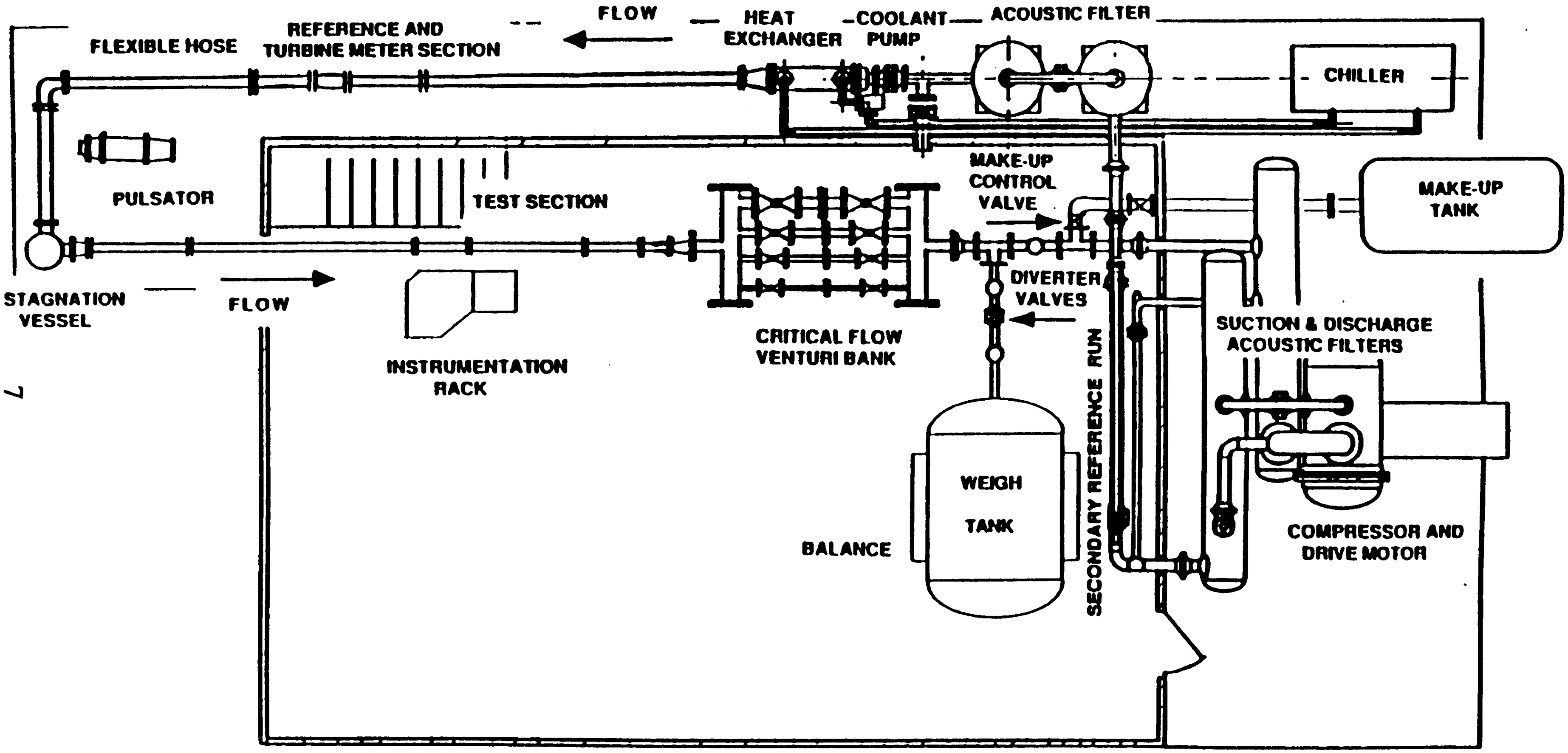

Figure 5. Metering Research Facility Interim Low Pressure Loop (ILPL) Configuration

A primary mass flow measurement system is a key part of the ILPL. This system shown in Figure 6 consist primarily of a weigh tank and a gyroscopic balance. The balance is a state-of-the-art instrument that can resolve the total mass of gas collected in the weigh tank with a precision of ±2.5 grams out of a gas weight of typically 50,000 grams. The volume of the vessel is in excess of 300 cubic feet, and the tare weight of the tank is about 2,000,000 grams. The accuracy of the scale and calibration procedure results in a mass flow rate measurement accuracy of better than 0.1 percent as shown in Figure 7.

5.0 FACILITY INSTRUMENTATION AND TEST PROCEDURE

All necessary instrumentation was calibrated in accordance with MRF calibration procedures. Table 1 contains a list of the key instrumentation for this test, the calibration range of each instrument and its corresponding uncertainty level. The output of the temperature and pressure sensors for the various sonic nozzles were used to calculate the actual volumetric flow rate in the ILPL during a given test. The ILPL absolute test section static pressure is equal to the algebraic sum of System Absolute Pressure and the Test Article Flow Differential Pressure.

Dry industrial grade nitrogen was used as the test gas for all tests. Following calibration checks on all instruments, the flow loop was operated for several minutes to stabilize the pressure, temperature, and flow rate at the selected test conditions. After the flow was stabilized at a desired test condition, facility system variables were sampled by the ILPL data acquisition computer at a rate of 15Hz for two minutes. Given the test flow rate and sample time, the corresponding number of ILPL reference turbine meter pulses was calculated. Time control was achieved through pulse counting.

Four sonic nozzles were used individually and in various combinations to generate 10 controllable flow rates over the range from 40 to 400 acfm. The nozzles were rated at 40, 80, 160, and 320 acfm (actual cubic feet per minute). Changes in system flow rate produced corresponding changes in Reynolds number, which was the primary independent test variable.

Following completion of a given test series, the ILPL test section was isolated from the rest of the loop and depressurized so that the test section could be reconfigured to accept the next test configuration. The test section was then purged back into nitrogen service. Gas analyses have been conducted prior to and after purging into service and have proven that the ILPL purge procedure results in a test gas that is 99.984 mole percent nitrogen at a minimum, with a balance of 0.016 mole percent oxygen, and less than 0.0005 mole percent methane and non-methane hydrocarbons. The analyses justify the use of pure nitrogen properties for all subsequent data reduction.

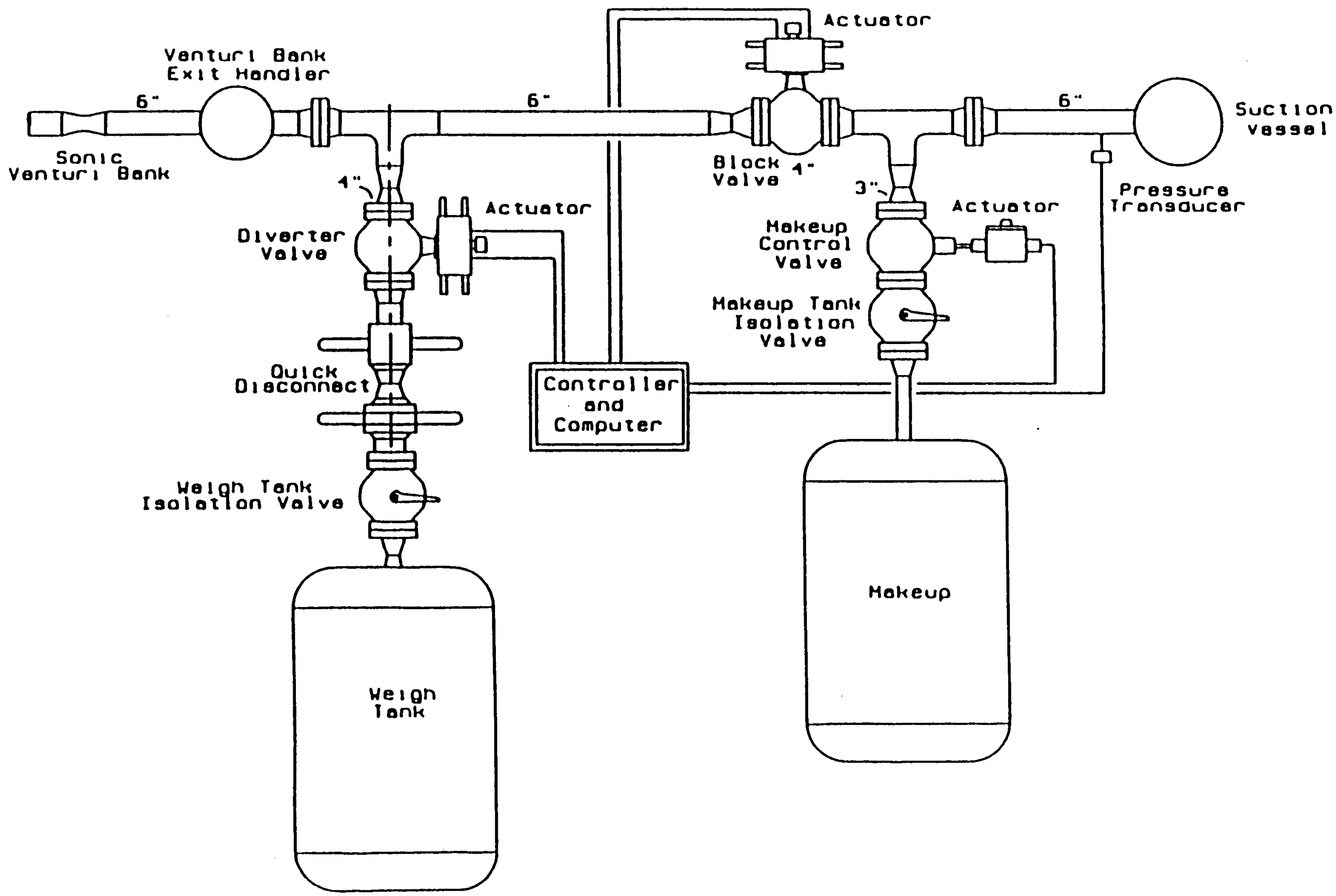

Figure 6. Primary Calibration System

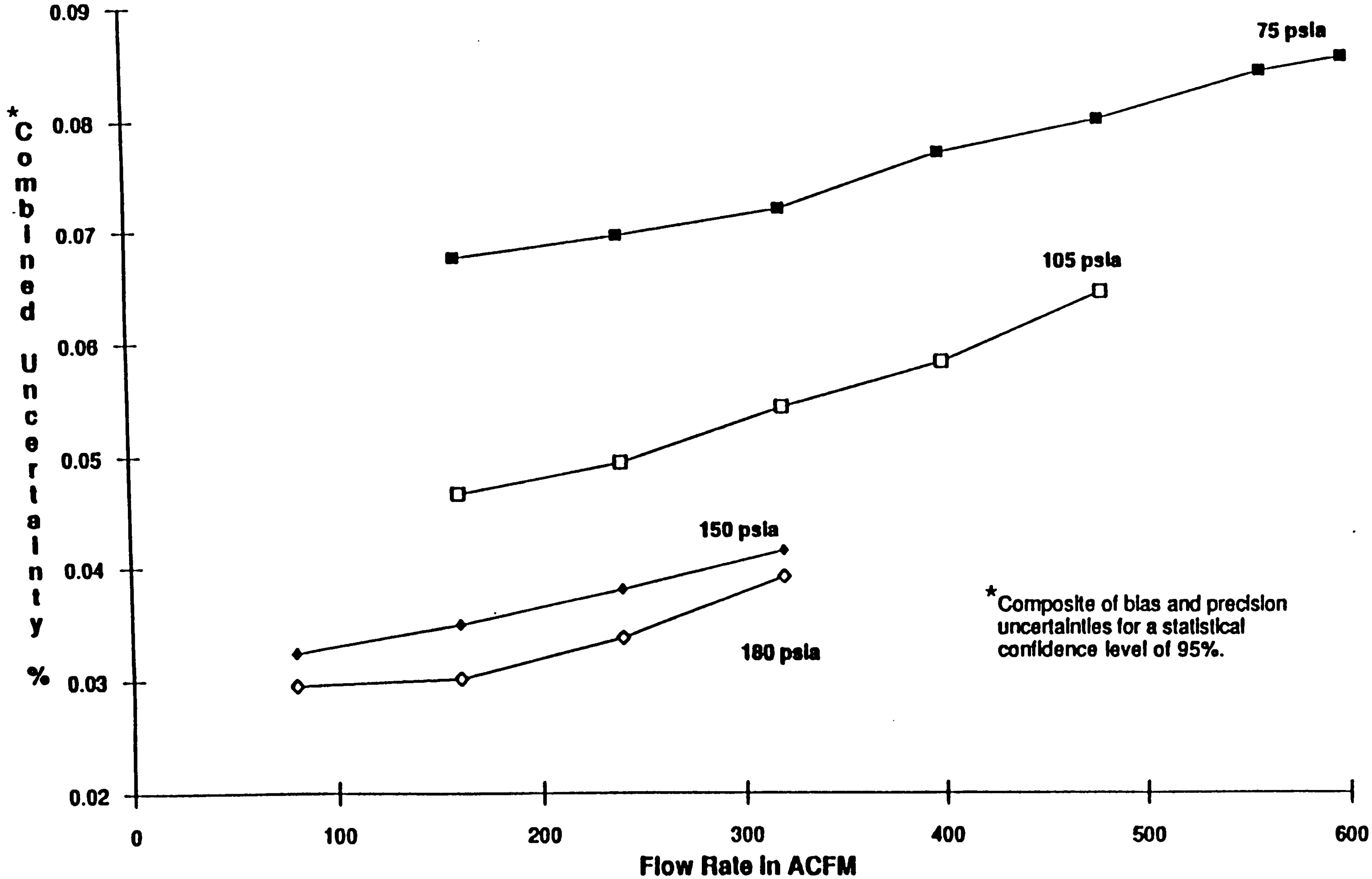

Figure 7. Mass Flow Measurement Accuracy of the MRF ILPL Gravimetric Primary Standard

Table 1. Test Instrumentation

Function	Serial No.	Type	Range	Uncertainty*
2" Nozzle Plenum Pressure	21064	Rosemount 3051C	0-2 psid	0.1%
3" Nozzle Plenum Pressure	21065	Rosemount 3051C	0-2 psid	0.1%
4" Nozzle Plenum Pressure	21066	Rosemount 3051C	0-2 psid	0.1%
6" Nozzle Plenum Pressure	21067	Rosemount 3051C	0-2 psid	0.1%
2" Nozzle Difference Temperature	18-103	Weed RTD	0-50°C	0.1°C
3" Nozzle Difference Temperature	18-105	Weed RTD	0-50°C	0.1°C
4" Nozzle Difference Temperature	18-106	Weed RTD	0-50°C	0.1°C
6" Nozzle Difference Temperature	114	Weed RTD	0-50°C	0.1°C
Test Article Flow Temperature	273322	Rosemount 3051C	0-50°C	0.1%
Test Article Flow Differential Pressure	6845	Rosemount 3051C	0-3 psid	0.1%
System Absolute Pressure	33505	Paroscientific	0-200 pisa	0.01%
V-Cone ΔP(High Range)	56845	Rosemount 3051C	Spanned to 0-2.5 psig	0.1%
V-Cone ΔP (Low Range)	92021306A	MKS Baratron	100 Torr	0.05%
V-Cone Head Loss	92021306A	MKS Baratron	100 Torr	0.05%

*Percentage uncertainties relative to transducer full scale

6.0 TEST RESULTS

Numerical test results are tabulated in spreadsheet form Appendix C. The format of each spreadsheet is the same, and it includes the following headings.

- Date - YearMonthDate format
- Time - 24-hour clock notation, HourMinuteSecond format at start of test
- Pup(psia) - absolute static pressure at the V-Cone in psia
- T(F) - gas temperature at the V-Cone in degrees Fahrenheit
- rho(lb/ft3) - gas density at the V-Cone
- DP(psid) - differential pressure across the V-Cone pressure ports
- ReD - Reynolds number based on pipe diameter

- UReD(%) - uncertainty in Reynolds number
- Cd - V-Cone discharge coefficient
- UCd(%) - uncertainty in V-Cone Cd measurement
- Y - V-Cone expansion factor
- SN(lb/s) - nozzle mass flow rate in pounds per second
- USN(%) - uncertainty in nozzle mass flow rate

Appendix B contains graphical representations of V-Cone performance corresponding to the tabular data. Appendix A contains the general performance equations for the V-Cone. The equations for V-Cone expansion factor, Y, were used in the ILPL post-processor to calculate discharge coefficient.

As a quality control check during the testing, a periodic primary weigh tank calibration run was performed on selected individual nozzles to verify their performance. In those cases, the sonic nozzle orifice coefficient as calculated from the weigh tank run fell between the upper and lower control limits, i.e. ,+0.1% about the mean nozzle coefficient, established by the ILPL for a given nozzle. These weigh tank runs verified that the ILPL operation was under control. The weigh tank runs are included in the spreadsheets in Appendix C. In between weigh tank runs, system control was verified by comparing the flow rate calculated from the sonic nozzles with the flow rate output from the ILPL reference turbine meter. The control criterion was that the nozzle flow rate should not differ from the turbine meter flow rate by a percentage that was greater than the total uncertainty of the turbine meter measurement.

Appendix A contains two graphs that pertain to the V-Cone expansion factor. Figure A.1 shows a comparative plot of the V-Cone expansion factor and the expansion factor for an orifice plate flow meter over a wide range of the ratio of meter pressure drop to flow static pressure. Figure A.2 shows a plot of the V-Cone expansion factor as a function of the normalized pressure drop in the baseline Test 1a. Both sonic nozzle and weigh tank data point arc 4represented in this figure. Note that, in all cases, test conditions were such that the V-Cone expansion factor exceeded the minimum value of 0.96 as recommended by McCrometer.

The following observations are offered on V-Cone performance.

Test 1: Baseline Cd Plus Permanent Head Loss

The V-Cone baseline discharge coefficient shown in Figure B.l is a slowly increasing function of pipe Reynolds number. Under reduced flowrate range but with an orifice plate beta ratio of 0.67, the ILPL baseline orifice discharge coefficient' decreases with increasing Reynolds number and follows the A.G.A. 3 RG equation. The average V-Cone discharge coefficient at 400 acfm was 1.5% higher than the average coefficient at 40 acfm. Similarly, average discharge coefficient uncertainty ranged from ±0.545% at 40 acfm down to ±0.189% at 400 acfm. For Reynolds numbers from about 600,000 to 1,250,000, the V-Cone differential pressure was at least one-half of the differential pressure measured in the ILPL baseline tests with an orifice plate beta ratio of 0.67 and the same line size and static pressure.

Figure B.2 shows the permanent head loss across the V-Cone as a function of Reynolds number. The head loss is presented in terms of a pressure coefficient, which is numerically equal to the actual pressure drop shown in Appendix C divided by the flow dynamic pressure expressed in the same units as pressure drop. In equation form, the pressure coefficient is defined as follows.

$$C_p = \frac{\Delta P}{1/2\rho(Q/A)^2}$$

Where:

AP = permanent pressure loss across the V-Cone

ρ = gas density at the V-Cone

Q = actual flow rate past V-Cone at test pressure and temperature

A = meter tube cross-sectional area

Test 2: Installation Effect of a 90" Elbow

The discharge coefficient as a function of Reynolds number is shown in Figures B.3, B.4, and B.5 for three V-Cone orientations with respect to the flow direction. In Figure B.3, the V-Cone was oriented vertically, i.e., pressure ports normal to the plane of the elbow. In Figure B.4, the V-Cone was rotated +90° (clockwise) as viewed looking upstream. Finally, the V-Cone was rotated -90° (counter clockwise), and the results are shown in Figure B.5.

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1 T.B. Morrow and J. T. Park, "Baseline Conditions for Orifice Meter Calibration," GRI Publication No. GRI-92/0097, October 1992.

The first observation is that the Cd values for the 0 and +90° orientations agree with each other across the Reynolds number range. At the -90° orientation, the Cd values fall below those at 0° for Reynolds numbers less than roughly 360,000 or 120 acfm potentially due to elbow-induced pressure instabilities. However, for Reynolds numbers greater than about 400,000, the presence of the upstream elbow appears to have negligible affect on Cd values compared to the V-Cone baseline in Figure B. 1.

Test 3: Installation Effect of a 90° Elbow and Inline Full Open Plug Valve

The results of Test 3 in Figure B.6 can be compared to the results from Test 2 in Figure B.3 to infer the effect of adding a plug valve to the Test 2 setup. The Test 3 results can also be compared to the baseline Test 1 to determine the affect of an elbow and plug valve in series upstream of the V-Cone. The results indicate that the addition of an upstream valve had a negligible affect on discharge coefficients relative to either the Test 2 configuration with a 90" elbow and the vertical V-Cone or the Test 1 baseline Cd values.

Test 4: Installation Effect of Short Coupling

As demonstrated by Figures B.7 and B.8, short coupling of the V-Cone to a 90° elbow had little affect on the measured discharge coefficient at any test Reynolds number for the V-Cone oriented either vertically or rotated 90° clockwise as viewed from a downstream observer. In addition, the Cd curves for these two close-coupled configurations generally agree with the baseline data of Test 1. The discharge coefficient data for the -90° orientation in Figure B.9 is somewhat higher than the baseline data of Test 1 throughout the test Reynolds number range. This suggests that the preferred short-coupled V-Cone installation is with the V-Cone pressure taps oriented either vertically to the plane of the elbow or rotated 90" toward the inside radius of the elbow.

Test 5: Flow Static Pressure Tap Location

In this test, the piping configuration was identical to that used in Test 4. The difference between Test 5 and Test 4 was that flow static pressure was obtained directly from a Tee on the V-Cone high pressure port as opposed to the pressure tap on the lead-in piping to the V-Cone in Test 4. A comparison of the Test 5 results in Figure B. 10 with the corresponding Test 4 results in Figure B.7 indicates that, within experimental variability, the change of pressure tap location had no affect on the discharge coefficient over the Reynolds number range tested.

Test 6: Modified Baseline Configuration

The results of this test are shown in Figure B.11, and they can be compared directly with the baseline results of Test 1. Recall that Test 6 differed from Test 1 in the location of the flow static pressure port and that in Test 6 an additional pipe segment was inserted between the meter tube and the V-Cone. A comparison of Figures B.l and B. 11 indicates that, within experimental variability, the discharge coefficients measured with the modified baseline agree with the baseline of Test 1. Since two factors were changed in Test 6 relative to Test 1, it is not possible determine if the individual change effects were negligible or if the change effects were offsetting and coincidentially produced the same result.

Test 7: Duplicate Baseline Test

This test was a duplicate rerun of Test 1A. Comparing Figure B. 1 with Figures B. 12, and B. 13 indicates that, within experimental variability, the two baseline runs resulted in reproducible discharge coefficient curves as a function of Reynolds number. In other words, the V-Cone calibration curves were reproducible. This is a significant result because Test 1 and Test 7 were separated by 15 days and 10 configuration changes.

APPENDIX A

General Equations for the V-Cone Flowmeter

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McCROMETER DIVISION • 3255 W. STETSON AVENUE, HEMET, CA 92545

General equations for the V-Cone flowmeter

$$\beta = \frac{\sqrt{D_1^2 - d^2}}{D_1}$$

where:
β is the meter beta ratio
D_1 is the meter inside diameter in inches
d is the cone diameter in inches

$$\rho = 2.698825 \frac{(G)(P_L)}{(Z)(T)}$$

where:
ρ is the flowing fluid density in pounds per cubic foot
G is the gas specific gravity
P_L is the static line pressure measured upstream of the meter in psia
Z is the gas compressibility factor
T is the flowing temperature in degrees Rankine

$$q_{ACFS} = \frac{\pi}{4} \sqrt{\frac{2G_C}{\rho}} \frac{D^2\beta^2}{\sqrt{1-\beta^4}} \sqrt{\Delta P}\, C_d Y$$

where:
q_{ACFS} is the gas flow rate in actual cubic feet per second
G_c is the acceleration of gravity (32.2 ft/sec^2)
ρ is the flowing fluid density in pounds per cubic foot
D is the meter inside diameter in feet
β is the meter beta ratio
AP is the differential pressure measured across the V-Cone in pounds per square foot
C_d is the flow coefficient of the meter
Y is the adiabatic expansion factor for contoured elements (see below)

$$R = 1 - \frac{\Delta P}{P_L}$$

$$Y = \left[\frac{\left(1-\beta^4\right) \frac{k}{k-1} R^{\frac{2}{k}} \left(1-R^{\frac{k-1}{k}}\right)}{\left(1-\left(\beta^4 R^{\frac{2}{k}}\right)\right)(1-R)} \right]^{\frac{1}{2}}$$

where:
R is simply a variable to keep the Y equation manageable
Y is the adiabatic expansion factor
AP is the differential pressure measured across the V-Cone in pounds per square inch
P_L is the static line pressure measured upstream of the meter in psia
β is the meter beta ratio
k is the fluid isentropic exponent at flowing conditions

$$v = \frac{q_{ACFS}}{\frac{\pi D^2}{4}}$$

where:

v is the fluid velocity through the pipe, in feet per second

q_{ACFS} is the gas flow rate in actual cubic feet per second

D is the meter inside diameter in feet

$$Re = \frac{123.9 v D_1 \rho}{\mu}$$

where:

Re is the Reynolds number

v is the fluid velocity through the pipe in feet per second

D_1 is the meter inside diameter in inches

ρ is the flowing fluid density in pounds per cubic foot

μ is the operating fluid viscosity, in Centipoise

$$q_{SCFH} = \frac{3600(q_{ACFS})(P_L)(T_s)}{(T)(P_s)}$$

where:

q_{SCFH} is the gas flow rate in standard cubic feet per hour

q_{ACFS} is the gas flow rate in actual cubic feet per second

P_L is the static line pressure measured upstream of the meter in psia

T_s is the temperature in degrees Rankine at standard conditions

T is the flowing temperature measured downstream of the meter in degrees Rankine

P_s is the pressure in psia at standards conditions

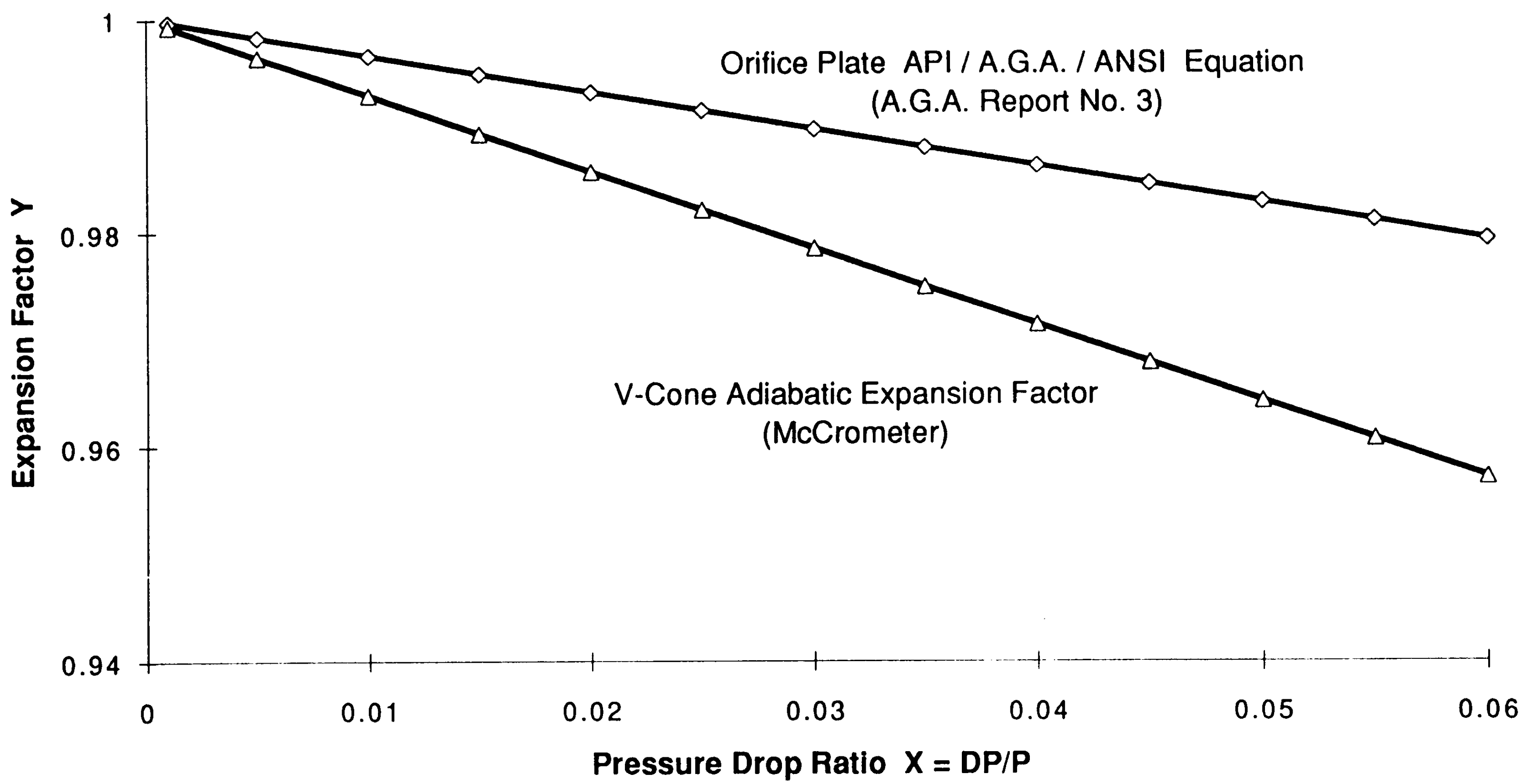

Figure A.1. Calculated Expansion Factors for the V-Cone Meter and Orifice Plate

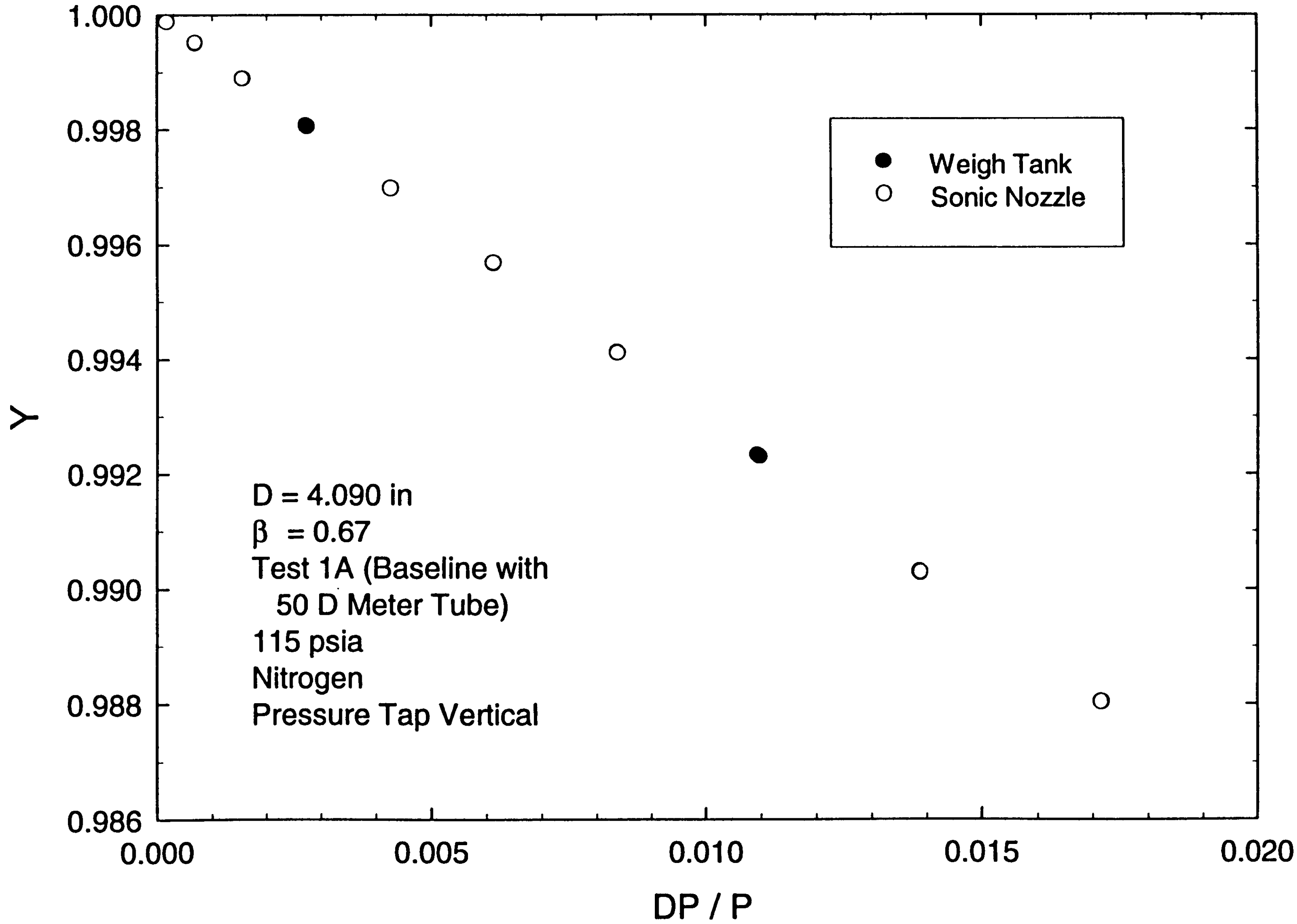

Figure A.2 V-Cone Expansion Factor Calculated Using Test Data

APPENDIX B

V-Cone Performance Graphs

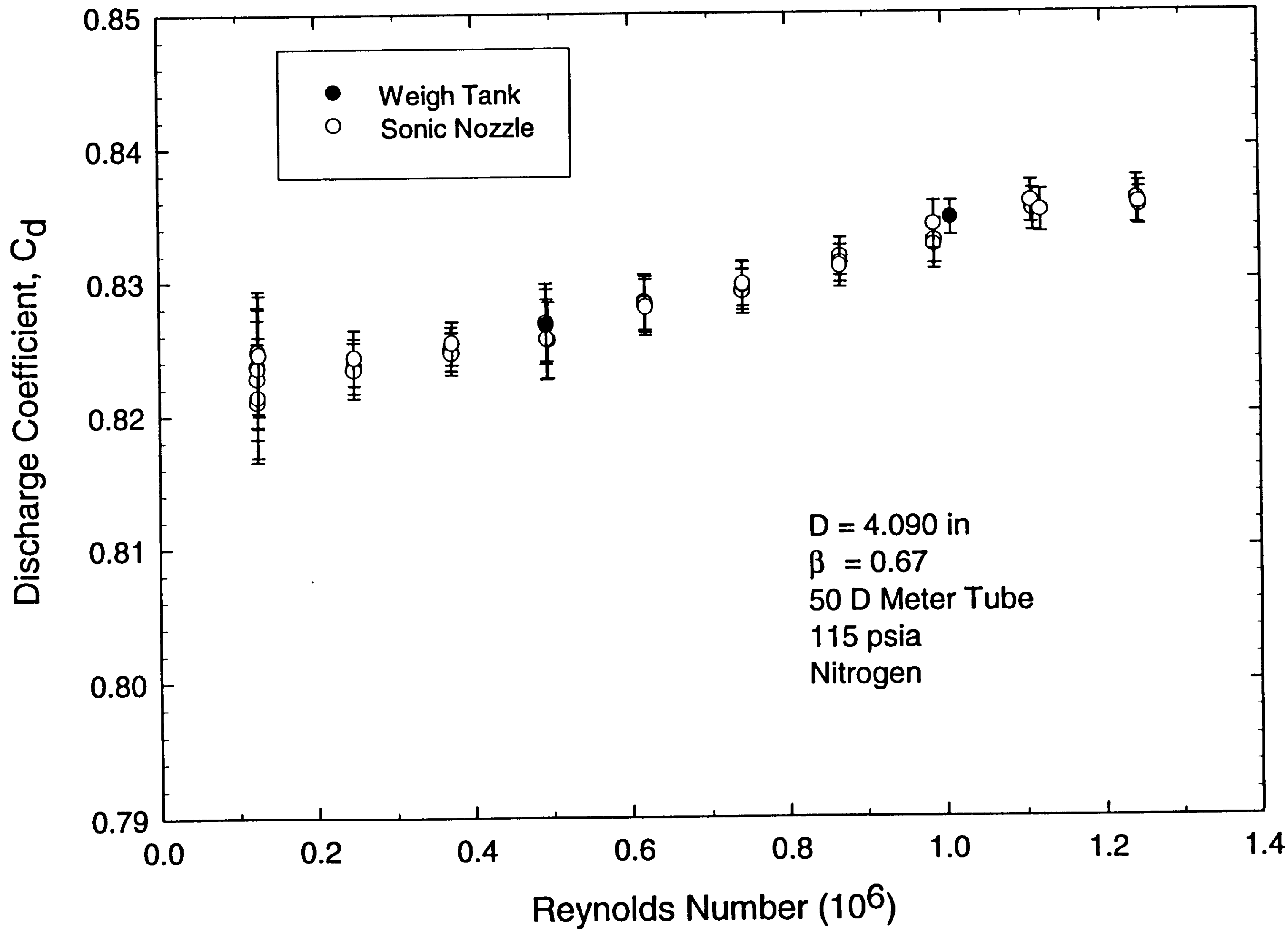

Figure B.1. Test 1A, V-Cone Baseline Discharge Coefficient

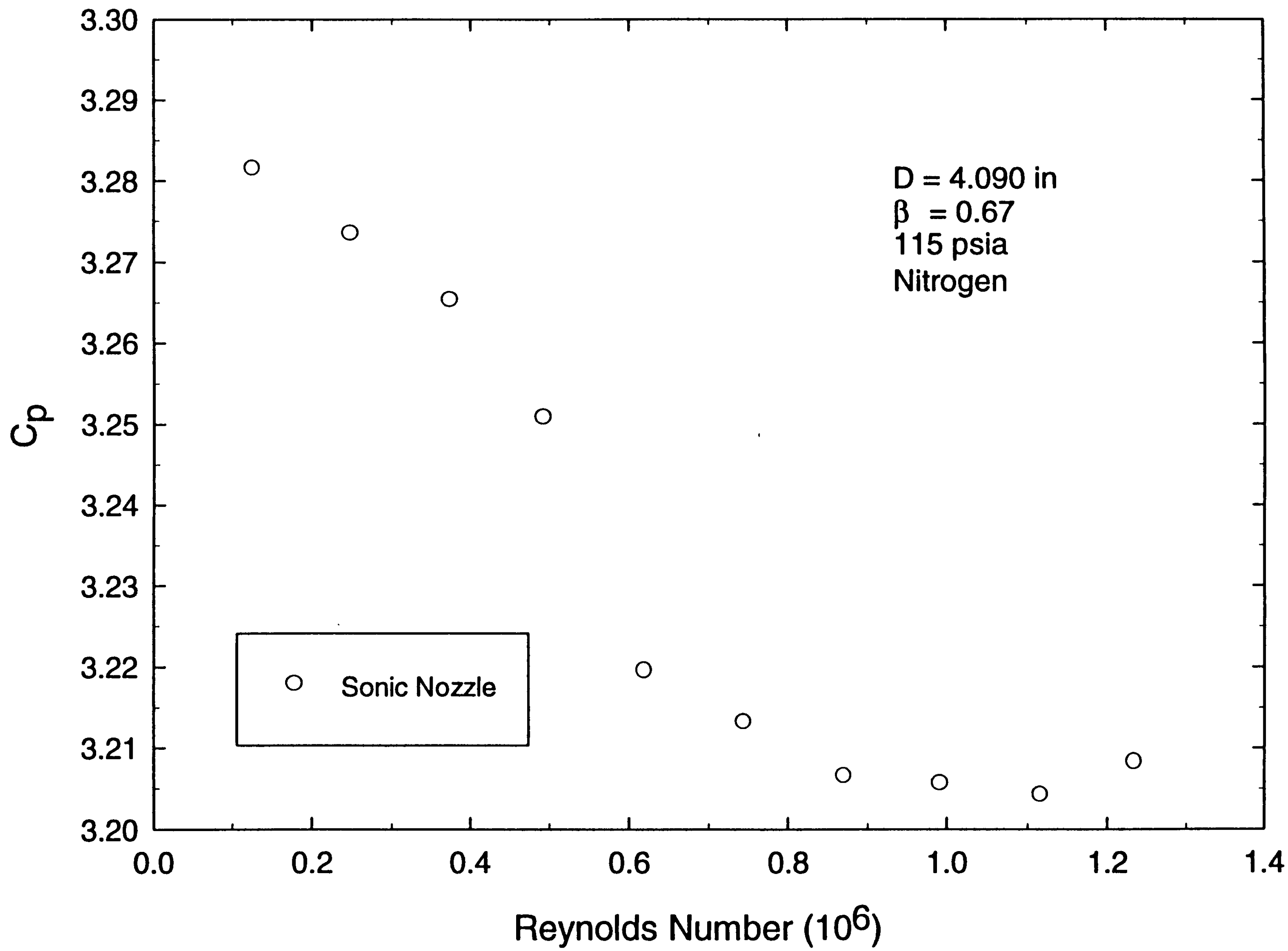

Figure B.2. Test 1B, V-Cone Pressure Head Loss

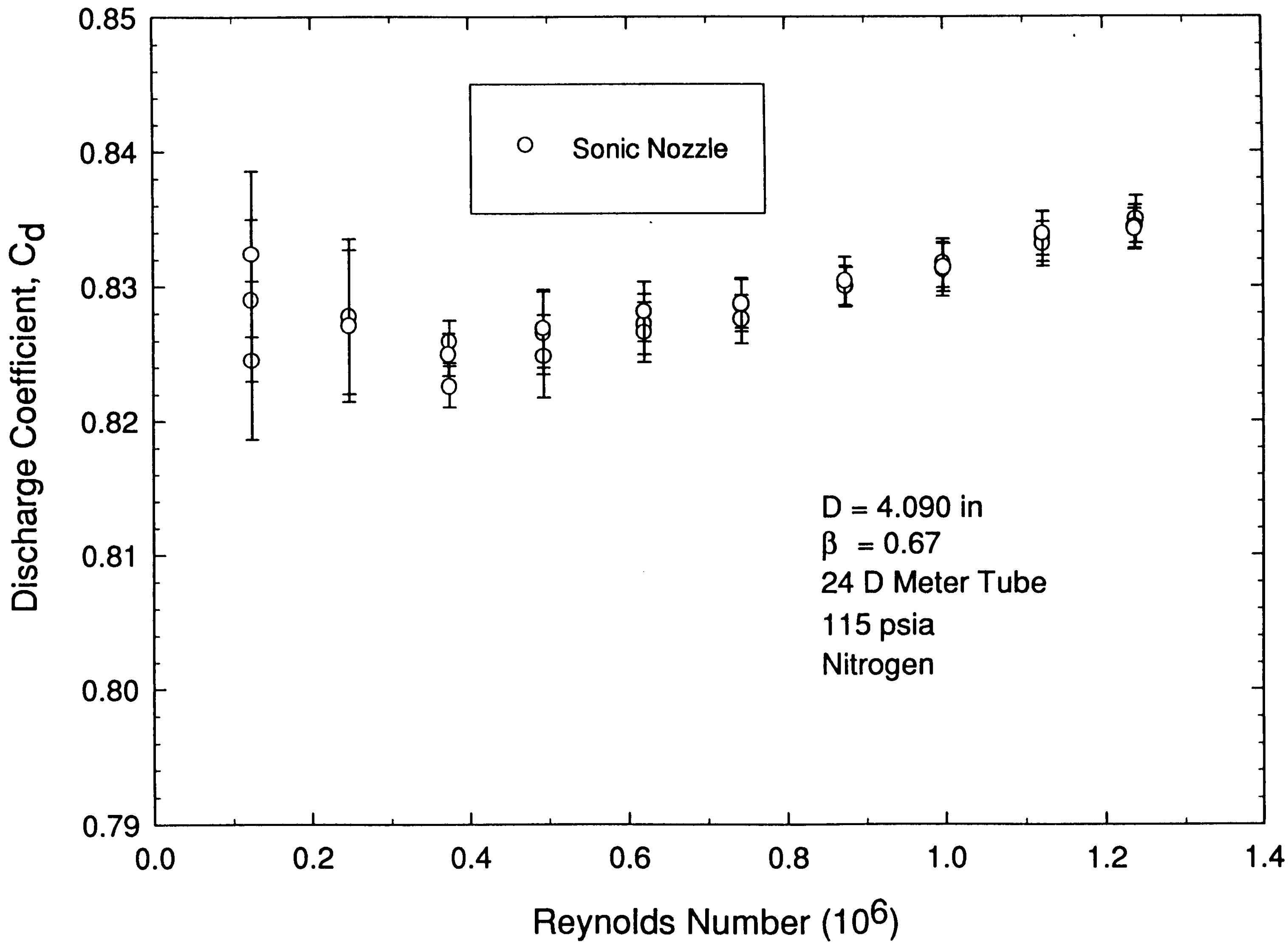

Figure B.3. Test 2A, 90° Elbow, V-Cone θ = 0°

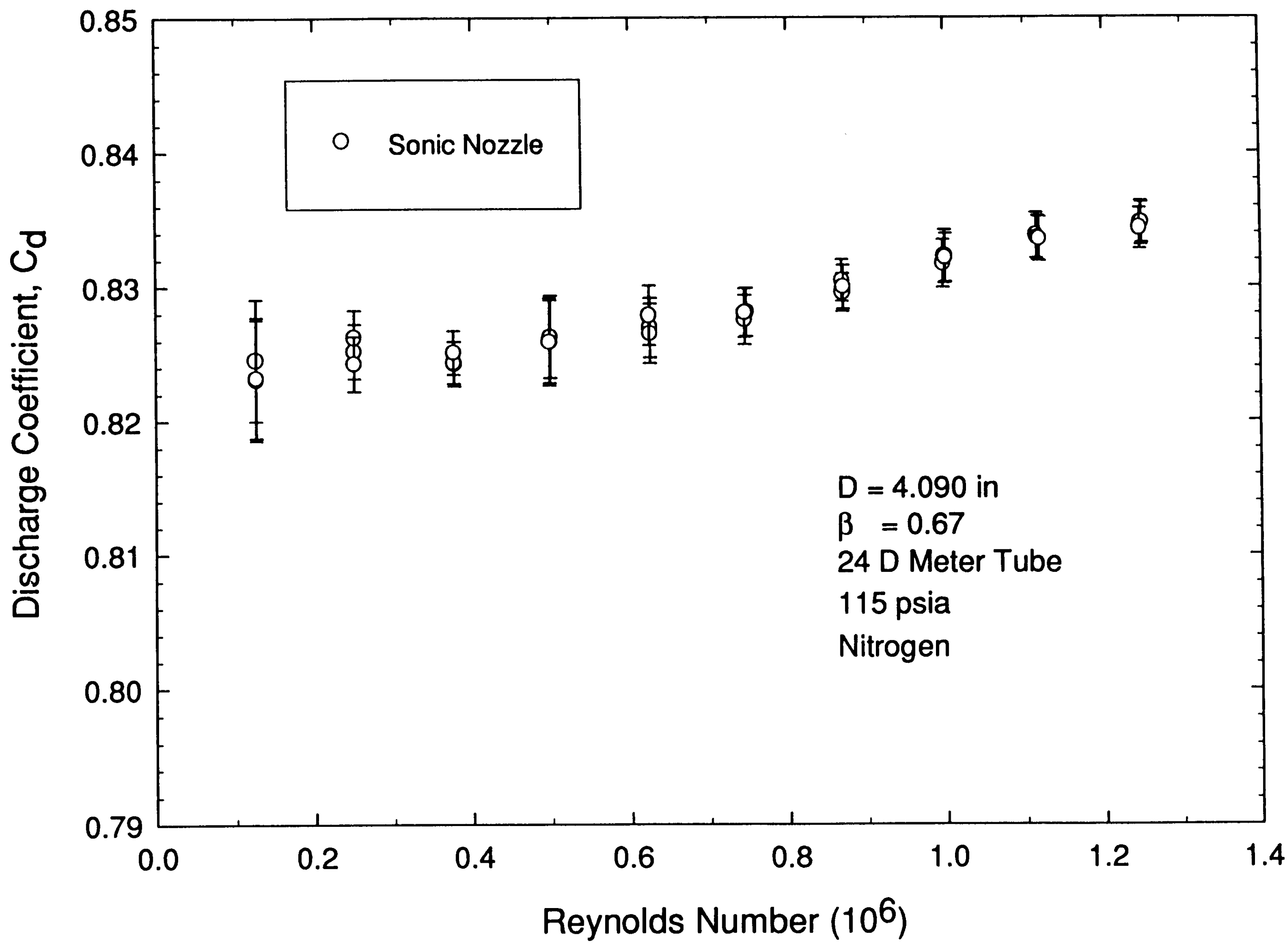

Figure B.4. Test 2B, 90° Elbow, V-Cone θ = +90°

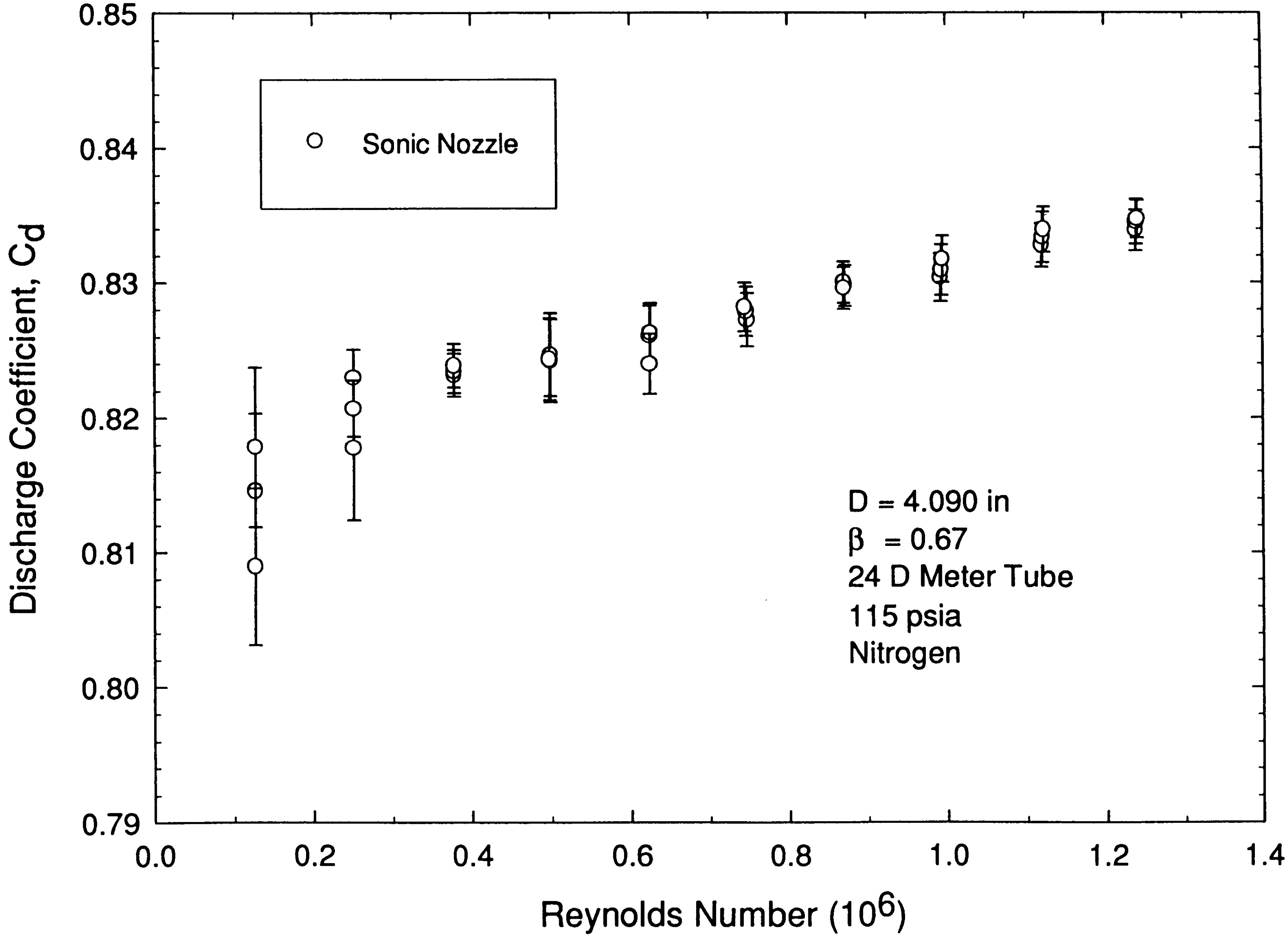

Figure B.5. Test 2C, 90° Elbow, V-Cone θ = -90°

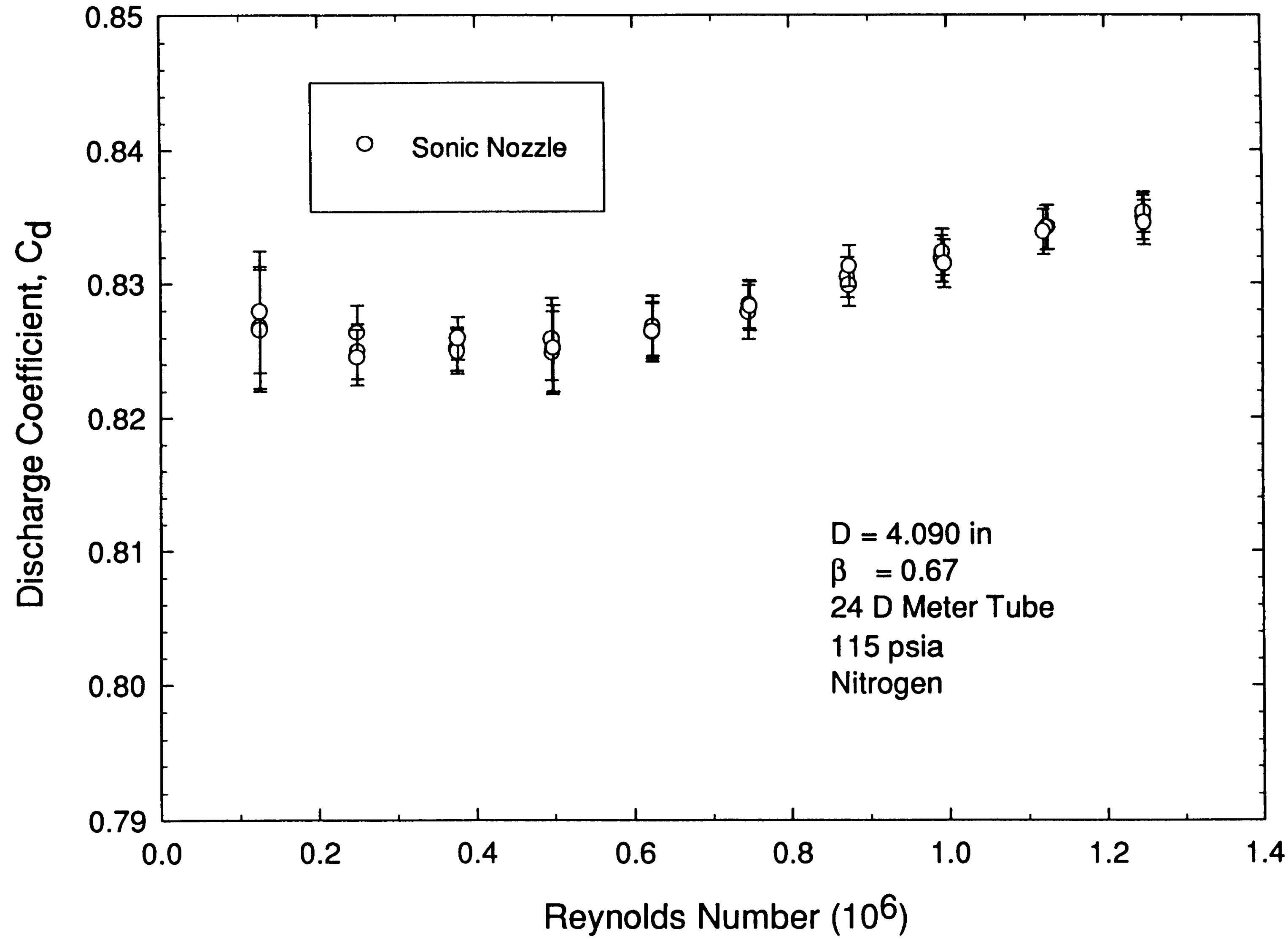

Figure Test B.6. Test 3, 90˚ Elbow and Plug Valve in Series Upstream of a V-Cone

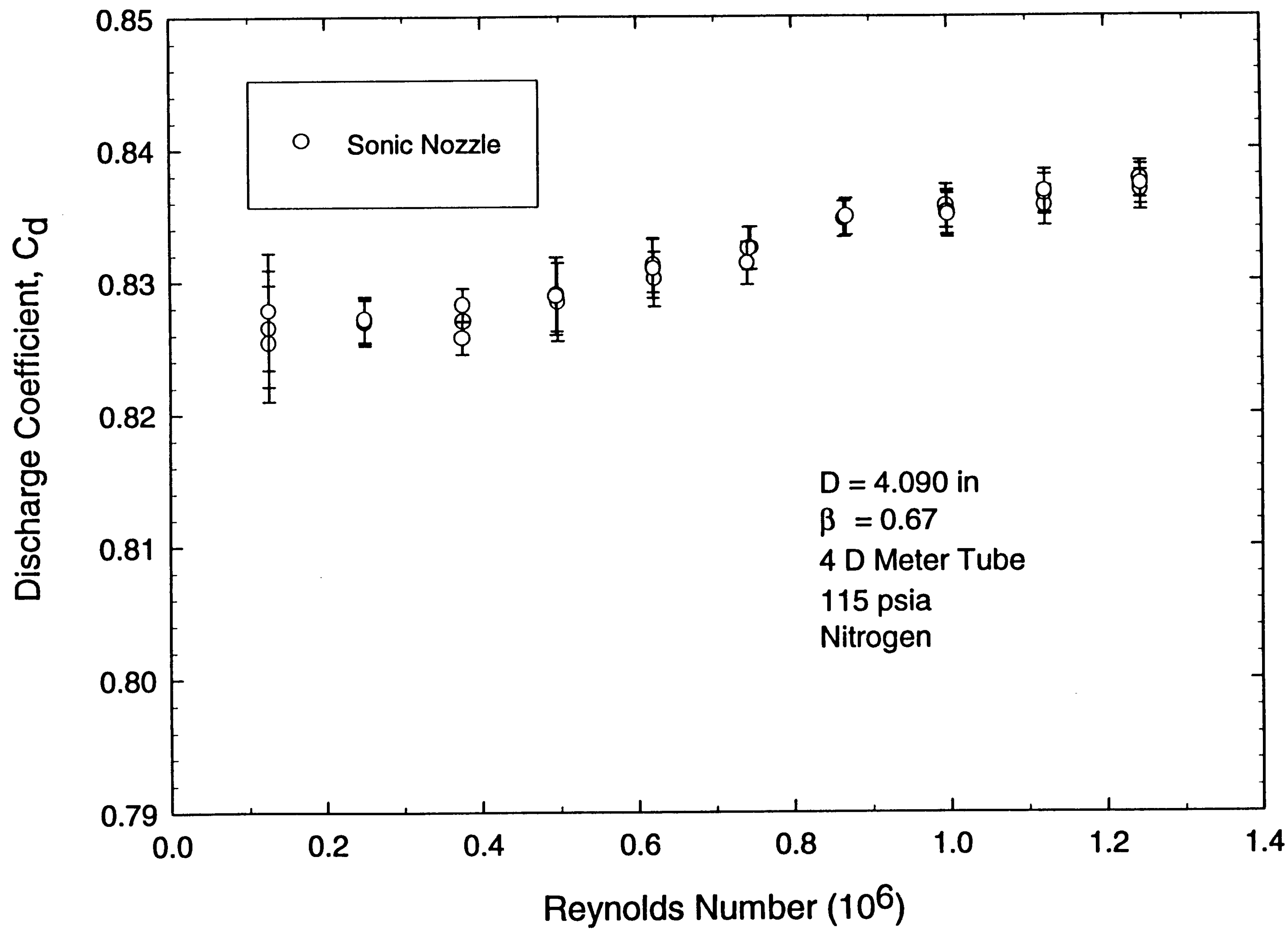

Figure B.7. Test 4A, Short Coupling to a 90° Elbow, V-Cone θ = 0°

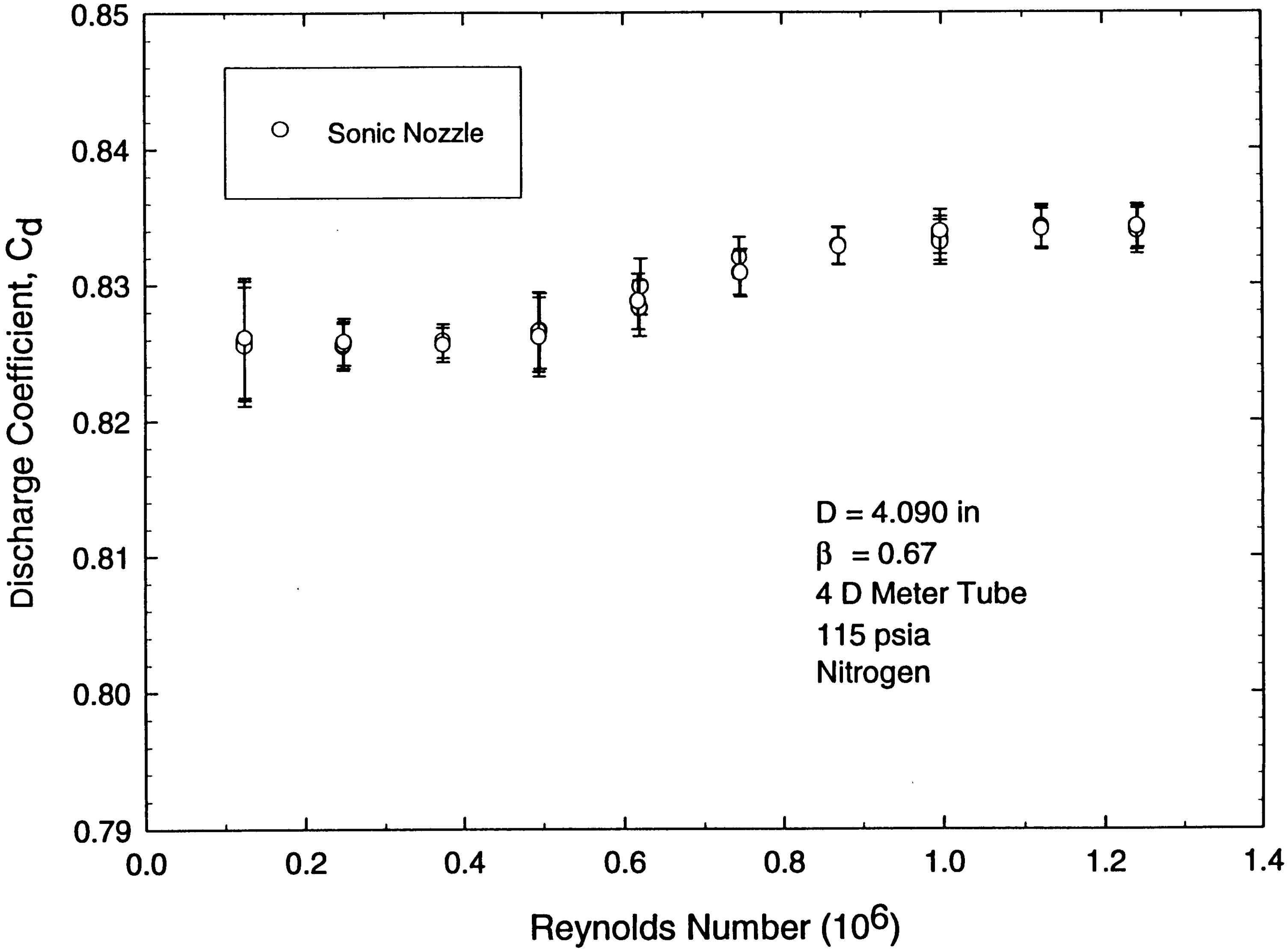

Figure B.8. Test 4B, Short Coupling to a 90˚ Elbow, V-Cone θ = +90˚

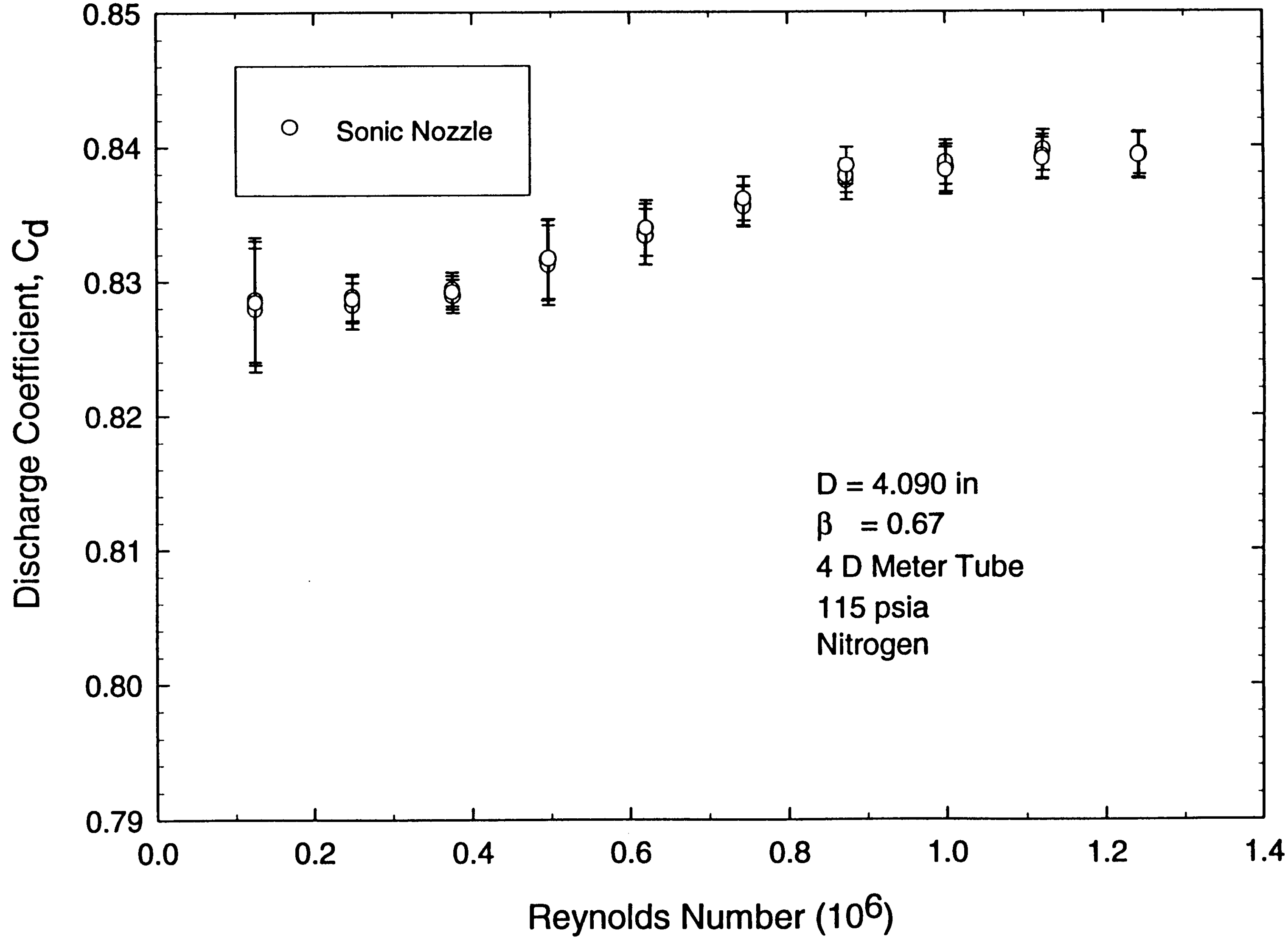

Figure B.9. Test 4C, Short Coupling to a 90° Elbow, V-Cone θ = -90°

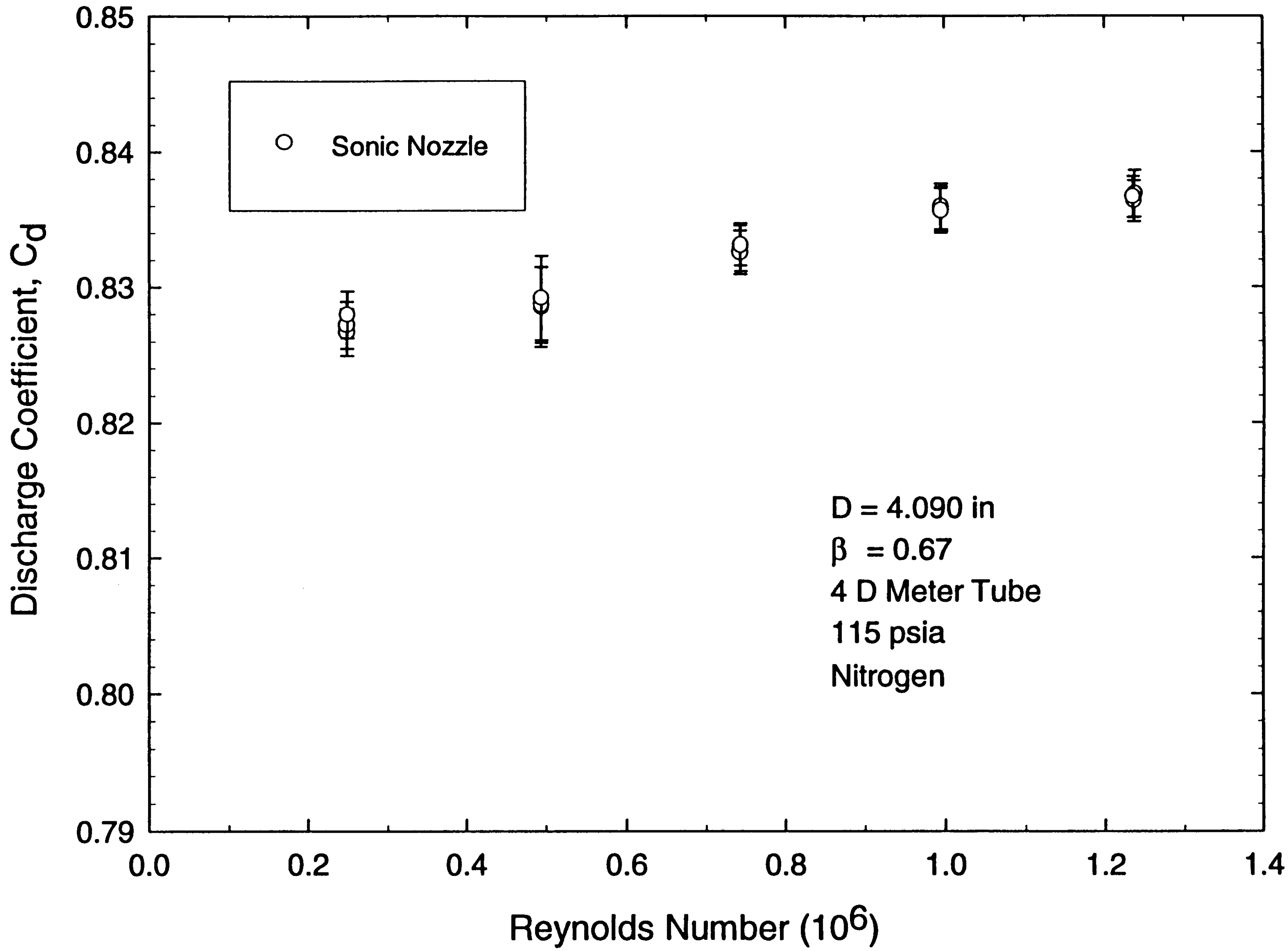

Figure B.10. Test 5, Effect of Pressure Tap Location on Short Coupled Configuration

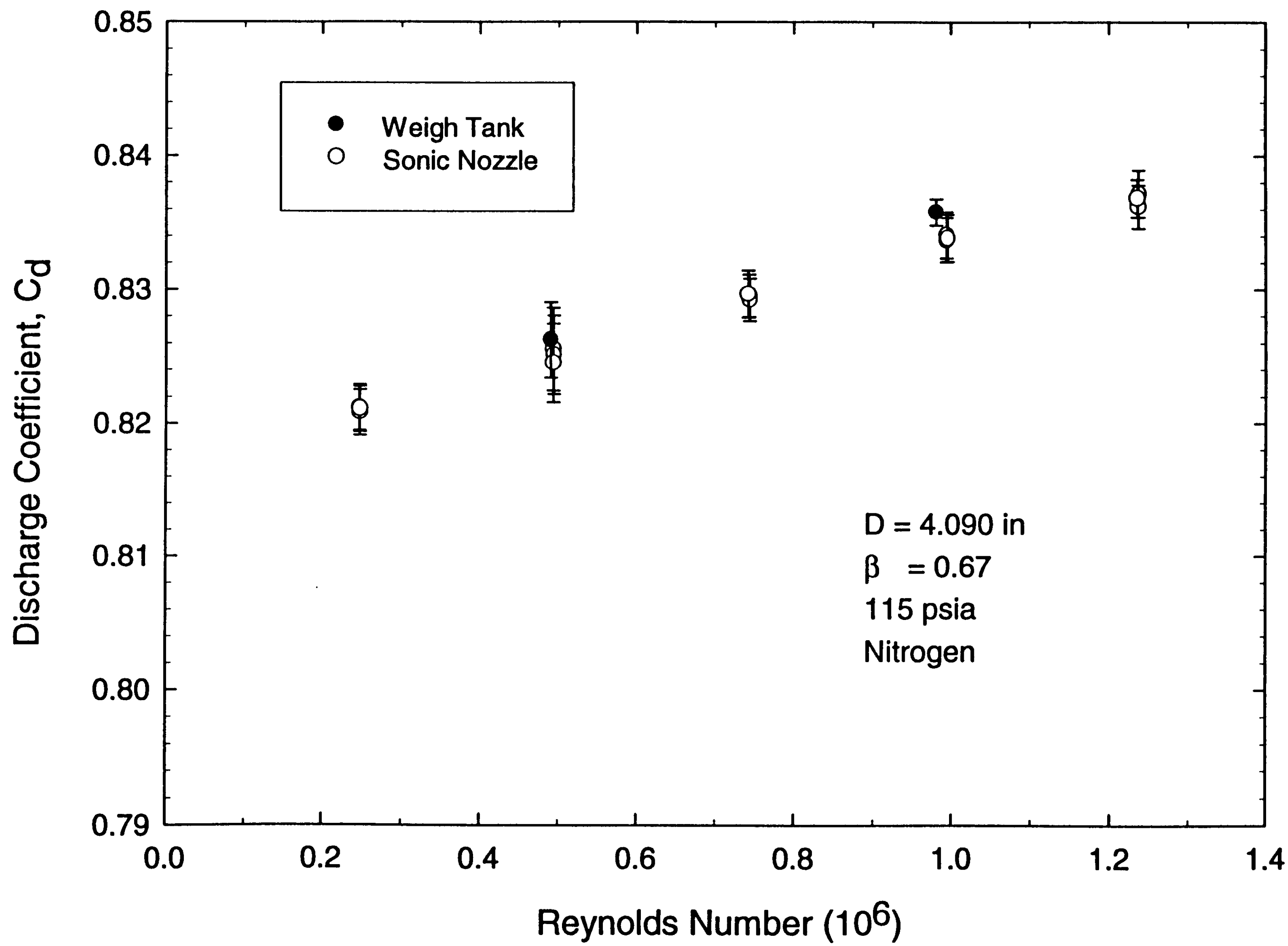

Figure B.11. Test 6, Modified Baseline Configuration

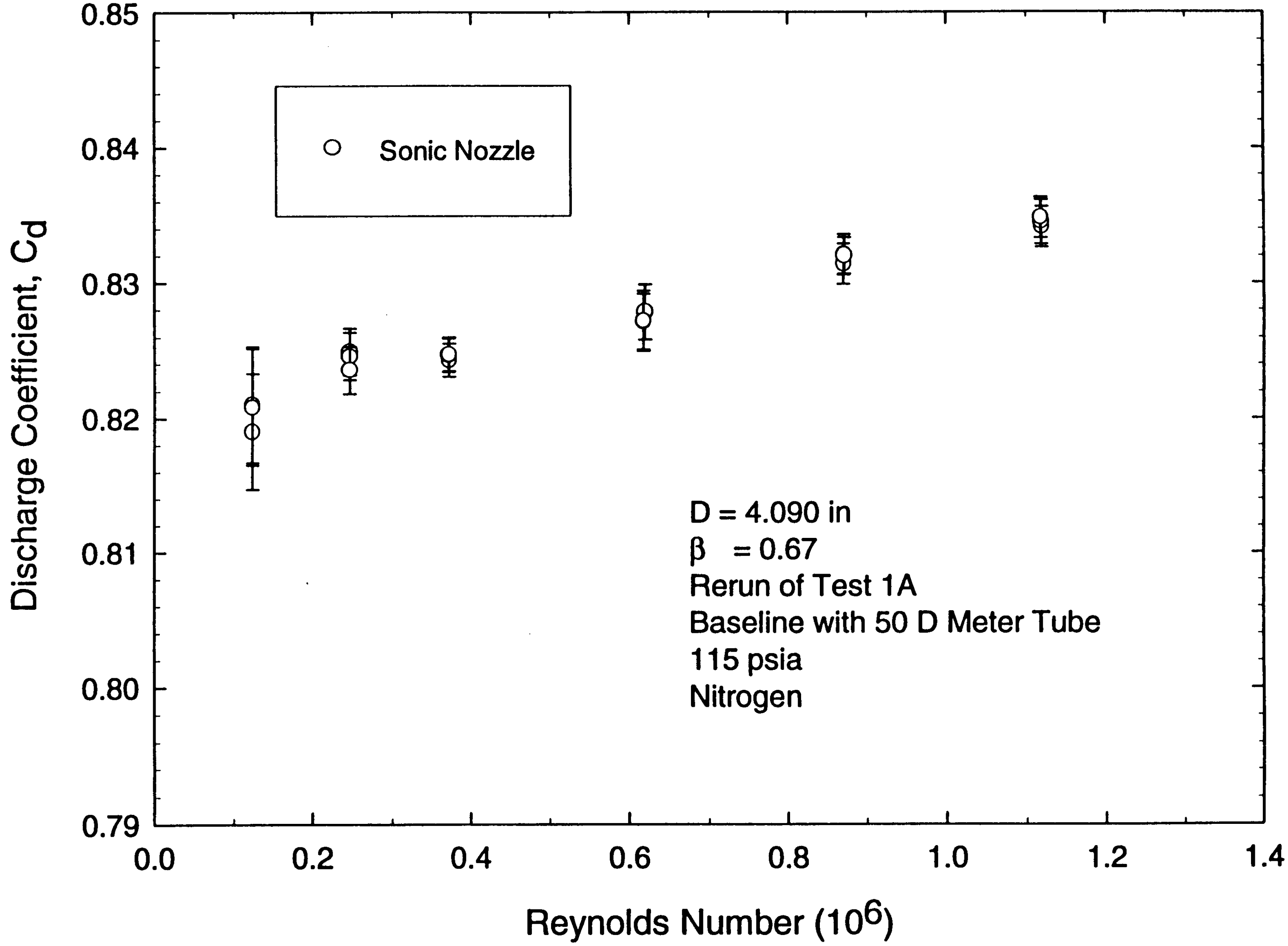

Figure B.12. Test 7A, Duplicate Baseline Test

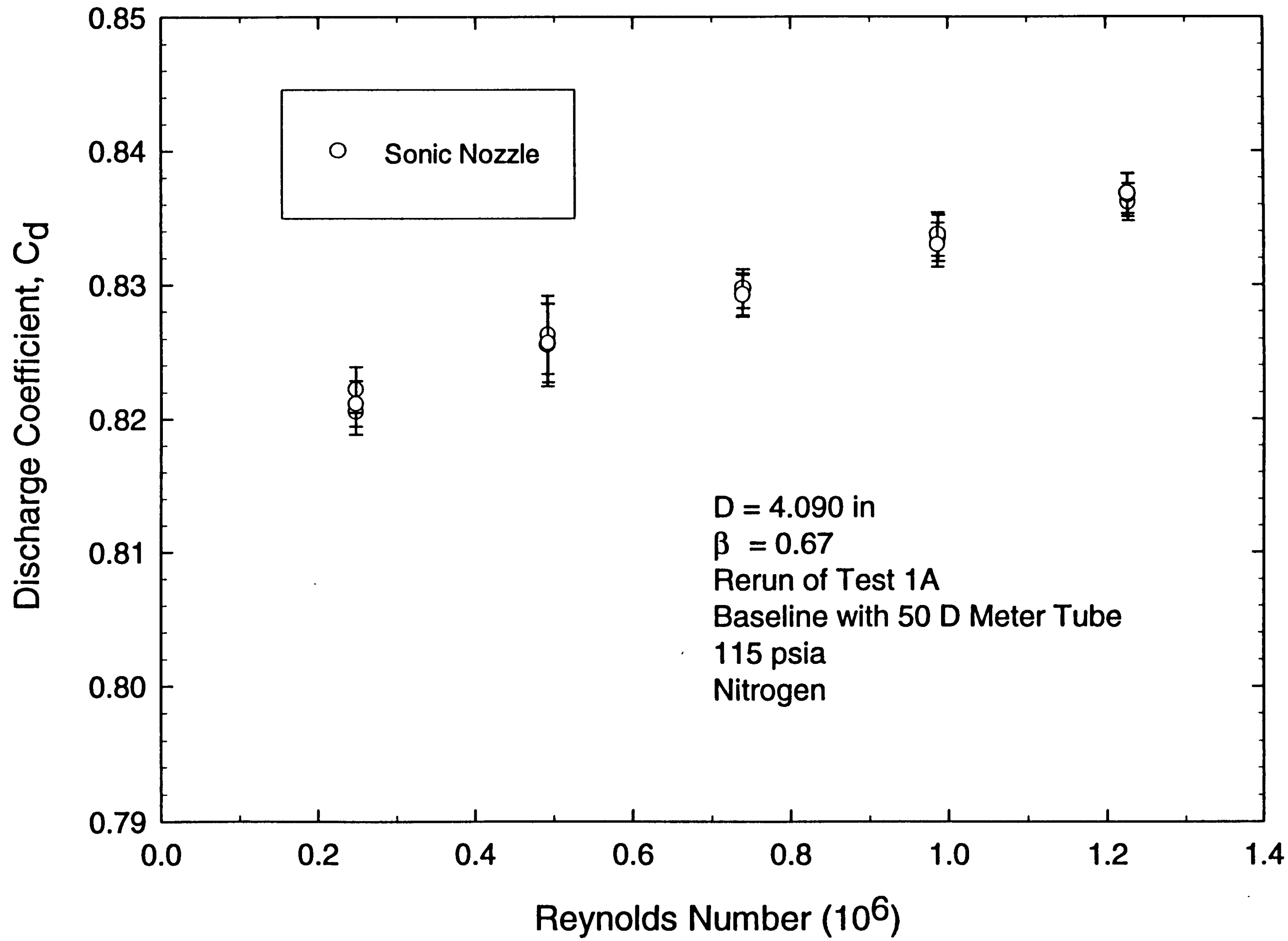

Figure B.13. Test 7B, Duplicate of Baseline Test

APPENDIX C

Test Data

McCrometer - Test 1A. V-Cone Baseline.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940427	130525	114.83090	60.12235	0.580300	0.489850	618261	0.244	0.82842	0.255	0.996986	1.942719	0.137
940427	130644	114.83040	59.79974	0.580667	0.490040	618719	0.244	0.82825	0.255	0.996983	1.943295	0.137
940427	130813	114.82670	59.54580	0.580940	0.490290	619064	0.244	0.82802	0.256	0.996983	1.943700	0.137
940427	131637	114.65830	59.07990	0.581699	0.703400	742469	0.235	0.82915	0.199	0.995674	2.329645	0.120
940427	131904	114.68020	59.06712	0.581821	0.702780	742648	0.235	0.82961	0.219	0.995674	2.330168	0.120
940427	132026	114.68330	59.08061	0.581820	0.702670	742663	0.235	0.82971	0.200	0.995679	2.330258	0.120
940427	133022	114.71430	59.87210	0.582366	0.959460	868028	0.229	0.83174	0.170	0.994116	2.726589	0.107
940427	133146	114.77240	60.09233	0.582415	0.961200	868040	0.229	0.83122	0.170	0.994107	2.727460	0.107
940427	133405	114.81950	60.29100	0.582430	0.962120	868007	0.229	0.83101	0.188	0.994102	2.728110	0.107
940427	112323	114.93560	62.30865	0.576784	0.179720	371300	0.238	0.82498	0.199	0.998891	1.170242	0.126
940427	112441	114.91300	61.82037	0.577223	0.179790	371601	0.238	0.82462	0.194	0.998891	1.170400	0.126
940427	112642	114.88260	61.26443	0.577698	0.179350	371944	0.238	0.82541	0.196	0.998893	1.170578	0.126
weigh tank:												
940426	95051	114.73341	59.88041	0.579203	0.315040	492880	0.204	0.82672	0.327	0.998058	1.547577	0.169
940426	154745	116.19593	59.13016	0.592287	1.273030	1009765	0.205	0.83460	0.156	0.992311	3.166560	0.175

McCrometer - Test 1A. V-Cone Baseline.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940427	134937	114.50330	61.35822	0.581093	1.254990	989125	0.261	0.83290	0.202	0.992305	3.113302	0.166
940427	135059	114.49800	61.40507	0.581018	1.255910	988970	0.262	0.83258	0.217	0.992298	3.113015	0.166
940427	135215	114.50590	61.42912	0.581007	1.251310	988945	0.262	0.83410	0.217	0.992326	3.113040	0.166
940427	140437	114.56610	63.15547	0.581053	1.591530	1111911	0.251	0.83520	0.190	0.990277	3.508492	0.149
940427	140646	114.47960	63.49768	0.580213	1.588000	1110178	0.251	0.83579	0.188	0.990294	3.504667	0.149
940427	153533	114.47090	58.90701	0.585432	1.590150	1121941	0.251	0.83509	0.189	0.990281	3.519440	0.149
940427	105258	115.13380	63.94928	0.575132	0.020440	124278	0.296	0.82099	0.544	0.999874	0.392588	0.216
940427	110130	115.42080	63.74604	0.576797	0.020400	124632	0.295	0.82273	0.545	0.999874	0.393600	0.216
940427	110248	115.45720	63.93782	0.576763	0.020370	124620	0.295	0.82366	0.546	0.999875	0.393669	0.216
940427	111315	115.28100	62.67038	0.577607	0.079660	247022	0.255	0.82373	0.251	0.999510	0.778953	0.155
940427	111435	115.30740	63.07000	0.577288	0.079770	246883	0.255	0.82339	0.254	0.999509	0.778947	0.155
940427	111610	115.28530	62.59660	0.577711	0.079560	247081	0.255	0.82432	0.250	0.999511	0.779062	0.155
940428	90024	114.38140	59.55420	0.586109	1.961760	1244378	0.244	0.83594	0.210	0.988032	3.906971	0.136
940428	90140	114.46050	58.85494	0.587334	1.965150	1247143	0.244	0.83541	0.167	0.988037	3.911908	0.136
940428	90333	114.25700	58.12881	0.587122	1.960280	1246972	0.244	0.83565	0.191	0.988035	3.907431	0.136
940428	132343	115.22250	60.14635	0.579879	0.020250	125419	0.296	0.82478	0.555	0.999875	0.394116	0.216
940428	132504	115.26110	60.33952	0.579854	0.020430	125413	0.296	0.82139	0.548	0.999874	0.394204	0.216
940428	132625	115.33340	60.51615	0.580017	0.020340	125448	0.296	0.82354	0.545	0.999875	0.394410	0.216
940428	90823	115.43350	56.94587	0.584623	0.020280	126532	0.296	0.82454	0.547	0.999875	0.395876	0.216
940427	124736	115.10010	61.37329	0.579339	0.312820	492456	0.260	0.82685	0.365	0.998077	1.550103	0.163
940427	125343	115.22370	59.46873	0.582141	0.313830	494967	0.260	0.82560	0.344	0.998073	1.553938	0.163
940427	125618	115.14650	60.85970	0.580162	0.313800	493214	0.260	0.82567	0.363	0.998071	1.551394	0.163

McCrometer - Test 1B. V-Cone Pressure Head Loss.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940427	162506	115.12880	62.03920	0.577268	0.022210	124833	0.296	0.78605	4.535	0.999863	0.393298	0.216
940427	161617	115.28920	62.13735	0.578261	0.081580	247393	0.255	0.81348	1.218	0.999498	0.779548	0.155
940427	162047	115.31170	60.93720	0.580242	0.182130	373639	0.238	0.82029	0.568	0.998880	1.175411	0.126
940427	162917	114.96210	60.98661	0.579098	0.315550	492052	0.260	0.82234	0.340	0.998058	1.547994	0.163
940427	163325	115.06390	60.44256	0.581132	0.494650	619027	0.244	0.82520	0.253	0.996963	1.946011	0.137
940427	163806	114.98890	59.43652	0.582980	0.707400	743895	0.235	0.82791	0.200	0.995661	2.335305	0.120
940427	164138	114.85040	59.46643	0.583539	0.963520	869718	0.229	0.83033	0.170	0.994098	2.730394	0.107
940427	164711	114.50170	60.28152	0.582330	1.258020	991563	0.261	0.83176	0.203	0.992295	3.116348	0.166
940427	165144	114.45580	61.39380	0.582533	1.596840	1115506	0.251	0.83339	0.187	0.990240	3.511256	0.149
940427	165540	114.23600	62.85202	0.581630	1.968050	1233508	0.244	0.83430	0.165	0.987994	3.890470	0.136

McCrometer - Test 2A. 90° Elbow, V-Cone θ = 0°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940429	125952	115.1355	58.48166	0.582148	0.17926	374894	0.238	0.825886	0.19	0.998897	1.175371	0.126
940429	130135	115.10060	58.92210	0.581474	0.180770	374519	0.238	0.82256	0.188	0.998887	1.174902	0.126
940429	130319	115.07470	59.70135	0.580447	0.179810	373873	0.238	0.82494	0.192	0.998893	1.174131	0.126
940429	111224	115.25920	63.74403	0.575990	0.020340	124317	0.296	0.82453	0.714	0.999875	0.392601	0.216
940429	111403	115.14170	63.86962	0.575260	0.020110	124171	0.296	0.82900	0.726	0.999876	0.392205	0.216
940429	111520	115.19120	64.01517	0.575343	0.019960	124194	0.296	0.83243	0.737	0.999877	0.392360	0.216
940429	112427	115.13730	61.22974	0.578515	0.079360	247275	0.255	0.82778	0.695	0.999511	0.778195	0.155
940429	112827	115.04730	60.55074	0.578834	0.079470	247512	0.255	0.82709	0.682	0.999510	0.778209	0.155
940429	131138	114.99350	59.53434	0.580904	0.313920	493840	0.259	0.82481	0.372	0.998068	1.550519	0.163
940429	131255	115.02440	60.52722	0.579921	0.312870	492959	0.259	0.82654	0.371	0.998075	1.549874	0.163
940429	131418	114.99990	59.91409	0.580495	0.312380	493431	0.260	0.82688	0.351	0.998078	1.550044	0.163
940429	132149	114.96710	58.85935	0.582444	0.491990	620733	0.244	0.82718	0.270	0.996979	1.947115	0.137
940429	132310	114.95300	58.98631	0.582230	0.492630	620475	0.244	0.82660	0.268	0.996973	1.946647	0.137
940429	132431	114.93250	58.61736	0.582540	0.490570	620805	0.244	0.82813	0.270	0.996985	1.946692	0.137
940429	133320	114.85930	59.34740	0.582420	0.705920	743373	0.235	0.82864	0.242	0.995663	2.333364	0.120
940429	133437	114.84960	59.27116	0.582466	0.707490	743322	0.235	0.82755	0.218	0.995654	2.332960	0.120
940429	133559	114.85070	59.08833	0.582671	0.705310	743542	0.235	0.82871	0.217	0.995669	2.333064	0.120
940429	145542	114.68820	55.82165	0.586926	0.962020	875335	0.229	0.82995	0.175	0.994099	2.734306	0.108
940429	145922	114.74330	56.49369	0.586429	0.962980	874640	0.229	0.82997	0.186	0.994098	2.734657	0.107
940429	150039	114.81170	57.16204	0.585998	0.962560	873766	0.229	0.83038	0.214	0.994100	2.734433	0.107
940429	151048	114.65120	58.09002	0.585618	1.260090	997365	0.261	0.83123	0.240	0.992282	3.125180	0.166
940429	151241	114.6069	57.7721	0.58575	1.25778	997591	0.261	0.831707	0.215	0.992301	3.124519	0.166
940429	151400	114.6595	57.6001	0.586223	1.2593	998414	0.261	0.831381	0.216	0.992287	3.126366	0.166

McCrometer - Test 2A. 90° Elbow, V-Cone θ = 0°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940429	152214	114.40920	57.97016	0.586215	1.592630	1123014	0.251	0.83364	0.221	0.990256	3.518267	0.149
940429	152333	114.45830	58.21775	0.586192	1.595480	1122890	0.251	0.83311	0.199	0.990251	3.519085	0.149
940429	152453	114.50980	58.48465	0.586131	1.593150	1122695	0.251	0.83391	0.197	0.990265	3.519771	0.149
940429	153238	114.28460	60.36319	0.584687	1.961380	1239976	0.244	0.83495	0.210	0.988026	3.897468	0.136
940429	153402	114.29790	60.71885	0.584361	1.964310	1239141	0.244	0.83441	0.189	0.988013	3.896754	0.136
940429	153530	114.30530	61.03440	0.584040	1.965210	1238281	0.244	0.83423	0.181	0.988013	3.895745	0.136

McCrometer - Test 2B. 90° Elbow, V-Cone θ = +90°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940430	115513	115.01200	55.57922	0.585553	0.312750	498415	0.260	0.82628	0.373	0.998075	1.556426	0.163
940430	115630	115.00830	56.23455	0.584775	0.313160	497758	0.260	0.82592	0.373	0.998072	1.555764	0.163
940430	115744	115.00930	56.99223	0.583904	0.313330	496995	0.260	0.82590	0.395	0.998070	1.554991	0.163
940430	120242	114.88370	55.60589	0.585779	0.491530	624783	0.244	0.82695	0.269	0.996977	1.951098	0.137
940430	120403	114.92040	56.09497	0.585401	0.492450	624437	0.244	0.82653	0.270	0.996974	1.951324	0.137
940430	120520	114.95770	56.93257	0.584614	0.491330	623600	0.244	0.82785	0.269	0.996979	1.950947	0.137
940430	121302	114.79250	57.60871	0.584085	0.706280	745890	0.235	0.82809	0.217	0.995662	2.335674	0.120
940430	121418	114.84680	58.82178	0.582971	0.707970	744334	0.235	0.82753	0.223	0.995655	2.334692	0.120
940430	121556	114.84790	59.17177	0.582570	0.707100	743700	0.235	0.82802	0.220	0.995657	2.333828	0.120
940430	122249	114.71050	59.72750	0.582540	0.964870	868329	0.229	0.82955	0.173	0.994084	2.726991	0.107
940430	122406	114.68870	60.02806	0.582073	0.962330	867428	0.229	0.83045	0.187	0.994095	2.725286	0.107
940430	122522	114.62590	58.79378	0.583171	0.962050	869057	0.229	0.82995	0.196	0.994096	2.725763	0.107
940430	123516	114.58470	58.29839	0.585026	1.257100	995946	0.261	0.83166	0.215	0.992298	3.121616	0.166
940430	123632	114.60080	57.29798	0.586255	1.255210	998278	0.261	0.83223	0.237	0.992310	3.124637	0.166
940430	123748	114.64950	57.10527	0.586733	1.256510	999321	0.261	0.83213	0.218	0.992303	3.127085	0.166
940430	124256	114.42860	61.74849	0.581972	1.593120	1113565	0.251	0.83378	0.204	0.990257	3.506858	0.149
940430	124411	114.43950	60.93929	0.582951	1.592950	1115436	0.251	0.83359	0.198	0.990271	3.508830	0.149
940430	124528	114.42910	60.01557	0.583955	1.592420	1117517	0.251	0.83352	0.198	0.990265	3.510903	0.149
940430	125112	114.26420	57.68144	0.587677	1.960080	1246986	0.244	0.83473	0.196	0.988048	3.905077	0.136
940430	125230	114.27570	57.49770	0.587950	1.960350	1247678	0.244	0.83475	0.180	0.988040	3.906264	0.136
940430	125343	114.35630	58.85263	0.586814	1.965930	1245255	0.244	0.83430	0.181	0.988014	3.905950	0.136

McCrometer - Test 2B. 90° Elbow, V-Cone θ = +90°.

Date	Time	Pdn(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y1	SN(lb/s)	USN(%)
940430	114635	115.0381	56.52884	0.58391	0.18012	376617	0.238	0.824279	0.202	0.99889	1.17761	0.126
940430	114748	115.0382	57.05787	0.5833	0.18014	376211	0.238	0.824353	0.191	0.99889	1.177193	0.126
940430	114903	115.0378	57.61157	0.582657	0.17986	375779	0.238	0.825117	0.196	0.998892	1.176733	0.126
940430	112152	115.14570	57.79139	0.582188	0.020220	125926	0.296	0.82456	0.552	0.999875	0.394430	0.216
940430	112312	115.20290	57.77208	0.582501	0.020300	126004	0.296	0.82304	0.547	0.999875	0.394666	0.216
940430	112433	115.22280	56.77711	0.583749	0.020280	126270	0.296	0.82323	0.548	0.999875	0.394962	0.216
940430	113547	115.15310	56.46019	0.584061	0.079210	250234	0.255	0.82522	0.247	0.999512	0.782365	0.156
940430	113704	115.14450	56.75687	0.583674	0.079030	250085	0.255	0.82625	0.249	0.999513	0.782218	0.156
940430	113821	115.13670	57.06381	0.583281	0.079430	249929	0.255	0.82427	0.249	0.999511	0.782057	0.156

McCrometer - Test 2C. 90° Elbow, V-Cone θ = -90°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940430	92414	115.11770	55.75039	0.585220	1.179140	377506	0.238	0.82316	0.195	0.998887	1.179139	0.126
940430	92536	115.15240	56.09018	0.585002	1.179310	377386	0.238	0.82343	0.193	0.998888	1.179313	0.126
940430	92654	115.18790	56.55544	0.584642	1.179340	377154	0.238	0.82386	0.195	0.998889	1.179343	0.126
940430	84030	115.19320	56.27149	0.584187	0.395540	126543	0.296	0.81456	0.710	0.999871	0.395539	0.216
940430	84216	115.14430	56.40659	0.583781	0.395330	126451	0.296	0.81781	0.724	0.999872	0.395325	0.216
940430	84335	115.22820	56.53488	0.584061	0.395580	126509	0.296	0.80896	0.719	0.999870	0.395576	0.216
940430	85257	115.12180	55.53446	0.584986	0.783130	250795	0.255	0.81777	0.657	0.999499	0.783127	0.155
940430	85535	115.22020	56.07323	0.584853	0.783530	250739	0.255	0.82298	0.253	0.999509	0.783534	0.155
940430	85712	115.19590	56.42102	0.584329	0.783180	250508	0.255	0.82070	0.254	0.999506	0.783181	0.155
940430	91348	115.00400	55.52195	0.585586	1.556170	498374	0.259	0.82421	0.373	0.998066	1.556173	0.163
940430	91516	115.01700	55.99570	0.585101	1.556090	498023	0.260	0.82467	0.374	0.998068	1.556087	0.163
940430	91646	115.04170	56.68034	0.584435	1.555800	497465	0.260	0.82432	0.369	0.998064	1.555801	0.163
940430	93759	114.94600	56.34525	0.585245	1.951220	624188	0.244	0.82605	0.270	0.996968	1.951216	0.137
940430	93916	114.94080	55.97692	0.585644	1.951770	624679	0.244	0.82627	0.267	0.996969	1.951767	0.137
940430	94036	114.95370	56.68354	0.584906	1.951310	623928	0.244	0.82397	0.269	0.996952	1.951309	0.137
940430	94755	114.86130	57.04565	0.585094	2.338060	747223	0.235	0.82721	0.239	0.995652	2.338056	0.120
940430	94929	114.91720	58.10752	0.584148	2.337430	745934	0.235	0.82785	0.222	0.995660	2.337427	0.120
940430	95045	114.97020	59.30476	0.583038	2.336280	744341	0.235	0.82817	0.216	0.995660	2.336279	0.120
940430	95708	114.74570	58.65882	0.583943	2.730140	870609	0.229	0.82976	0.184	0.994088	2.730144	0.107
940430	95824	114.85400	60.10155	0.582837	2.729610	868709	0.229	0.83000	0.185	0.994087	2.729611	0.107
940430	95948	114.80730	59.78998	0.582958	2.728440	868711	0.229	0.82957	0.186	0.994082	2.728439	0.107

V-Cone Differential Pressure
Appendix C, Test 2C
MRF Report No. 94-3

Test Time (HHMMSS)	DP (psid)
92414	0.180670
92536	0.180680
92654	0.180600
84030	0.020860
84216	0.0207
84335	0.02118
85257	0.08137
85535	0.079780
85712	0.080220
91348	0.314210
91516	0.31408
91646	0.314560
93759	0.493120
93916	0.49278
94036	0.495950
94755	0.70803
94929	0.707670
95045	0.70774
95708	0.964300
95824	0.965160
95948	0.965150
100751	1.265370
100921	1.262030
101138	1.257200
101712	1.596830
101829	1.593930
101945	1.591170
102514	1.966170
102643	1.960940
102801	1.959460

McCrometer - Test 2C. 90° Elbow, V-Cone θ = -90°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940430	100751	114.73050	61.37280	0.582271	3.119700	991126	0.261	0.83038	0.215	0.992259	3.119702	0.166
940430	100921	114.7195	60.60244	0.58308	3.11984	992225	0.261	0.830933	0.227	0.992283	3.119843	0.166
940430	101138	114.5953	59.18182	0.584061	3.11948	994058	0.261	0.83174	0.21	0.992308	3.119483	0.166
940430	101712	114.44970	59.81767	0.584309	3.513510	1118650	0.251	0.83276	0.198	0.990241	3.513510	0.149
940430	101829	114.46410	59.19183	0.585087	3.515170	1120143	0.251	0.83335	0.226	0.990252	3.515174	0.149
940430	101945	114.45540	58.51787	0.585808	3.516710	1121672	0.251	0.83393	0.203	0.990271	3.516714	0.149
940430	102514	114.31000	61.16191	0.583922	3.896320	1238244	0.244	0.83387	0.180	0.988005	3.896317	0.136
940430	102643	114.25830	60.70506	0.584160	3.894990	1238605	0.244	0.83451	0.200	0.988029	3.894986	0.136
940430	102801	114.27000	60.20047	0.584791	3.896640	1239992	0.244	0.83472	0.167	0.988052	3.896641	0.136

McCrometer - Test 3. 90° Elbow and Plug Valve.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940502	162400	115.14800	58.15208	0.582593	0.179770	375395	0.238	0.82513	0.194	0.998894	1.176409	0.126
940502	162516	115.14960	57.25772	0.583632	0.179760	376088	0.238	0.82495	0.200	0.998893	1.177137	0.126
940502	162631	115.16640	56.84319	0.584194	0.179330	376478	0.238	0.82593	0.193	0.998897	1.177691	0.126
940502	160925	115.26610	58.62078	0.581844	0.020150	125889	0.296	0.82677	0.550	0.999876	0.394766	0.216
940502	161135	115.18170	58.99738	0.580986	0.020150	125699	0.296	0.82654	0.552	0.999876	0.394371	0.216
940502	161314	115.20780	59.27488	0.580800	0.020090	125656	0.296	0.82792	0.550	0.999876	0.394389	0.216
940502	155220	115.16190	57.45425	0.582957	0.079190	249558	0.255	0.82496	0.251	0.999512	0.781315	0.155
940502	155439	115.14070	57.74136	0.582518	0.078950	249401	0.255	0.82634	0.248	0.999514	0.781129	0.155
940502	155558	115.22830	58.02848	0.582633	0.079380	249456	0.255	0.82452	0.251	0.999511	0.781613	0.155
940503	82321	115.02370	57.65279	0.583215	0.313460	496343	0.260	0.82586	0.372	0.998071	1.554361	0.163
940503	82443	114.97400	56.29142	0.584538	0.313800	497472	0.260	0.82484	0.374	0.998067	1.554990	0.163
940503	82601	114.96370	55.38093	0.585540	0.313340	498359	0.260	0.82519	0.392	0.998070	1.555824	0.163
940503	83443	114.85800	56.31330	0.584830	0.492130	623635	0.244	0.82640	0.268	0.996971	1.949394	0.137
940503	83602	114.86690	55.59673	0.585704	0.491540	624662	0.244	0.82683	0.271	0.996976	1.950692	0.137
940503	83735	114.89920	56.23211	0.585135	0.492430	624113	0.244	0.82646	0.250	0.996974	1.950677	0.137
940503	101447	114.95090	57.98661	0.584458	0.707620	746222	0.235	0.82785	0.243	0.995658	2.337947	0.120
940503	101616	114.89850	57.37731	0.584888	0.705840	746716	0.235	0.82843	0.217	0.995668	2.337534	0.120
940503	101731	114.90640	56.42492	0.586032	0.705780	748234	0.235	0.82829	0.220	0.995668	2.339235	0.120
940503	84910	114.67080	57.67995	0.584676	0.960760	871453	0.229	0.83046	0.185	0.994107	2.729112	0.107
940503	85026	114.63680	56.50773	0.585865	0.961460	873368	0.229	0.82985	0.190	0.994098	2.730715	0.107
940503	85142	114.63080	55.94581	0.586469	0.957890	874418	0.229	0.83130	0.186	0.994120	2.731898	0.107

McCrometer - Test 3. 90° Elbow and Plug Valve.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940503	90443	114.65530	60.80356	0.582513	1.259310	991478	0.262	0.83182	0.210	0.992299	3.118350	0.166
940503	90604	114.62480	60.08616	0.583165	1.256150	992379	0.261	0.83233	0.209	0.992312	3.118095	0.166
940503	90730	114.62910	59.18815	0.584229	1.258200	994246	0.262	0.83147	0.218	0.992298	3.120104	0.166
940503	92007	114.41800	56.61564	0.587812	1.588520	1125927	0.251	0.83420	0.198	0.990289	3.520856	0.149
940503	92123	114.48930	57.93042	0.586660	1.591220	1123733	0.251	0.83417	0.198	0.990285	3.520345	0.149
940503	92245	114.52590	59.53556	0.585004	1.593950	1120213	0.251	0.83385	0.204	0.990260	3.517070	0.149
940503	93816	114.32080	57.70689	0.587929	1.959090	1247231	0.244	0.83494	0.201	0.988047	3.905993	0.136
940503	93938	114.35260	57.48738	0.588338	1.957680	1248193	0.244	0.83534	0.180	0.988064	3.907837	0.136
940503	94106	114.37200	57.33337	0.588637	1.961980	1248925	0.244	0.83455	0.200	0.988035	3.909309	0.136

McCrometer - Test 4A. Short Coupling, V-Cone $\theta = 0$.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940504	91029	115.16590	56.51080	0.583767	0.020100	126285	0.296	0.82652	0.533	0.999876	0.394863	0.216
940504	91151	115.18110	56.24997	0.584147	0.020150	126366	0.296	0.82538	0.531	0.999876	0.394974	0.216
940504	91340	115.09533	56.22986	0.583734	0.020020	126286	0.296	0.82779	0.533	0.999876	0.394712	0.216
940504	92608	115.06072	55.84711	0.584299	0.078670	250202	0.255	0.82691	0.209	0.999515	0.781607	0.156
940504	92742	115.07790	56.01754	0.584189	0.078680	250192	0.255	0.82706	0.208	0.999515	0.781757	0.156
940504	92900	115.09820	56.34750	0.583910	0.078710	250103	0.255	0.82717	0.209	0.999515	0.781832	0.155
940504	93902	115.10643	56.36464	0.584440	0.178740	376731	0.238	0.82701	0.150	0.998900	1.177705	0.126
940504	94038	115.13404	56.96469	0.583884	0.178360	376412	0.238	0.82825	0.152	0.998902	1.177675	0.126
940504	94209	115.10370	57.86314	0.582700	0.179530	375668	0.238	0.82576	0.151	0.998895	1.176795	0.126
940504	100132	114.93880	56.49086	0.584111	0.310420	496739	0.260	0.82848	0.356	0.998088	1.553120	0.163
940504	100250	114.93840	57.34333	0.583124	0.310290	495986	0.259	0.82905	0.336	0.998091	1.552576	0.163
940504	100404	114.94520	58.22156	0.582149	0.310630	495174	0.259	0.82892	0.356	0.998087	1.551901	0.163
940504	102944	114.72682	56.73639	0.584711	0.696450	746032	0.235	0.83250	0.194	0.995720	2.333323	0.120
940504	103101	114.86791	59.14734	0.582657	0.698770	743493	0.235	0.83247	0.194	0.995709	2.333101	0.120
940504	103311	114.90270	60.48463	0.581314	0.701340	741639	0.235	0.83135	0.195	0.995697	2.331573	0.120
940504	104009	114.95070	58.17822	0.583125	0.488140	621561	0.244	0.83018	0.249	0.996999	1.947889	0.137
940504	104130	115.00220	59.28527	0.582109	0.487450	620440	0.244	0.83123	0.249	0.997007	1.947341	0.137
940504	104251	114.99324	59.21854	0.582141	0.487550	620380	0.244	0.83097	0.270	0.997003	1.946974	0.137
940504	105131	114.75170	61.33644	0.580845	0.952270	864947	0.229	0.83466	0.163	0.994160	2.722404	0.107
940504	105247	114.75510	60.26563	0.582079	0.951070	866655	0.229	0.83473	0.163	0.994168	2.723756	0.107
940504	105407	114.73480	59.24769	0.583138	0.950000	868290	0.229	0.83485	0.163	0.994173	2.725074	0.107
940504	110423	114.61650	57.59818	0.585927	1.243340	997055	0.261	0.83561	0.197	0.992384	3.122094	0.166
940504	110540	114.62554	57.03823	0.586629	1.244690	998422	0.261	0.83518	0.199	0.992377	3.123979	0.166
940504	110659	114.68342	57.58366	0.586299	1.246600	998038	0.261	0.83507	0.197	0.992371	3.125122	0.166
940504	113059	114.59250	56.88616	0.586643	1.245660	998737	0.261	0.83494	0.197	0.992371	3.124309	0.166

McCrometer - Test 4A. Short Coupling, V-Cone $\theta = 0$.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940504	111413	114.68830	58.53756	0.586932	1.584980	1123003	0.251	0.83566	0.180	0.990337	3.521027	0.149
940504	111535	114.53550	58.18092	0.586545	1.579630	1122412	0.251	0.83648	0.180	0.990351	3.517422	0.149
940504	111710	114.50640	57.89095	0.586726	1.578220	1122885	0.251	0.83675	0.196	0.990353	3.517498	0.149
940504	133134	114.3854	58.61213	0.587114	1.94095	1244050	0.244	0.837634	0.167	0.988172	3.900889	0.136
940504	133300	114.36524	58.32893	0.587359	1.944770	1244755	0.244	0.83681	0.181	0.988142	3.901579	0.136
940504	133426	114.35391	58.16403	0.587482	1.942450	1245111	0.244	0.83726	0.181	0.988159	3.901808	0.136

McCrometer - Test 4B. Short Coupling, V-Cone θ = +90°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940505	92558	115.19790	61.80420	0.577870	0.020090	124612	0.295	0.82592	0.531	0.999876	0.392477	0.216
940505	92730	115.15263	61.15044	0.578384	0.020090	124736	0.296	0.82550	0.531	0.999876	0.392512	0.216
940505	92854	115.19860	60.98233	0.578806	0.020070	124845	0.296	0.82613	0.533	0.999876	0.392765	0.216
940505	93613	115.15510	60.44751	0.579492	0.078950	247632	0.255	0.82546	0.209	0.999514	0.778479	0.155
940505	93744	115.12300	60.02838	0.579808	0.078900	247801	0.255	0.82559	0.208	0.999514	0.778561	0.155
940505	93902	115.16720	58.87828	0.581345	0.078820	248459	0.255	0.82582	0.209	0.999514	0.779395	0.156
940505	94443	115.05270	59.30494	0.580784	0.178980	373813	0.238	0.82590	0.152	0.998898	1.173302	0.126
940505	94602	115.10210	59.92421	0.580327	0.179300	373548	0.238	0.82560	0.152	0.998896	1.173471	0.126
940505	130201	115.00861	57.67597	0.583105	0.312080	495725	0.260	0.82662	0.336	0.998080	1.552472	0.163
940505	131400	115.02380	59.53699	0.581048	0.312680	494019	0.259	0.82654	0.355	0.998076	1.551089	0.163
940505	131518	114.98840	58.66690	0.581865	0.312570	494655	0.260	0.82617	0.355	0.998075	1.551226	0.163
940505	132115	114.96460	58.28211	0.583077	0.488330	621330	0.244	0.82985	0.249	0.996997	1.947445	0.137
940505	132232	115.03750	59.69185	0.581839	0.490970	619961	0.244	0.82827	0.249	0.996983	1.946930	0.137
940505	132409	114.98980	60.89238	0.580225	0.490370	618094	0.244	0.82878	0.248	0.996985	1.944274	0.137
940505	133235	114.77160	57.37715	0.584202	0.697530	745173	0.235	0.83199	0.183	0.995715	2.332687	0.120
940505	133355	114.72590	56.97903	0.584439	0.699150	745573	0.235	0.83086	0.194	0.995701	2.332661	0.120
940505	133553	114.90311	56.87836	0.585461	0.700430	747001	0.235	0.83086	0.213	0.995699	2.336828	0.120
940505	134135	114.79184	58.85834	0.583900	0.955000	869510	0.229	0.83288	0.162	0.994146	2.727452	0.107
940505	134251	114.77922	58.57573	0.584161	0.954820	869923	0.229	0.83285	0.163	0.994142	2.727684	0.107
940505	134407	114.76012	58.27114	0.584414	0.954700	870350	0.229	0.83278	0.163	0.994146	2.727880	0.107
940505	135341	114.59454	57.44413	0.586028	1.249970	997293	0.261	0.83338	0.197	0.992344	3.122178	0.166
940505	135506	114.57792	57.41533	0.585981	1.250810	997268	0.261	0.83308	0.197	0.992339	3.121972	0.166
940505	135626	114.56904	57.39643	0.585946	1.248350	997236	0.261	0.83387	0.197	0.992353	3.121790	0.166

McCrometer - Test 4B. Short Coupling, V-Cone θ = +90°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940505	140135	114.49284	57.92165	0.586671	1.587930	1122805	0.251	0.83425	0.191	0.990292	3.517395	0.149
940505	140250	114.50950	58.08633	0.586567	1.588370	1122570	0.251	0.83422	0.180	0.990298	3.517457	0.149
940505	140405	114.52083	58.21376	0.586481	1.589270	1122386	0.251	0.83405	0.180	0.990291	3.517496	0.149
940505	140950	114.42390	59.18908	0.586751	1.962750	1243553	0.244	0.83420	0.181	0.988035	3.902431	0.136
940505	141123	114.42170	59.57557	0.586300	1.964200	1242454	0.244	0.83391	0.201	0.988029	3.901053	0.136
940505	141300	114.47610	59.86792	0.586235	1.963690	1242189	0.244	0.83422	0.200	0.988031	3.901803	0.136

McCrometer - Test 4C. Short Coupling, V-Cone θ = -90°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940504	145251	115.07680	60.81801	0.578379	0.019980	124887	0.296	0.82866	0.560	0.999877	0.392807	0.216
940504	145417	115.17350	60.89966	0.578774	0.020040	124983	0.296	0.82793	0.559	0.999876	0.393153	0.216
940504	145536	115.25710	61.00168	0.579078	0.020030	125057	0.296	0.82843	0.559	0.999877	0.393443	0.216
940504	150212	115.08531	58.32933	0.581558	0.078230	248671	0.255	0.82884	0.210	0.999518	0.779470	0.155
940504	150333	115.14650	58.47696	0.581699	0.078430	248782	0.255	0.82821	0.210	0.999517	0.779979	0.156
940504	150455	115.20260	58.75016	0.581669	0.078420	248807	0.255	0.82869	0.209	0.999517	0.780353	0.156
940504	151056	114.95380	56.99743	0.582927	0.177350	375332	0.238	0.82892	0.152	0.998907	1.174339	0.126
940504	151213	114.94580	57.46014	0.582352	0.177250	375043	0.238	0.82943	0.152	0.998908	1.174177	0.126
940504	151331	114.94812	58.06427	0.581670	0.177480	374651	0.238	0.82919	0.152	0.998906	1.173921	0.126
940504	154409	114.86724	58.90398	0.582904	0.692940	743624	0.235	0.83563	0.178	0.995747	2.332732	0.120
940504	154526	114.83750	58.44375	0.583281	0.692560	744043	0.235	0.83554	0.178	0.995747	2.332569	0.120
940504	154642	114.80484	57.93128	0.583699	0.691130	744591	0.235	0.83613	0.196	0.995755	2.332640	0.120
940504	155502	114.67830	56.50216	0.585989	0.943200	873237	0.229	0.83743	0.164	0.994215	2.730293	0.107
940504	155617	114.66520	56.44316	0.585986	0.942240	873262	0.229	0.83781	0.149	0.994221	2.730147	0.107
940504	155732	114.64990	56.33211	0.586028	0.940350	873356	0.229	0.83858	0.164	0.994227	2.730023	0.107
940504	153431	114.96890	59.48754	0.581692	0.483980	619559	0.244	0.83353	0.271	0.997023	1.945114	0.137
940504	153549	114.93080	58.78060	0.582309	0.483790	620206	0.244	0.83332	0.249	0.997026	1.945250	0.137
940504	153707	114.89243	58.08579	0.582909	0.482690	620891	0.244	0.83396	0.250	0.997033	1.945537	0.137
940504	160827	114.72383	56.85929	0.587295	1.236600	999855	0.261	0.83838	0.210	0.992438	3.127714	0.166
940504	160944	114.71530	56.99331	0.587089	1.235260	999472	0.261	0.83881	0.197	0.992443	3.127090	0.166
940504	161102	114.69990	57.08799	0.586910	1.237150	999166	0.261	0.83816	0.209	0.992429	3.126534	0.166
940504	161530	114.47162	57.98491	0.586384	1.567000	1122404	0.251	0.83967	0.180	0.990422	3.516438	0.149
940504	161645	114.46410	58.25165	0.586046	1.568630	1121653	0.251	0.83922	0.192	0.990416	3.515370	0.149
940504	161759	114.45591	58.38285	0.585855	1.569140	1121204	0.251	0.83905	0.185	0.990400	3.514595	0.149

McCrometer - Test 4C. Short Coupling, V-Cone θ = -90°.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940504	152636	114.92170	57.65824	0.582664	0.307900	495187	0.259	0.83159	0.359	0.998104	1.550743	0.163
940504	152752	114.88540	56.78277	0.583490	0.307950	495949	0.260	0.83123	0.359	0.998103	1.551262	0.163
940504	152919	114.98560	57.00327	0.583744	0.308030	496251	0.260	0.83170	0.358	0.998104	1.552684	0.163
940504	162239	114.45790	59.12788	0.586883	1.940960	1243847	0.244	0.83942	0.181	0.988171	3.903031	0.136
940504	162404	114.44902	59.42618	0.586497	1.941620	1242950	0.244	0.83929	0.210	0.988159	3.901816	0.136
940504	162610	114.43481	59.66580	0.586147	1.941350	1242118	0.244	0.83930	0.195	0.988177	3.900485	0.136

McCrometer - Test 5. Effect of Pressure Tap Location on Short Coupled Configuration.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940506	140551	115.12940	60.17566	0.579672	0.078880	248026	0.255	0.82668	0.210	0.999514	0.779424	0.155
940506	140720	115.10420	60.27970	0.579426	0.078770	247921	0.255	0.82721	0.210	0.999515	0.779207	0.155
940506	140849	115.14730	59.29542	0.580766	0.078580	248470	0.255	0.82799	0.209	0.999516	0.779878	0.155
940506	142336	115.00473	60.56403	0.579771	0.311050	492696	0.260	0.82853	0.355	0.998085	1.549121	0.163
940506	142454	115.00140	60.40090	0.579939	0.310830	492807	0.260	0.82870	0.337	0.998087	1.549122	0.163
940506	142610	114.98542	59.62938	0.580736	0.310210	493470	0.260	0.82920	0.377	0.998090	1.549557	0.163
940506	143237	114.77101	58.88483	0.582459	0.696880	743047	0.235	0.83294	0.213	0.995715	2.330847	0.120
940506	143356	114.80043	59.48726	0.581922	0.697850	742270	0.235	0.83255	0.195	0.995713	2.330343	0.120
940506	143513	114.80951	59.20329	0.582287	0.696710	742652	0.235	0.83307	0.178	0.995723	2.330633	0.120
940506	144515	114.66223	58.56199	0.585048	1.244130	995462	0.261	0.83573	0.197	0.992385	3.121239	0.166
940506	144630	114.67144	58.73236	0.584896	1.243760	995200	0.261	0.83593	0.201	0.992393	3.121150	0.166
940506	144747	114.67994	58.91695	0.584732	1.244950	994914	0.262	0.83562	0.197	0.992383	3.121045	0.166
940506	145410	114.37140	61.08326	0.584244	1.950790	1237806	0.244	0.83689	0.206	0.988113	3.894528	0.136
940506	145529	114.41903	61.50852	0.584015	1.954370	1237139	0.244	0.83634	0.182	0.988089	3.894725	0.136
940506	145648	114.41350	61.88867	0.583544	1.952930	1235985	0.244	0.83663	0.181	0.988100	3.893135	0.136

McCrometer - Test 6. Modified Baseline Configuration.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940510	93237	114.94332	59.59278	0.580581	0.313270	493663	0.259	0.82555	0.375	0.998070	1.550082	0.163
940510	93352	114.90614	58.99683	0.581076	0.313450	494152	0.259	0.82511	0.355	0.998068	1.550345	0.163
940510	93508	114.91120	59.33383	0.580719	0.314000	493842	0.260	0.82450	0.355	0.998066	1.550091	0.163
940510	100038	114.64840	58.42266	0.582400	0.702840	743565	0.235	0.82953	0.194	0.995676	2.330977	0.120
940510	100213	114.70180	58.45296	0.582640	0.703740	743902	0.235	0.82924	0.193	0.995673	2.332138	0.120
940510	100329	114.73172	59.63361	0.581436	0.703570	742244	0.235	0.82967	0.212	0.995675	2.330721	0.120
940510	102255	114.39450	58.95539	0.583276	1.251070	993736	0.261	0.83370	0.200	0.992330	3.117465	0.166
940510	102416	114.35620	58.85937	0.583185	1.249470	993627	0.262	0.83409	0.208	0.992338	3.116704	0.166
940510	102623	114.51890	58.71744	0.584184	1.252020	995367	0.262	0.83385	0.210	0.992323	3.121584	0.166
940510	103929	114.14250	61.02487	0.583169	1.952720	1237882	0.244	0.83717	0.210	0.988063	3.894406	0.136
940510	104043	114.17092	61.25687	0.583072	1.957780	1237555	0.244	0.83620	0.193	0.988054	3.894630	0.136
940510	104223	114.11172	61.55368	0.582414	1.953670	1236015	0.244	0.83684	0.166	0.988066	3.891364	0.136
940510	112320	115.14010	60.44353	0.579427	0.080140	248076	0.255	0.82082	0.209	0.999506	0.779872	0.156
940510	112651	115.05134	60.87420	0.578490	0.080020	247659	0.255	0.82120	0.208	0.999507	0.779017	0.156
940510	112821	115.06260	60.24995	0.579256	0.080020	248001	0.255	0.82109	0.208	0.999507	0.779425	0.156
weightank:												
940510	95014	114.52110	61.30967	0.576496	0.312220	490368	0.204	0.82623	0.342	0.998069	1.542658	0.166
940510	143806	114.24490	64.69051	0.575984	1.245980	980502	0.205	0.83579	0.117	0.992346	3.095899	0.171

McCrometer - Test 7A. Duplicate Baseline Test 1A.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940510	133754	115.09014	61.77824	0.577660	0.080140	247167	0.255	0.82054	0.209	0.999506	0.778442	0.155
940510	133911	115.11590	61.39852	0.578218	0.079820	247411	0.255	0.82220	0.208	0.999508	0.778804	0.155
940510	134035	115.15200	61.57762	0.578198	0.080050	247401	0.255	0.82116	0.207	0.999507	0.778967	0.155
940510	134709	114.97460	62.18621	0.577789	0.313370	490808	0.260	0.82553	0.375	0.998070	1.546643	0.163
940510	134828	114.97091	61.54118	0.578498	0.312710	491479	0.260	0.82629	0.355	0.998075	1.547376	0.163
940510	134943	114.95482	60.91176	0.579134	0.313090	492093	0.259	0.82566	0.354	0.998072	1.547964	0.163
940510	135822	114.83580	61.54102	0.579786	0.703850	739452	0.235	0.82971	0.177	0.995678	2.328080	0.120
940510	135954	114.76654	61.48515	0.579503	0.704200	739077	0.235	0.82922	0.199	0.995674	2.326709	0.120
940510	140112	114.77650	61.44033	0.579604	0.704230	739212	0.235	0.82924	0.182	0.995674	2.326993	0.120
940510	141219	114.50850	62.22335	0.580124	1.252910	987114	0.261	0.83348	0.208	0.992325	3.110686	0.166
940510	141334	114.51250	62.38031	0.579962	1.252080	986755	0.261	0.83375	0.197	0.992328	3.110233	0.166
940510	141449	114.51310	62.62212	0.579703	1.254600	986266	0.261	0.83297	0.197	0.992309	3.109729	0.166
940510	142120	114.16272	64.43245	0.579417	1.956980	1228031	0.244	0.83616	0.166	0.988055	3.881672	0.136
940510	142239	114.23920	64.95284	0.579206	1.955960	1227373	0.244	0.83667	0.190	0.988069	3.882410	0.136
940510	142353	114.30313	65.34723	0.579083	1.956390	1226909	0.244	0.83681	0.181	0.988068	3.883082	0.136

McCrometer - Test 7B. Duplicate Baseline Test 1A.

Date	Time	Pup(psia)	T(F)	rho(lb/ft3)	DP(psid)	ReD	UReD(%)	Cd	UCd(%)	Y	SN(lb/s)	USN(%)
940511	73854	115.12560	64.27277	0.574729	0.020510	124113	0.296	0.81902	0.524	0.999874	0.392242	0.216
940511	74018	115.12620	64.37024	0.574622	0.020410	124093	0.296	0.82103	0.524	0.999874	0.392231	0.216
940511	74141	115.18710	64.44185	0.574847	0.020440	124143	0.296	0.82084	0.526	0.999874	0.392429	0.216
940511	74948	115.01691	62.34947	0.576642	0.079170	246570	0.255	0.82495	0.208	0.999512	0.777172	0.156
940511	75104	115.01251	62.47897	0.576474	0.079250	246515	0.255	0.82461	0.211	0.999511	0.777137	0.156
940511	75220	114.98610	61.87546	0.577024	0.079410	246783	0.255	0.82358	0.210	0.999510	0.777332	0.155
940511	75913	115.05840	61.69366	0.578099	0.180080	372174	0.238	0.82433	0.150	0.998891	1.172007	0.126
940511	80040	115.03320	62.23579	0.577358	0.179940	371684	0.238	0.82470	0.151	0.998892	1.171341	0.126
940511	80154	115.03310	61.64757	0.578022	0.179850	372136	0.238	0.82477	0.152	0.998892	1.171813	0.126
940511	93927	114.92983	59.56559	0.581442	0.491220	619715	0.244	0.82787	0.247	0.996979	1.945809	0.137
940511	94052	114.91933	60.67225	0.580130	0.492280	618205	0.244	0.82714	0.247	0.996972	1.944025	0.137
940511	94216	114.89380	60.59447	0.580089	0.492030	618137	0.244	0.82720	0.268	0.996973	1.943600	0.137
940511	94756	114.64492	58.58173	0.583497	0.959220	869869	0.229	0.83138	0.180	0.994109	2.727519	0.107
940511	94912	114.64850	58.29694	0.583834	0.957590	870465	0.229	0.83209	0.178	0.994122	2.728322	0.107
940511	95025	114.64534	58.06435	0.584088	0.957750	870920	0.229	0.83201	0.162	0.994124	2.728875	0.108
940511	100909	114.24920	59.43739	0.583704	1.590890	1118510	0.251	0.83412	0.180	0.990258	3.511194	0.149
940511	101025	114.27100	59.71466	0.583491	1.589920	1118033	0.251	0.83449	0.196	0.990260	3.511039	0.149
940511	101142	114.29400	59.98407	0.583292	1.588910	1117529	0.251	0.83481	0.180	0.990273	3.510763	0.149