13443

T OF COMMERCE

National Institute of Standards and Technology

NIST Technical Note 1264

Measurements of Coefficients of Discharge for Concentric Flange-Tapped Square-Edged Orifice Meters in Water Over the Reynolds Number Range 600 to 2,700,000

James R. Whetstone, William G. Cleveland, George P. Baumgarten, Samuel Woo, and M. Carroll Croarkin

NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY
Research Information Center
Gaithersburg, MD 20899

The National Institute of Standards and Technology[1] was established by an act of Congress on March 3, 1901. The Institute's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Institute conducts research to assure international competitiveness and leadership of U.S. industry, science and technology. NIST work involves development and transfer of measurements, standards and related science and technology, in support of continually improving U.S. productivity, product quality and reliability, innovation and underlying science and engineering. The Institute's technical work is performed by the National Measurement Laboratory, the National Engineering Laboratory, the National Computer Systems Laboratory, and the Institute for Materials Science and Engineering.

The National Mea

Provides the national s
coordinates the system
and furnishes essential
physical and chemical
community, industry, a
services to other Gove
research; develops, pro
Materials; provides cal
Standard Reference Da
following centers:

- Basic Standards[2]
- Radiation Research
- Chemical Physics
- Analytical Chemistry

The National Eng

Provides technology an
sectors to address natio
conducts research in en
efforts; builds and main
required to carry out th
neering data and measu
ment traceability servic
neering standards and c
engineering practices; a
transfer results of its res
consists of the following

- Computing and Applied Mathematics
- Electronics and Electrical Engineering[2]
- Manufacturing Engineering
- Building Technology
- Fire Research
- Chemical Engineering[3]

The National Com

Conducts research and p
Federal agencies in the s
computer technology to
ment operations in acco
relevant Executive Orde
by managing the Federal
developing Federal ADP
participation in ADP vol
tific and technological advisory services and assistance to Federal agencies; and provides the technical foundation for computer-related policies of the Federal Government. The Laboratory consists of the following divisions:

- Information Systems Engineering
- Systems and Software Technology
- Computer Security
- Systems and Network Architecture
- Advanced Systems

The Institute for Materials Science and Engineering

Conducts research and provides measurements, data, standards, reference materials, quantitative understanding and other technical information fundamental to the processing, structure, properties and performance of materials; addresses the scientific basis for new advanced materials technologies; plans research around cross-cutting scientific themes such as nondestructive evaluation and phase diagram development; oversees Institute-wide technical programs in nuclear reactor radiation research and nondestructive evaluation; and broadly disseminates generic technical information resulting from its programs. The Institute consists of the following divisions:

- Ceramics
- Fracture and Deformation[3]
- Polymers
- Metallurgy
- Reactor Radiation

[1] Headquarters and Laboratories at Gaithersburg, MD, unless otherwise noted; mailing address Gaithersburg, MD 20899.
[2] Some divisions within the center are located at Boulder, CO 80303.
[3] Located at Boulder, CO, with some elements at Gaithersburg, MD.

NIST Technical Note 1264

Measurements of Coefficients of Discharge for Concentric Flange-Tapped Square-Edged Orifice Meters in Water Over the Reynolds Number Range 600 to 2,700,000

James R. Whetstone, William G. Cleveland, George P. Baumgarten, Samuel Woo

Chemical Process Metrology Division
Center for Chemical Engineering
National Engineering Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

and M. Carroll Croarkin

Statistical Engineering Division
Center for Computing and Applied Mathematics
National Engineering Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

June 1989

NOTE: As of 23 August 1988, the National Bureau of Standards (NBS) became the National Institute of Standards and Technology (NIST) when President Reagan signed into law the Omnibus Trade and Competitiveness Act.

U.S. Department of Commerce
Robert A. Mosbacher, Secretary

National Institute of Standards and Technology
Raymond G. Kammer, Acting Director

National Institute of Standards and Technology
Technical Note 1264
Natl. Inst. Stand. Technol.
Tech. Note 1264
546 pages (June 1989)
CODEN: NTNOEF

U.S. Government Printing Office
Washington: 1989

For sale by the Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

Measurements of Coefficients of Discharge for Concentric Flange-Tapped Square-Edged Orifice Meters in Water Over the Reynolds Number Range 600 to 2,700,000

James R. Whetstone, William G. Cleveland
George P. Baumgarten, Samuel Woo, and M. Carroll Croarkin

Abstract

Presented here is a description of the measurement procedures and standards, data acquisition systems, and data bases developed in the American Petroleum Institute (API)-sponsored orifice discharge coefficient data base project performed at the National Bureau of Standards (NBS) primary water flow rate measurement facility. Measurements were performed on five orifice meter sizes, 2, 3, 4, 6, and 10 inches, over the beta ratio range of 0.08 to 0.75. The measurement systems and procedures were designed to provide full documentation of the relation between the observations comprising the data base developed and U.S. national measurement standards.

Data acquisition procedures were automated to minimize human error in data recording, particularly for differential pressure observation. Laboratory-quality transducers and pressure standards were used and data acquisition was automated for observation of differential pressure, flowing fluid temperature, collected mass of water, and time of collection. Only a few parameter observations were made manually and entered into the data base. A large data base stored in computer-accessible form has resulted. This data base consists of the recorded raw data and the results calculated from them.

To realize the full potential of the transduction equipment used in the project, appropriate working standards were incorporated into the measurement systems to allow calibration of differential pressure transducers, thermometers, length-measuring devices, and weigh scales. These working standards were, in turn, calibrated against U.S. national working standards over the course of the project and are described in detail. Gravimetric measurement of the mass flow rate through the orifice meters utilized the NBS primary water mass flow rate measurement system. Documentation of the measurements, standards, and procedures utilized in this project is given in an NBS report to be published shortly. The data base will be available from NBS and API.

NOTE: On August 23, 1988 with the signing of the Omnibus Trade and Competitiveness Act, the National Bureau of Standards (NBS) became the National Institute of Standards and Technology (NIST). Since this report was written and reviewed before this change, references to NBS in the body of the report have not been changed to NIST.

Table of Contents

Page

List of Figures Page

Page

Page

List of Tables

I. Introduction

For the last 2 decades it has been recognized in the flowmetering community that a need exists for well-documented, experimental data bases of coefficients of discharge for orifice meters in order to achieve a greater degree of accuracy in custody transfer measurements. The American Petroleum Institute (API) and the American Gas Association (AGA) made an initial attempt to resolve the situation for flange-tapped orifice meters in the mid-1970's; however, this attempt did not come to fruition. A subsequent effort was made by API and the Gas Processors Association (GPA) to develop a comprehensive and well-documented database of discharge coefficients for flange-tapped orifice meters spanning their range of use. The three major parameters to be varied were the Reynolds number, the meter tube diameter, and the ratio of the orifice diameter to the pipe diameter (known as the beta ratio). To accomplish this objective a program consisting of three projects was planned. Common to the program would be a set of orifice meters comprised of meter tubes in five sizes with each size having sets of seven orifice plates with a beta ratio range from 0.1 to 0.75. Each project would concentrate on one region of the Reynolds number range by using a particular fluid for flow tests. The fluids were selected on a practical basis and the three projects were designed so that the data developed by any one project would overlap that developed by a companion project in the adjacent Reynolds range. The low Reynolds number project would be performed using a moderate viscosity liquid and the smaller diameter orifice meters. The intermediate Reynolds number project would use water as the test fluid and would involve all orifice meters. The high Reynolds number project would use natural gas and the largest orifice meters.

In 1981 the API and the U.S. National Bureau of Standards (NBS) entered into a contractual arrangement to develop a well-documented data base of discharge coefficients for flange-tapped orifice meters over the range of Reynolds numbers obtainable in the NBS water flow rate measurement facility. The measurement devices, standards and procedures, data acquisition methods, a condensed data base, and the results of this extensive test project are described herein. The approach taken by NBS was to document all measurement procedures and standards and relate them to U.S. national standards of measurement. This document describes the experiments, procedures, instrumentation, measurement traceability, software documentation, and the resulting analysis used to develop the orifice discharge coefficient data base reported here.

As with any data base development or research project, a set of initial assumptions and conditions are necessary to form the basic framework within which the project operates and its goals are accomplished. The following is written to describe this framework. It is written with the benefit of a considerable degree of hindsight developed over the 6-year period of the project's lifetime. During the course of the project some of the specific conditions, procedures and methods changed. In some facets of the project these changes were profound, strongly affecting the manner in which it was finally completed. However, the basic framework and objective of the project remained essentially constant.

The rationale for the configurations of the orifice meters and the measurement system was the following:

(1) A primary condition was to develop a fundamental discharge coefficient data base. Effects on the orifice meter from sources extraneous to fundamental orifice meter configuration were to be eliminated or their effect minimized.

(2) The complete set of orifice meter tubes in five sizes (2, 3, 4, 6, and 10 inches) would be used. Two duplicate meter tube assemblies in each size were used. Flange taps would be used to reflect the preponderance of U.S. commercial practice.

(3) Each meter tube size had two sets of orifice plates with beta ratios ranging from nominally 0.1 to 0.75. The two sets were nominally identical in each size.

(4) The manufactured quality of the meter tubes and orifice plates was to be of commercial quality in order to reflect a level of variability normally seen in commercial metering installations. Therefore, the meter tubes were constructed of seamless steel tubing, and fitted with ANSI 600 psi steel flanges. (Although rather low pressures were used in this project, the high Reynolds project was to be done at gas pipeline pressures necessitating the use of the appropriate flanges.) However, a departure from commercial practice was made in the types of flange seals. Rather than the compression gasket seals normally used in commercial orifice metering, O-ring seals were used. The use of O-ring seals provided a reproducible method for locating the pressure taps relative to the orifice plate. This also minimized any step in the diameter between the meter tube and the orifice, and eliminated the question of the effect of gaskets of variable thickness and diameter on the discharge coefficients calculated from the data base.

(5) The maximum differential pressure would be approximately 800 inches of water or 28 psid. The minimum differential pressure would be determined by the capability of the measurement system.

(6) Where feasible, state-of-the-art measurement techniques would be employed.

(7) All measured parameters were to be referred directly to U.S. measurement standards.

(8) Documentation of the measurement systems and procedures was to be as complete as possible.

(9) In an attempt to isolate the orifice meter from effects caused by the installation of the orifice meters in the test facility, a flow conditioner and an approach tube (approximately 40 diameters long) were added to the normal commercial meter tube configuration.

In developing this data base it was decided at the beginning of the project that the amount of data acquired manually would be minimized. In particular the parameters observed for flow rate determination and in the observation of differential pressure across the orifice meter would be automated to minimize the incidence of human error. In the final system used for data acquisition, automated logging of the observed parameter values was used exclusively except for entry of the observed barometric pressure. As a consequence, the rate at which differential pressure values could be acquired was much higher than could have been possible with manual observation and recording. Each of the differential pressure values was recorded on magnetic media and became part of the total data base which is quite voluminous. The entire data base is available in computer readable form. The structures of this data base are given here and the data base itself is available from the NBS and from the API.

The remainder of the report gives comprehensive descriptions of the measurement systems used to acquire the observed data, descriptions of the hardware, analyses of its performance, and the methods used to tie each observed parameter to national standards. An analysis of the overall uncertainty in the measurement of discharge coefficient values is given. The data base is analyzed and the results tabulated and discussed.

The magnitude of the data base is quite large and could not be accommodated in a document of any reasonable length. Additionally, the great majority of the data was collected by, stored in, and analyzed with computers. Any analysis which one may wish to do is possible by obtaining the entire observational data base on magnetic tape either from the NBS or the API.

The major difficulty encountered during the execution of this project was identifying, to some extent quantifying, and arresting the effects of changing surface roughness of the meter tubes due to corrosion. The efforts expended by the NBS and the API are summarized in Appendix A of this report which gives the operating history of the project. Placing this description in an appendix is done to encourage reading of the body of the report first, since the operating history is written with the assumption that the reader has an understanding of the various measurement systems and procedures used in the work. The final solution to arresting corrosion induced effects on the results of the test data was the plating with nickel of the meter tubes. The plating was done using the electroless process to minimize the modification of the surface finish of the meter tube, while inhibiting corrosion. Data collected after nickel plating the meter tubes constitutes the final data base. However, these data were collected after a substantial body of data had been collected and analyzed. The data base which is archived contains data taken for test runs beginning well before the nickel plating and collection of the final segment of the data base. This has been done to satisfy the wishes of the API that the complete record of the project be well documented.

The remainder of this report contains detailed descriptions of the measurement systems and methods employed and the results obtained in final data base. These may seem to be overly detailed at some points. This was done intentionally to provide full documentation of this work for the use of any future workers interested in its evaluation without the aid of those involved, much as has been the case with the original work of Beitler [1], upon which much of current orifice metering practice is based.

II. Experimental Facilities and Measurement Systems

A. General Description of the Experimental Approach

The experimental work was performed using the water flow rate measurement facility of the NBS. Added to this facility was a system for automated measurement of differential pressure, diversion timing, mass, and temperature. The measurement systems are shown schematically in figures 1 and 2. Included in the measurement and data storage system (fig. 2) is the provision for periodic calibration and surveillance of the differential pressure transducers and the scales used for flow rate measurement. The general philosophy used in the development of the measurement system and data base developed from it, was to tie each measured parameter included in the data base to the national standards of measurement as maintained by the NBS (see fig. 1). Assessment of the magnitude of the effects of each parameter on the total measurement uncertainty for the orifice discharge coefficient was determined by a propagation of error analysis. The work of Ku [2] provided the basis for this analysis, which was used to determine the rigor with which each measured parameter was compared with national standards. Efforts were made to minimize the primary contributors to the error budget. The following sensitivity analysis is a tool to estimate the error contributions of the independent variables.

B. Sensitivity Analysis of the Measurement System and Variation of the Discharge Coefficient with Various Observed Parameters

1. Sensitivity Analysis of the Measurement System

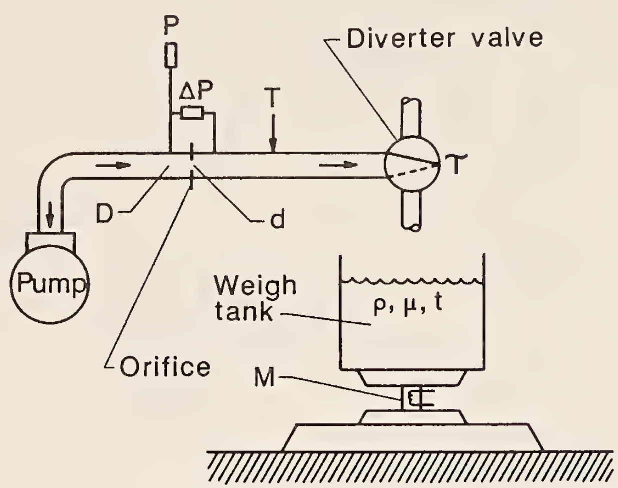
The total accuracy or uncertainty with which orifice discharge coefficients may be determined is dependent upon the combined uncertainty of the independent variables from which it is computed. The magnitude of the contribution of each independent variable's measurement uncertainty to the discharge coefficient's uncertainty may be estimated by an elementary sensitivity analysis. The basis for this analysis is the mathematical expression for the discharge coefficient which is given here as eq (1). This relationship is derived from fluid dynamic considerations in section III.

FORMULATION

$$\dot{m} = NC_d d^2 Fa \sqrt{\frac{\rho \Delta P}{(1-\beta^4)}}$$

$$C_d = f(Re)$$

$$Re = \frac{4\dot{m}}{\pi \mu D}$$



SYMBOL	PARAMETER OR FUNCTION	MEASUREMENT TRACEABILITY
C_d	Orifice discharge coefficient	Calculated from formulation
d	Orifice diameter	Length standard
D	Pipe diameter	Length standard
N	Units conversion constant	....
$\dot{m}$	Mass flow rate	Mass & time standards
M	Mass of test fluid	Mass standard
P	Static pressure	Pressure standard
Re	Reynolds number	Calculated from formulation
t	Collection time	Time standard
T	Test fluid temperature	Temperature standard
β	d/D, diameter ratio	Length standard
μ	Test fluid viscosity	Interpolated from best available data
ρ	Test fluid density	Mass & volume standards
τ	Diverter correction time	Time standard
Fa	Orifice expansion factor	Calculated from formulation

Figure 1. Orifice Flow Rate Measurement System

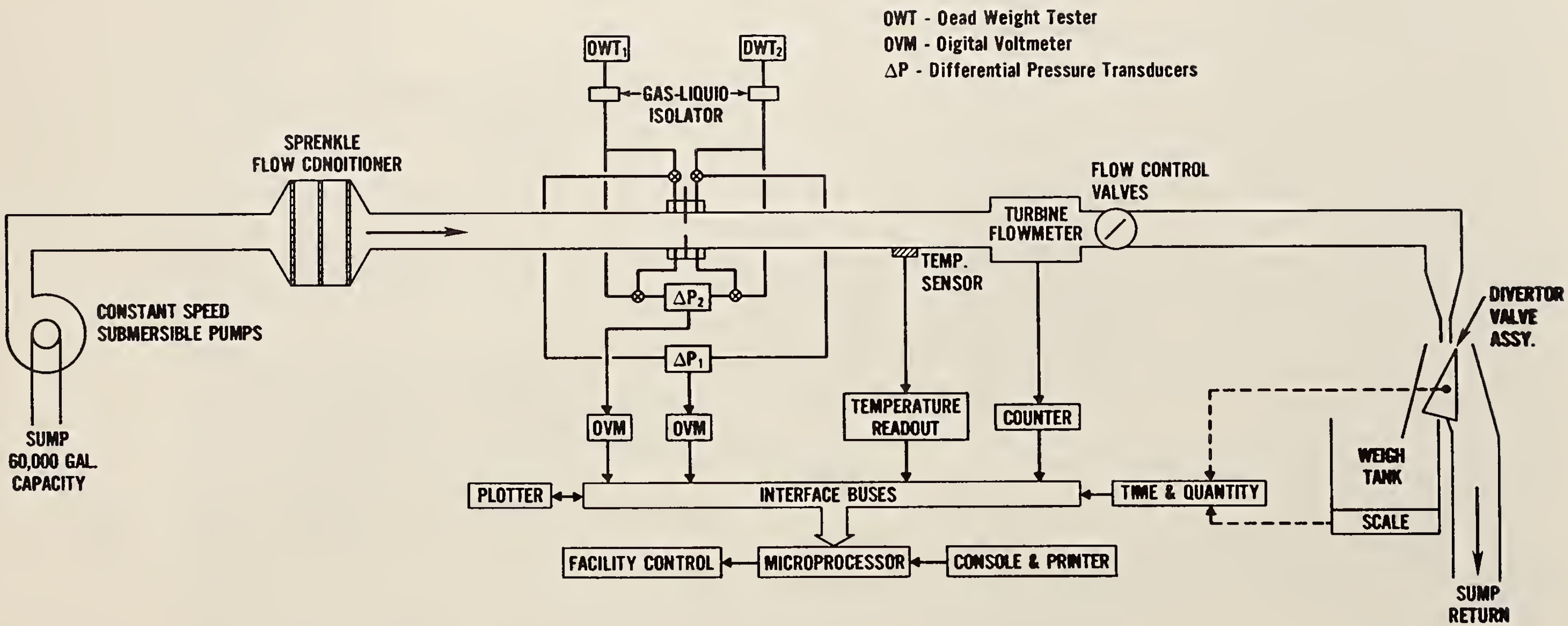


Figure 2. Flow Measurement System/Orifice Meter Diagram

$$C_d = \dot{m}(1 - \beta^4)^{1/2} / [N d^2 F_a (\rho \Delta P)^{1/2}] , \qquad (1)$$

where C_d = discharge coefficient,
$\dot{m}$ = mass flow rate,
d = diameter of the orifice,
F_a = orifice thermal expansion factor,
N = a units conversion constant dependent on measured parameters,
ρ = density of the flowing fluid, water in this project,
ΔP = the differential pressure developed across the orifice meter,
β = d/D, the beta ratio, and
D = the diameter of the meter tube.

The relative magnitude of the variation in each parameter was calculated, and the results used for selection of the procedures and hardware for data collection purposes. Analysis of the sensitivity of the discharge coefficient value to changes in the independent variables may be investigated by differentiation of eq (1) with respect to each. Normalization of each of these partial derivatives by the discharge coefficient results in an expression for the relative change in discharge coefficient, $\Delta C_d/C_d$, due to relative change in the independent variable of interest. This method will be used to estimate the relative effect of variation in each independent variable to quantify the rigor necessary in its measurement.

Each independent variable is either a directly observed quantity or is the result of observed values of two or more auxiliary observable quantities. The two diameter values are directly measured quantities, i.e., the micrometers and measuring machines used gave their indications in length units and were calibrated. All of the independent variables require calibration procedures in order to make a direct tie to the U.S. National Measurement System as maintained by NBS or are the results of metrological work recognized as representing the most accurate data available, e.g., the dependence of water density on temperature. Discussions of the methods of calibration and measurement traceability for each of these are given in subsequent sections of this report. In this section we will discuss the effects of the measurement sensitivity in the parameters appearing explicitly in the discharge coefficient equation given above. The partial derivatives of interest and the corresponding expression for relative variation of the discharge coefficient due to relative changes in each parameter are discussed.

2. Discharge Coefficient Variation Due to Independent Variable Variation

Mass Flow Rate Variation

$$\frac{1}{C_d}\frac{\partial C_d}{\partial \dot{m}} = \frac{1}{\dot{m}} \quad ; \quad \frac{\Delta C_d}{C_d} = \frac{\Delta \dot{m}}{\dot{m}} \ .$$

The discharge coefficient varies directly as the mass flow rate varies. As will be discussed later the uncertainty in the mass flow rate as determined by the NBS gravimetric water flow rate measurement facility was initially expected to lie between 0.1 and 0.2%. This value appeared to be a limiting one for flow rate measurement. Therefore, the magnitude of this variation/uncertainty in the measurement of the discharge coefficient was taken as an upper limit target for the other independent parameter measurements.

Flowing Fluid Density Variation

$$\frac{1}{C_d}\frac{\partial C_d}{\partial \rho} = -\frac{1}{2\rho} \quad ; \quad \frac{\Delta C_d}{C_d} = -\frac{1}{2}\frac{\Delta \rho}{\rho} .$$

Quite accurate values of the density of the flowing fluid, water, may be obtained from temperature observations. The relative variation in the water density values is 1 to 2 parts in 10,000 (0.01-0.02%). The effect of this variation on the discharge coefficient is reduced by one-half according to the above equation.

Differential Pressure Variation

$$\frac{1}{C_d}\frac{\partial C_d}{\partial (\Delta P)} = -\frac{1}{2\Delta P} \quad ; \quad \frac{\Delta C_d}{C_d} = -\frac{1}{2}\frac{\Delta(\Delta P)}{(\Delta P)} .$$

The variation relation of the discharge coefficient with the differential pressure developed across the orifice meter is similar to that of the flowing fluid density. However, this measurement has traditionally been one of the more difficult to make with a small uncertainty value. The approach taken in this work was to make a large number of differential pressure measurements, and to make them using state-of-the-art transduction and calibration apparatus to attain a high degree of accuracy. In this way the uncertainty in this measurement parameter is minimized. The uncertainty in the measurement of the differential pressure is constant over the pressure range. Therefore, the relative uncertainty increases at the lower differential pressure values. Realistic estimates of the uncertainty in the differential pressure working standards and transducers are on the order of 0.001 to 0.005 psid (7 to 34 pascals, 0.02 to 0.1 inches of water). Taking the upper limit of this range as the uncertainty in the differential pressure value and the highest and lowest nominal differential pressure values used in the testing procedures gives an approximate relative uncertainty range of 0.01% (diff. press. of 28 psid) to 0.63% (diff. press. of 0.4 psid). As is the case with the measurement of mass flow rate, the contribution of this pressure uncertainty component is a dominant and limiting one. The measurement methods and techniques used here are considered to be state-of-the-art.

Orifice and Meter Tube Diameter Variation

$$\frac{1}{C_d}\frac{\partial C_d}{\partial d} = \frac{-2}{1-\beta^4}\frac{1}{d} \quad ; \quad \frac{\Delta C_d}{C_d} = \frac{-2}{1-\beta^4}\frac{\Delta d}{d} .$$

$$\frac{1}{C_d}\frac{\partial C_d}{\partial D} = \frac{2\beta^4}{1-\beta^4}\frac{1}{D} \quad ; \quad \frac{\Delta C_d}{C_d} = \frac{2\beta^4}{1-\beta^4}\frac{\Delta D}{D} .$$

The $2/(1-\beta^4)$ term in each of these relations increases the relative variation/uncertainty in the diameter measurements on that of the discharge coefficient. The magnitude of this term ranges from 2 (for β = 0.1) to 3 (for β = 0.75). Diameter measurement uncertainty was expected to be approximately 0.0002 inches (5 micrometers). The effect of relative variation in the meter tube diameter, $\frac{\Delta D}{D}$, on the discharge coefficient, $\frac{\Delta C_d}{C_d}$, is reduced by the β^4 multiplier. Typical values are given in the following table.

Meter Tube Diameter (inches)	Orifice Diameter (inches)	Beta Ratio	β^4	$\left[\frac{\Delta C_d}{C_d}\right]_d$ (%)	$\left[\frac{\Delta C_d}{C_d}\right]_D$ (%)
2.0	0.25	0.12	0.0002	0.16	$4.9\text{x}10^{-6}$
2.0	0.62	0.31	0.0092	0.07	$1.9\text{x}10^{-4}$
2.0	1.00	0.50	0.0625	0.04	0.001
2.0	1.50	0.75	0.3164	0.04	0.009
4.0	0.37	0.09	$7.3\text{x}10^{-5}$	0.108	$7.3\text{x}10^{-7}$
4.0	1.25	0.31	0.0095	0.032	$9.6\text{x}10^{-5}$
4.0	2.00	0.50	0.0625	0.021	$6.7\text{x}10^{-4}$
4.0	3.00	0.75	0.3164	0.020	0.005
10.0	1.0	0.10	0.0001	0.040	$4.0\text{x}10^{-7}$
10.0	3.0	0.30	0.0081	0.013	$3.3\text{x}10^{-5}$
10.0	5.0	0.50	0.0625	0.009	$2.7\text{x}10^{-4}$
10.0	7.5	0.75	0.3164	0.008	0.002

Orifice Thermal Expansion Factor

The effect of variations in the orifice thermal expansion factor, F_a, is small due to the magnitude of the thermal expansion coefficient of the orifice plate material, stainless steel. The thermal expansion of stainless steel is of the order of 10^{-5}/°C, and for the temperatures used in this work, 15 to 40 °C, errors in the measured temperature and expansion coefficient are extremely small.

C. Water Mass Flow Rate Measurement System and Its Uncertainty

1. General Description

The NBS water flow rate measurement facility is a closed loop flow system. Its general arrangement is shown in figure 2. The flow rate measurement system is installed above the system's reservoir (or sump) which has a capacity of approximately 60,000 U.S. gallons (230 m^3). Water flow rates are maintained in the system by four submersible, shaft turbine pumps, three of which have 3,000 gallons/minute capacities. The fourth has a 1,000 gallons/minute capacity. For flow rates below approximately 50 gallons per minute the primary pumps were found to be too large to produce stable non pulsating flow. Additional small submersible, turbine pumps of 20 and 100 gallons/minute capacities were installed and used at lower flow rates. All of these pumps are constant-speed pumps. Flow and back pressure at the metering device is controlled through the use of two sets of valves. One set is located near the pump discharge manifold and controls the amount of water passed back to the reservoir directly without passing through the facility test sections. The other set of valves is located downstream from the test section. These are the primary controls for back pressure and flow rate through the test sections of the flow rate measurement system.

Measurement of the flow rate of water through a meter under test is done gravimetrically, i.e., through the use of the weighing and timing method. (This method is often categorized as a primary flow rate measurement.) As shown in figure 3 the apparatus consists of a wedge-shaped valve which diverts the flow, to and from a return chute leading either to the reservoir or to a tank mounted on the deck of a weigh scale. The NBS system utilizes four such weigh tank/scale combinations based on load cell scales of varying sensitivities and sizes to cover the 1 to 10,000 gallon/minute flow rate range used in this project. Each weigh tank has associated with it a diverter valve sized according to the flow rate range of the scale and weigh tank. The scale capacities and sensitivities of each system are listed in table 1 with the approximate flow rate range of each.

Table 1. Weighing System Parameters

System No.	Scale Capacity (pounds)	Scale Sensitivity (pounds)	Flow Rate Range (Gallons/Min)	Flow Rate Range (Pounds/Sec)
1	50,000	5.00	1,000 - 10,000	139 - 1390
2	6,000	0.50	250 - 1,400	35 - 194
3	2,000	0.10	40 - 400	5.5 - 55
4	400	0.05	1 - 40	0.1 - 5.5

Each of the scales is connected to an electronic multiplexing device which allows manual selection of the scale to be connected to the

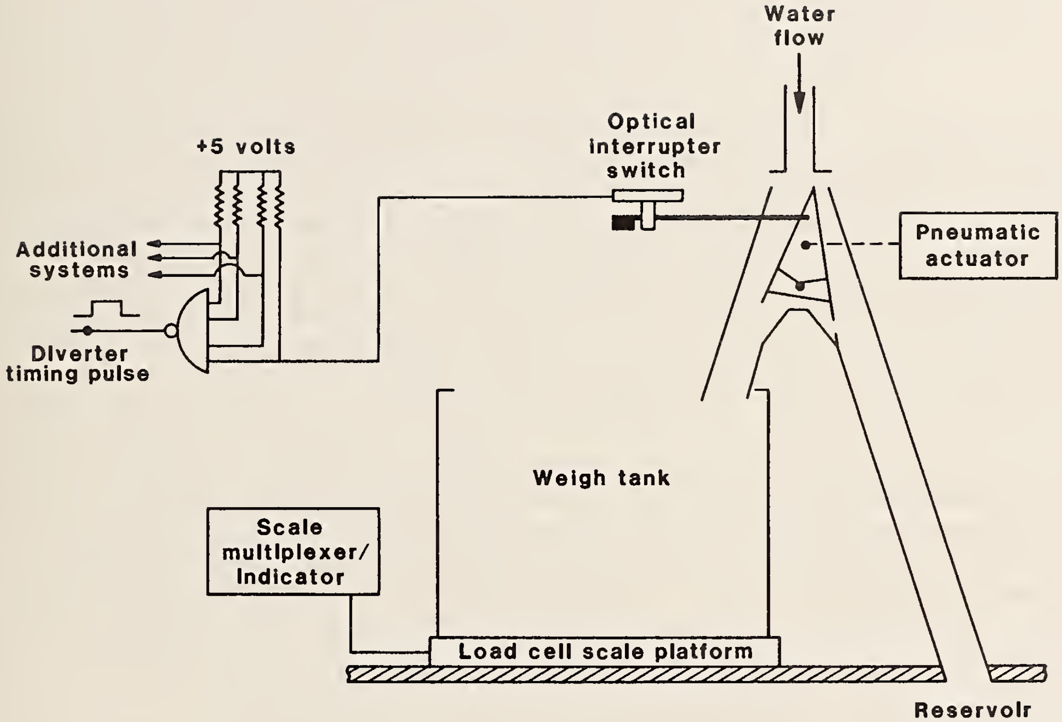


Figure 3. Diverter Valve Schematic Diagram with Timing Circuitry

electronic indicator unit. The indicator unit displays the mass value from the selected scale and transfers this value and scale diagnostic parameters, via an RS-232C interface, to the microprocessor-based data acquisition and control system. The diverter valve position may be controlled either manually from the flow measurement system control panel or automatically by the microprocessor.

The method of measuring the time of diversion of the water flow into the weigh tank uses an optical interrupter switch/flag mechanism to generate a timing signal to control a universal counter/timer. An optical interrupter switch block is mounted on the stationary framework of each diverter valve. A metal flag is mounted on the movable portion of the diverter valve such that the flag interrupts the light beam of the switch very near the mid-point of the valve's traverse. A schematic diagram of the switching arrangement is given in figure 3. The collector of each interrupter switch's output phototransistor is connected to the pull-up resistor of the individual inputs of the four input TTL NAND gate electronic logic circuit. When the light beam is not interrupted, the phototransistor is turned on, pulling the voltage at the gate's input to a logical 0 (0 volts). Light beam interruption forces the output of the NAND gate to a logical 1 (+5 volts). In the rest position each diverter valve's flag places the corresponding input of the switch circuit in the logical 1 state. During normal operation the output of the NAND gate is a pulse having a duration equal to the time that a diverter valve's flag opens the light beam. This timing pulse was connected to the input of a Hewlett-Packard Model 5316A universal counter/timer [3] for measurement of the duration of the pulse. The resolution of the counter/timer is 0.0001 seconds or less for periods of 10 to 10,000 seconds. The measured diversion time value is transferred to the data acquisition system from the counter/timer via an IEEE-488 interface.

In the gravimetric determination of mass flow rate realized in the NBS flow facility the effective collection time is generally not equal to the measured diversion time interval. With the diverter valve construction used in the facility, the water flow is actually split between the chutes leading to the weigh tank and to the reservoir during the movement of the valve between its two positions. Pneumatic cylinders are used to actuate the valves. The time required to move the valve from one position to the other is less than 1 second and varies somewhat with the size of the diverter. Adjustment of the optical interrupter switching flag was made to minimize, but could not eliminate, the correction to the measured diversion times. Measurement and characterization of the diverter correction is necessary for each of the four weighing and timing systems. Each interrupter switch flag is adjusted so that the tip of the triangular section of the diverter valve is located directly below the center of the rectangular chute carrying the water flow into the valve. With the valve in this position, the interrupter switch flag is adjusted to partially interrupt the switch's light beam and cause the switch circuit to change state to a logical 1.

Systems 1, 2, and 3 cover a flow rate range of approximately 10:1 with sufficient overlap to allow measurement of flow rates in these regions with two weighing/diversion systems, thereby allowing a comparison of the system's performance. This type of system crossover checking was done throughout the development of the data base. In the case of system 4 the diverter valve was modified to include a section of phosphor bronze sheet which allowed the entrance chute of the diverter valve to adjust to the flow rate of the water passing over it. The phosphor bronze sheet thickness was 0.010 inches (0.254 mm). The elasticity of the sheet causes the edge contacting the side of the diverter chute to be drawn away from the chute's edge as the flow rate increases. In this way the cross-sectional area of the water jet is maintained in a rectangular shape of variable thickness over a larger range of flow rates. The sheet's ends were formed so that a close fit was achieved to eliminate the flow of water through spaces between them and the body of the valve's upper chute. For this diverter valve the interrupter switch flag's position corresponded with the chute edge contacting the phosphor bronze sheet.

Various methods have been devised for adjusting the diverter valve's switch/flag position or calculating corrections to the measured time or mass values [4,5,6]. The method of Jones [6] is used here for calculation of the diverter correction and its variation.

The measured time interval is the period of diverter valve movement to divert water to the weigh tank. This time is large compared to the time necessary to switch the valve. Because the valve switching characteristics split the water flow between the weigh tank and the return chute, a correction must be made to either the observed time or mass in order to account for this effect. The value of this correction must be evaluated for each system. Estimates of the diverter valve correction value at one flow rate are obtained utilizing an auxiliary flow rate measurement device (in this case a turbine meter) having short-term flow rate measurement stability. Observations are made for a series of long and short diversions into the weigh tank. The long observations fill the weigh tank in a single diversion and are used to determine the turbine meter's characteristics at the flow rate of interest and over the time necessary to complete the measurement. Short observations are used to fill the weigh tank a second time in several diversions. In this way the cumulative effect of the diverter correction of several diversions can be determined.

2. Analysis of Diverter Valve Corrections

Gravimetric measurement of the mass flow rate of water in the NBS flow facility may be modelled with the following relation:

$$\dot{m} = \frac{M}{(t + \tau)}, \qquad (2)$$

where $\dot{m}$ = mass flow rate,
M = mass of water collected,
t = measured collection time, and
τ = the diverter valve correction.

The time $t + \tau$ is the effective collection time. The method of estimating the value of τ is based on multiple diversions into the weigh tank over short time intervals, short relative to the amount of time necessary to fill the tank at the flow rate of interest. Typically 10 short diversions are used to fill the tank. It is assumed that the value of τ is constant for a given flow rate and independent of the diversion time. Mass flow rate values for these short diversion times may be computed using eq (2). Determination of the mass flow rate during the short diversions must be obtained from an auxiliary flow rate measurement device in the flow system, which has good short-term flow rate measurement characteristics. The approximate relationship between the indication of the auxiliary device and the mass flow rate must be known or measured. In this case turbine meters of the appropriate sizes were used because of their excellent short time reproducibility and high resolution. The relation between the mass flow rate and the output frequency of the turbine meter is assumed to be the following for each flow rate:

$$\dot{m} = Cf,$$

where C = turbine meter coefficient, and
f = turbine meter output frequency.

Each determination of the diverter correction is performed in the following manner. After stabilization of the flow rate in the flow system (determined by observation of the turbine output frequency), estimates of C are obtained by diversions of the flow which fill the weigh tank. The mass flow rate is calculated using eq (2) with τ set to zero. These mass flow rate values are designated $\dot{m}_o$, and the measured diversion times, t_o. Then values of C are calculated using the relation:

$$\dot{m}_o = M_o/t_o = Cf_o,$$

where f_o is the observed turbine meter frequency.

After the first long diversion the weigh tank is drained, and then refilled using n short diversions. It is again drained and refilled in a single diversion. This constitutes an observation procedure. The previously estimated value of C, the meter constant, is used to estimate the mass flow rate value, $\dot{m}_i$, for each short diversion time, t_i, i.e., $\dot{m}_i = Cf_i$ for each diversion. Substitution of this relation for the $\dot{m}_i$'s into eq (2) yields the following relation for the diverter correction, τ_i,

$$\tau_i = M_i/Cf_i - t_i. \tag{3}$$

Substitution into eq (3) of the number of turbine meter counts observed during the diversion gives the working equation for the diverter correction time.

$$\tau_i = t_i(M_i/N_iC - 1), \tag{4}$$

where N_i = Number of turbine meter counts occurring during t_i.

These estimates are assumed to apply to the same flow conditions during the series of diversions because once the flow rate has been set prior to the initial long diversion measurement, the flow rate setting control valves are maintained in the same position throughout the measurement cycle. A check of the flow rate stability is made with a long diversion immediately following the series of short diversions. The mean value of C for the two long diversions is used to form the meter constant value used in the computations described below. This also provides a means to eliminate observation sequences in which the flow rate is not sufficiently constant. The observation procedure comprised the following:

- one long diversion which filled the weigh tank,
- drain the weigh tank
- n short diversions which also filled the weigh tank
- drain the weigh tank, and
- a final long diversion which filled the weigh tank.

Although this procedure yields a set of estimates for the τ_i, it should be noted that the initial estimate of the value of C is made using zero as the diverter correction value, thereby introducing an error into the values of the τ_i's. To compensate for this an iterative procedure is employed to determine the best values for the estimates of the τ_i's. The mean of the n estimated values of τ, τ_m, is used to recompute the value of C using the following relation,

$$C = M_o/f_o(t_o + \tau_m). \qquad (5)$$

This new estimate of the value of C is used to recompute the estimate of the τ_i values. This procedure is repeated until the difference in the values of C calculated for two successive iterations is less than a fixed limit. The acceptance criteria were that the differences in successively calculated values of the turbine meter constant differ by less than approximately one half the number of digits of precision in the total number of counts collected during the long diversion time.

Table 2 is an example of the data collected and of the computed results for a set of diverter correction observations. The table contains three sections, the short and long diversion parameters and the observed parameter values. The mean correction time and its standard deviation are listed below the short diversion parameter list.

3. Diverter Correction Values for Each Weighing and Timing System

The diverter correction values and their standard error estimates are given in tables 3 through 6 for each of the four weigh tank/diverter valve systems. For diverter system 1 a flow rate dependence is observed in the diverter correction for which a quadratic function was fit to the data using the least squares technique. This function is used to interpolate through the range of the diverter correction values for this system. In the case of the other systems the dependence on flow rate is smaller and the average diverter correction value is used. For each system the range of the diverter tests has been set to span the flow rate range. The interpolation relation for system 1 is of the form

$$\tau = Y_o + Y_1\dot{m} + Y_2\dot{m}^2$$

where $\dot{m}$ is the mass flow rate in units of pounds/second.

Table 7 lists the coefficients for the system 1 correction function and the mean values for the other three systems. The residual standard deviation for the system 1 fit is listed. The values listed in the residual standard deviation column for the other systems are the computed standard deviations for the data set.

For the upper flow rate range covered by system 1 the diverter corrections ranged from -0.11 second at 200 pounds/seconds to -0.061 seconds at 680 pounds/seconds.

The minimum diversion time for each weighing/diverter system was set at 30 seconds to minimize effects of diverter correction time uncertainty. These effects are further reduced by using the largest weighing system to increase the diversion time thereby reducing the relative error.

Tables 2, and 3 through 6 indicate a contribution to random variation in mass flow rate measurements attributable to scatter in the diverter correction values. In table 3 it is evident that the estimated value of the diverter correction varied between days. While the correction for system 1 was adjusted for the effect of flow rate, there were additional between-day variations.

The diverter corrections listed in table 7 are average values. The local diversion time correction applicable at run time cannot be estimated directly. The residual standard deviations given in table 3 are not direct estimates of the contribution to random error attributable to diversion times, since they were derived from auxiliary experiments with short diversion times. They do, however, provide a method for approximate estimates of the contribution from this source of variability to the random error in mass flow rate measurements.

4. Mass Measurement and Uncertainty

Measurement of the mass flow rate using the gravimetric method requires knowledge of the three quantities discussed above (1) the true mass of water collected during a diversion, (2) the time of the diversion, and (3) the switching characteristics of the diverter valve. All mass flow rate values are stated on a true (vacuum) mass basis and not on an apparent mass basis.

Table 2. Diverter Correction Computation of Weighing System 1 at 1583.222 GPM -- 11/25/85

Obs No.	Short Diversion Parameters: Collected Mass (lbm)	Diversion Time (sec)	Turbine Meter Counts	Turbine Meter Frequency (Hz)	Diverter Correction (sec)
2	3840.56	17.555	5664	322.64	-0.1128
3	3932.14	17.986	5789	321.87	-0.0845
4	3781.13	17.324	5575	321.80	-0.1071
5	3872.45	17.750	5713	321.86	-0.1201
6	3789.54	17.335	5591	322.52	-0.1183
7	3986.36	18.271	5877	321.67	-0.1111
8	3996.73	18.337	5897	321.60	-0.1261
9	3972.47	18.231	5862	321.53	-0.1278
10	3882.25	17.812	5728	321.58	-0.1222
11	3866.54	17.747	5705	321.46	-0.1223

Long Diversion Parameters: Collected Mass (lbm)	Diversion Time (sec)	Turbine Meter Counts	Turbine Meter Frequency (Hz)
39366.74	179.687	57721	321.23
39392.62	179.630	57760	321.55

Collected mass = 39379.68 lbm
Collection time = 179.6585 sec
Mass flowrate = 219.1919 lbm/sec
Number of iterations = 5

Mean diverter correction = -0.1152 sec.
Estimate of standard error = 0.0040 sec.

Observed Parameter Values

Obs No.	Tare Weight (lbm)	Gross Weight (lbm)	Flow Temp. Deg. C	Air Temp. Deg C
1	372.08	39738.82	30.82	30.67
2	456.77	4297.33	30.87	30.71
3	4297.33	8229.47	30.87	30.71
4	8229.47	12010.60	30.87	30.71
5	12010.60	15883.05	30.87	30.71
6	15883.05	19672.59	30.87	30.71
7	19672.59	23658.95	30.87	30.71
8	23658.95	27655.68	30.87	30.71
9	27655.68	31628.16	30.87	30.71
10	31628.16	35510.41	30.87	30.71
11	35510.41	39376.95	30.87	30.71
12	456.77	39849.39	30.89	30.73

Barometric Pressure = 75.71 cm Hg
Relative Humidity = 33%
Water Density

Table 3. Diverter Correction Values for System 1

System No.	Date\Time	Flow Rate (lbm/sec)	Diverter Correction (sec)	Std. Error (sec)
1	11/25/85-13:43	186.9518	-0.1106	0.0031
1	11/25/85-15:01	219.1919	-0.1152	0.0040
1	11/25/85-15:27	246.7773	-0.1087	0.0035
1	11/25/85-15:52	270.1524	-0.0976	0.0028
1	11/25/85-16:14	301.2940	-0.0959	0.0019
1	11/25/85-16:32	328.2265	-0.0944	0.0042
1	11/26/85-09:31	685.0880	-0.0595	0.0013
1	11/26/85-09:47	678.4531	-0.0580	0.0017
1	11/26/85-10:14	625.9438	-0.0624	0.0013
1	11/26/85-10:29	570.1273	-0.0691	0.0021
1	11/26/85-10:56	519.2268	-0.0720	0.0030
1	11/26/85-11:42	463.8214	-0.0786	0.0029
1	11/26/85-12:04	407.2061	-0.0842	0.0042
1	11/26/85-12:26	353.4898	-0.0880	0.0023
1	11/26/85-13:00	299.7684	-0.0954	0.0029
1	11/26/85-13:19	245.0634	-0.1038	0.0048
1	11/26/85-13:39	190.1348	-0.1175	0.0044
1	11/26/85-14:35	356.7263	-0.0936	0.0033
1	11/26/85-15:00	411.1569	-0.0784	0.0023
1	11/26/85-15:19	465.2753	-0.0750	0.0018
1	11/26/85-15:36	517.8587	-0.0739	0.0016
1	11/26/85-15:52	573.6771	-0.0694	0.0026
1	11/26/85-16:11	628.4513	-0.0667	0.0014
1	11/26/85-16:28	680.1666	-0.0635	0.0018
1	11/29/85-13:51	272.2335	-0.0994	0.0039
1	11/29/85-14:47	273.2980	-0.1037	0.0043
1	11/29/85-15:10	273.3920	-0.1054	0.0037
1	11/29/85-15:33	327.8049	-0.0885	0.0037
1	12/02/85-14:09	274.1538	-0.0989	0.0034

Table 4. Diverter Correction Values for System 2

System No.	Date\Time	Flow Rate (lbm/sec)	Diverter Correction (sec)	Std. Error (sec)
2	11/25/85-11:14	192.4332	0.0274	0.0015
2	11/25/85-11:55	172.5101	0.0292	0.0016
2	11/27/85-08:50	171.1529	0.0272	0.0008
2	11/27/85-09:34	136.4090	0.0297	0.0013
2	11/27/85-10:20	100.6641	0.0336	0.0018
2	11/27/85-10:53	67.5246	0.0345	0.0022
2	11/27/85-11:57	54.8271	0.0289	0.0034
2	11/27/85-14:22	36.5908	0.0194	0.0034
2	11/27/85-15:53	171.7879	0.0297	0.0011
2	11/27/85-16:32	136.1678	0.0272	0.0019
2	04/15/86-22:14	35.9134	0.0262	0.0032
2	04/15/86-22:42	45.6147	0.0285	0.0023

Table 4. Diverter Correction Values for System 2 -- Continued

System No.	Date\Time	Flow Rate (lbm/sec)	Diverter Correction (sec)	Std. Error (sec)
2	04/15/86-23:02	55.7667	0.0265	0.0015
2	04/15/86-23:23	63.8362	0.0253	0.0025
2	04/15/86-23:43	74.0715	0.0262	0.0019
2	04/15/86-01:33	110.3024	0.0259	0.0014
2	04/15/86-01:55	128.9345	0.0231	0.0013
2	04/15/86-03:21	146.5766	0.0219	0.0006
2	04/15/86-04:18	165.6850	0.0218	0.0011
2	04/15/86-04:54	53.3422	0.0260	0.0027
2	04/15/86-05:14	36.4864	0.0258	0.0033
2	04/15/86-05:32	73.1850	0.0251	0.0021

Table 5. Diverter Correction Values for System 3

System No.	Date\Time	Flow Rate (lbm/sec)	Diverter Correction (sec)	Std. Error (sec)
3	04/16/85-11:49	7.9051	-0.0044	0.0020
3	04/16/85-12:16	8.9890	-0.0030	0.0016
3	04/16/85-12:40	8.9768	-0.0047	0.0015
3	04/16/85-13:01	10.3343	-0.0039	0.0011
3	04/16/85-13:20	10.3402	-0.0043	0.0011
3	04/16/85-13:37	5.7960	-0.0081	0.0019
3	04/16/85-14:04	5.1774	-0.0030	0.0024
3	07/22/85-08:55	49.3029	-0.0014	0.0030
3	07/22/85-09:15	36.7209	-0.0175	0.0037
3	07/22/85-09:37	36.7364	-0.0190	0.0054
3	07/22/85-09:57	25.6210	-0.0139	0.0018
3	07/22/85-10:13	14.8649	-0.0228	0.0032
3	07/22/85-11:14	15.0275	-0.0194	0.0051
3	07/23/85-15:50	4.0684	-0.0085	0.0036
3	07/24/85-08:14	49.5016	-0.0234	0.0075
3	11/29/85-10:28	18.2016	-0.0292	0.0079
3	11/29/85-10:48	36.7179	-0.0145	0.0011
3	11/29/85-11:08	55.0695	-0.0144	0.0006
3	11/29/85-11:44	18.2981	-0.0241	0.0058

Table 6. Diverter Correction Values for System 4

System No.	Date\Time	Flow Rate (lbm/sec)	Diverter Correction (sec)	Std. Error (sec)
4	04/15/85-16:08	1.4913	-0.0270	0.0119
4	04/15/85-16:31	2.6062	-0.0051	0.0060
4	04/15/85-17:02	3.7676	-0.0110	0.0036
4	04/15/85-17:17	5.2978	-0.0093	0.0015
4	04/15/85-17:35	6.0342	-0.0066	0.0011

Table 6. Diverter Correction Values for System 4 -- Continued

System No.	Date\Time	Flow Rate (lbm/sec)	Diverter Correction (sec)	Std. Error (sec)
4	04/15/85-17:51	1.5482	-0.0191	0.0041
4	04/15/85-18:10	5.1259	-0.0056	0.0019
4	04/15/85-18:22	5.9767	-0.0041	0.0008
4	04/15/85-18:32	3.6967	-0.0117	0.0017
4	04/15/85-18:43	2.6380	-0.0132	0.0019
4	04/25/85-09:16	1.6632	-0.0159	0.0046
4	04/25/85-09:37	1.6748	-0.0131	0.0030
4	04/25/85-10:14	1.3606	-0.0131	0.0061
4	04/25/85-11:42	1.1159	-0.0118	0.0047
4	04/25/85-12:09	0.9225	-0.0117	0.0070
4	04/25/85-12:43	0.7000	-0.0366	0.0204
4	04/25/85-13:23	0.4651	-0.0154	0.0108
4	07/24/85-00:05	1.6630	-0.0031	0.0031
4	07/24/85-00:22	1.3893	0.0007	0.0046
4	07/24/85-00:43	1.0771	0.0002	0.0069
4	07/24/85-01:06	0.9526	0.0001	0.0049
4	07/24/85-01:32	0.6874	-0.0011	0.0101
4	07/24/85-02:06	0.4638	-0.0084	0.0097
4	07/24/85-03:26	0.2356	-0.0044	0.0222

Table 7. Diverter Correction Interpolation Function Coefficients

System	Y_o (sec)	Y_1 (sec^2/lbm)	Y_2 (sec^3/lbm^2)	Residual Std. Dev. (sec)
1	-0.1529	2.26229×10^{-4}	-1.34741×10^{-7}	0.0030
2	0.0268			0.0035
3	-0.0126			0.0087
4	-0.0103			0.0087

a. Measurement of the Mass of Water Collected

Once the water has been collected in the weigh tank and the transients associated with filling it have ceased (indicated by the scale indicator through its scale motion index), successive observations of the scale indication are made by the data acquisition system, averaged, and the average value is stored in the data base. The scale indicator was adjusted internally to indicate directly in mass value based on a stainless steel mass scale of density of 8.0 g/cm^3 [7] for three of the four weighing platforms. These were system 2 (10,000-pound capacity), system 3 (2,000-pound capacity), and system 4 (400-pound capacity). This adjustment to the indicator was possible because these scales could be loaded to near their capacity with a known mass standard. However, this could not be done on system 1 (50,000-pound capacity). A calibration function was necessary, and was developed using the scale calibration procedures described below.

The observed mass of water in a weigh tank is an apparent mass value. The true or vacuum mass value is computed by accounting for the buoyant effect of the atmosphere upon the water. In the case of water, with a nominal density of 1 g/cm^3, immersed in air, having a nominal density of 0.0011 g/cm^3, the effect of air buoyancy on the true mass value of water has a relative magnitude of approximately 1 part in 1000. The buoyancy effect acts to decrease the mass value observed by a weighing device since the buoyant force of the atmosphere is oppositely directed to that of the force of gravity. Therefore, the apparent mass of water is the difference in the observed mass with the tank empty and filled. The relationship between the apparent mass value and the true mass value is the following:

$$M_t = M_{app}/(1 - \rho_a/\rho_w), \tag{6}$$

where M_t = true mass value,

M_{app} = apparent mass value,

ρ_a = density of the atmosphere, and

ρ_w = density of the water.

b. Scale Calibration Procedures and Mass Standards

Calibration of the weighing scales used a sequential, incremental loading method based on working mass standards calibrated at NBS. These working mass standards were calibrated using primary mass standards at the 50- and 500-pound level. Two sets of working mass standards were used for calibration and for checking of the operation of the weighing scales. For all systems other than system 4 the calibration procedures required the use of partial fills of each scale's weigh tank with water to calibrate the full-use capacity of the scale. In the case of system 4 (400- to 600-pound capacity) a sufficient number of mass standards were available to complete the calibration without partial water fills. The sequential, incremental method of scale calibration utilizes the following operations:

1. Close the drain valve of the weigh tank and record the scale indication.

2. Place the desired mass standard(s) on the scale and record the scale indication.

3. Repeat step 2 until the scale capacity has been reached or all of the mass standards have been used.

4. For systems 1, 2, and 3 remove the mass standards from the scale and fill the tank until the scale indicator value is identical to that obtained in the last iteration of steps 2 and 3. Care must be exercised to match the value indicated when loaded with the mass standards. Small additions or removal of water may be necessary to achieve this. The weigh tanks of systems 1 and 3 were fitted with small drain valves for this purpose. System 2

had easy access from the top of the weigh tank for addition or removal of small amounts of water.

5. For system 4 only steps 2 and 3 were used. Additionally, after reaching scale capacity the mass standards were removed sequentially and the indication recorded.

Scale calibration procedures were performed at various times during the data collection phase of the project. The performance of systems 2 through 4 was such that the difference between the indicated mass value and the true mass value of the standards was at most one unit of the indicator. Checking of the scale performance was done each day of data collection by placing a stack of the working mass standards on the scale in use. The mass value indicated was stored in the data base. The difference between the mass standard's mass value and the indicated value was rarely greater than one indication unit.

Calibration Equation for System 1

As discussed above, the near equality between the indicated and actual mass values achieved by the other scales was not the case for system 1, since the scale could not be loaded with a standard of mass 40,000 to 50,000 pounds. Therefore, the indicator input channel for this scale was installed without second order response compensation as was the case for the other scales. Coefficient values for a quadratic equation were obtained using the least squares method from scale calibration data. This relation is given below:

$$M = -0.693 + 0.9957774\ I + 7.86096 \times 10^{-8}\ I^2$$

where M = mass value, and
I = scale indication.

The residual standard deviation for the fit is 2.36 pounds. Three times this value, 7.08 pounds, is taken as the uncertainty in the mass value determination.

50-Pound Working Mass Standards

Two sets of mass standards were used for the scale calibration procedures. A set of 12 cast iron, 50-pound weights were refurbished, given numerical designations, and calibrated against the NBS primary 50-pound mass standards using comparative methods. The mass values assigned to these working mass standards are listed in table 8.

The comparative precision attained in the assignment of the mass values to these weights is less than 0.0001 pounds. The uncertainty in the primary mass standards is approximately 0.000005 pounds. Therefore, the total uncertainty of the mass value assigned to one of these weights is less than 0.0001 pounds. The uncertainty in the mass values of the weights may be taken as the sum of these two uncertainties, or 0.000105 pounds for each weight.

Table 8. 50-Pound Working Standard Mass Values

Weight Number	True Mass Value (lb)	Weight Number	True Mass Value (lb)
1	49.949	7	49.979
2	50.000	8	49.941
3	49.997	9	49.994
4	49.965	10	49.995
5	49.995	11	50.001
6	50.005	12	49.946

Mass Value of the 12 Weight Summation = 599.767 pounds.
Uncertainty in the Mass Value = 0.0012 pounds

For scale calibration purposes the uncertainty of interest is the total uncertainty of the weights on the scale. An estimate of the maximum uncertainty of the mass standards used for scale calibration is obtained for the 600-pound summation of all 12 weights which would have an uncertainty of 0.0012 pounds at most. These working standards were used for calibration of the scales in systems 2, 3, and 4. The uncertainty value of 0.0012 pounds is at least 10 times smaller than the sensitivity of the smallest scale used, system 4 with a sensitivity of 0.02 pounds. Therefore, the contribution of the mass standards to the uncertainty of the calibration procedure is not detectable by the scale and is negligible in its effect on scale calibration.

<u>500-Pound Working Mass Standards and Actuator System</u>

A set of working standards each near the 500-pound level were used for calibration of the 50,000-pound scale of system 1. Nine of these stainless steel weights were incorporated into a hydraulically actuated loading system permanently attached to the bottom of the scale's weigh tank. The suspension arrangement is shown diagrammatically in figure 4. The system consists of three stacks of three weights each placed symmetrically around the frame of the scale. The hydraulic actuators and the weight hangers become a permanent load on the scale and are attached to the weigh tank bottom. The weight hangers are suspended so that, with the actuators fully extended, the weight stacks rest fully on their floor support and the hangers swing freely. Loading of the weights onto the scale is accomplished by retracting the actuators with the hydraulic pump mounted to the weigh tank. Mounting of the pump, actuators, weight hangers and interconnecting hoses to the weigh tank, allows only the mass standards to be loaded and unloaded onto the scale. In this way the movement of hydraulic fluid between the pump and actuators does not constitute an unknown and variable, additional load on the scale during calibration procedures.

The nine stainless steel working standards were assigned mass values using the same double substitution weighing procedures employed in the mass value assignment of the 50-pound working standards. Four sets of observations were performed on each weight over a period of several days. The comparative device used was a 2,500-pound platform scale with a mechanical dial indicator having scale graduations of 0.2 pounds.

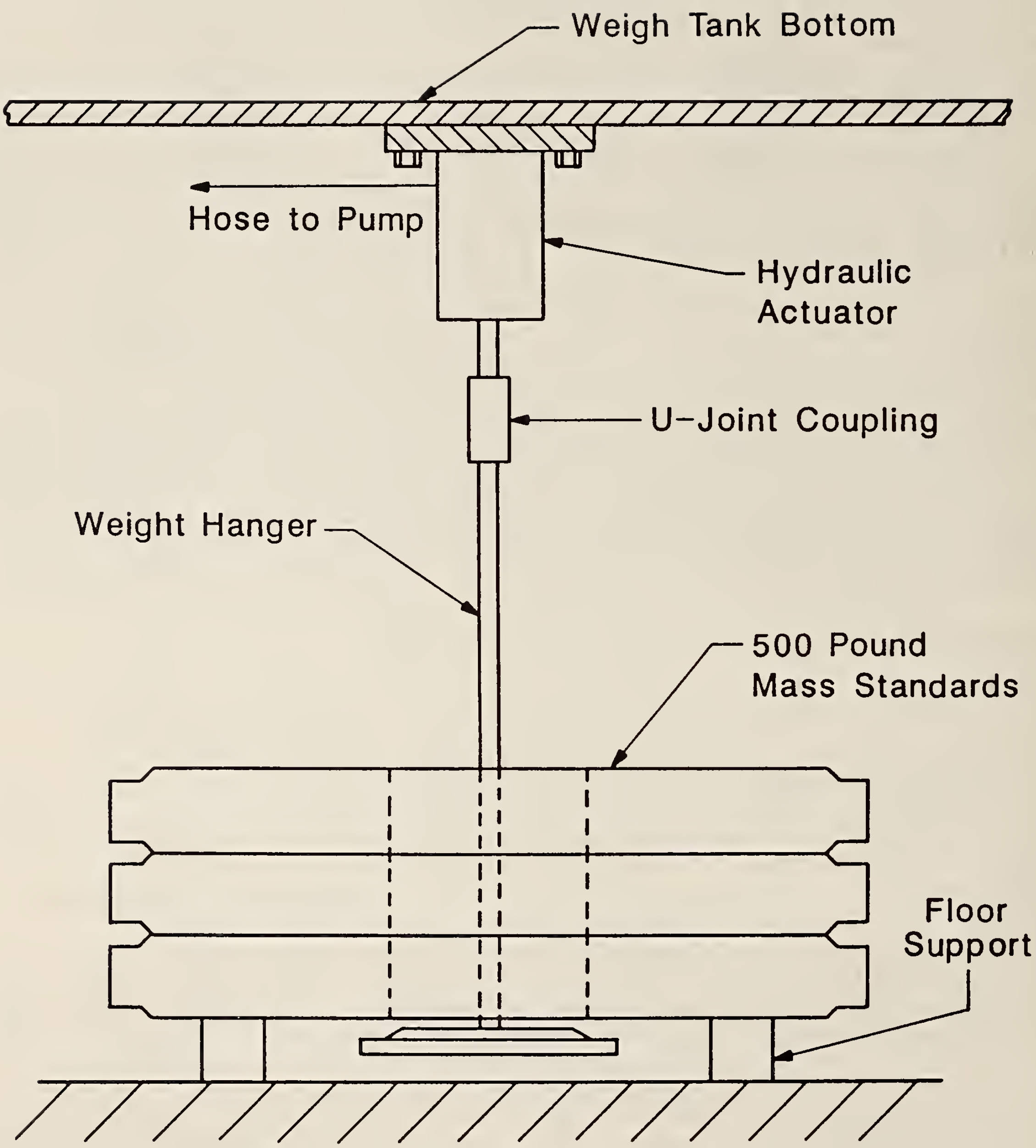


Figure 4. Hydraulic Mass Standard Loading Mechanism for 50,000-Pound Scale Calibration

This scale was selected because these mass standards were to be used for calibration and checking of the 50,000-pound scale which had an indication sensitivity of 5.0 pounds. It was desired to have a cumulative uncertainty in the nine weight summation no greater than approximately one half of the indication sensitivity. The mass values assigned to these nine weights are listed in table 9 with the comparative precision of each assignment procedure, which is three standard deviations of the mean value. The uncertainty in the 500-pound standards used in these mass value assignment procedures is 0.01 pounds.

Table 9. 500-pound Working Standard Mass Values

Weight Desig.	Mass Value (lb)	Precision (lb)	Weight Desig.	Mass Value (lb)	Precision (lb)
16515	487.739	0.108	165165	489.298	0.056
165142	487.002	0.086	165173	487.843	0.192
165150	489.146	0.173	165174	489.230	0.074
165151	487.632	0.197	165176	487.814	0.105
165155	489.350	0.152			

Mass Value of the Nine Weight Summation = 4,395.06 pounds
Uncertainty in the Mass Value = 0.44 pounds

The uncertainty in the mass value of the summation of weights is the root sum of squares of the precisions of the individual masses.

c. Uncertainty in the True Mass Value of Water Collected

The analysis of uncertainty in the measured mass value of water is based upon eq (6). The elements contributing to the uncertainty of the observed true mass value are the observed mass value of the water collected and the density values of the atmosphere and water, which account for the buoyant effect of the atmosphere in the weighing process.

Uncertainty in the Observed Mass Value

The uncertainty in the observed mass value is composed of (1) the uncertainty in the scale indication itself and (2) the uncertainty in the mass standards used in the scale calibration procedures. For this project the objective of assignment procedures for the working mass standards was to obtain a total uncertainty in the assigned mass value substantially below the minimum indication sensitivity of the scales.

The variation in the indication of the mass value of each scale is modelled as a random process for these scales, which were sensitivity-limited, and, therefore, contributed finite levels of uncertainty to the measurement process. The uncertainty assigned to the indication alone is taken as the square root of 2 times the indication sensitivity based on the following assumption. For a fixed mass on the scale, its mass value has an equally probable chance of lying above or below the position within a particular indication interval at which the indication is forced to the next interval, and is treated as a random effect. This digitization effect accounts for a substantial portion of the total mass measurement uncertainty in the case of systems 2 through 4 since these scales were shown to be direct reading to a high degree. For the scale of system 1 the fitting procedure used to obtain the scale calibration equation's coefficients gives the indication uncertainty. The indication uncertainty for this scale is taken as three times the residual standard deviation to the fit. This value (3 x 2.36 pounds or 7.08 pounds) also equals the scale resolution multiplied by the square root of 2. It appears that this scale is also resolution limited. Additionally, one can conclude that the addition of water to the tank necessary to incrementally load the scale to capacity during the calibration procedure introduces an undetectable level of variability into the calibration process. Otherwise the $\sqrt{2}$ multiplied by the indication sensitivity would be less than three standard deviations of the scale calibration fit.

The absolute uncertainty in the observed mass due to uncertainty in the calibrating mass standards is dependent upon the magnitude of the load, the calibration method, and the uncertainty in the summation of mass standards used in calibration. The mass used to load a scale during calibration may be termed a virtual mass standard, which is composed of the summations of the mass standards discussed above combined with an appropriate amount of water. The need for the concept of a virtual mass standard arises from the lack of mass standards of sufficient size to fully load the scales with mass standards only. The virtual mass standard is considered to be composed of an integral number of summations of the actual mass standard used. As described above in the calibration procedures, this weight summation is applied to the scale incrementally combined with a sufficient amount of water. Therefore, the uncertainty in this mass value will be the uncertainty in the actual standard weight summation, s_w, multiplied by the number of steps necessary to achieve the desired level of scale load. For example, using the large summation listed in table 9 with scale 1, 10 summations yields a load of 43,950.5 pounds. The uncertainty in that value is 2.8 pounds, i.e., 10 times the uncertainty in the mass standards themselves.

Of course, when the scale is used, integer multiples of the standard mass involved in calibration are rarely encountered. Therefore, the multiplier necessary to calculate the absolute uncertainty, s_{ma}, in the observed mass value, M, due to the calibrating weights is the ratio of the observed water mass to the mass value of the calibrating weight summation mass, M_s, i.e., 4,395.05 pounds for scale system 1 and 599.77 pounds for scale systems 2 and 3, as shown below:

$$s_{ma} = s_w * (M/M_s) .$$

To facilitate the combination of the various uncertainty components in subsequent discussions, each will be expressed as a relative value. Therefore, the relative uncertainty in the observed mass of water becomes

$$s_{ma}/M = s_w/M_s .$$

Relative uncertainties in the observed mass values are tabulated in table 10. Typical values of observed mass are used for each scale system. The relative uncertainty in the mass value due to the scale indication and to the mass standards are computed using the observed masses (load) and indicator uncertainty, and the mass values of the standards and their respective uncertainties.

Table 10. Uncertainty in the Observed Mass Value of Water

System No.	Load (lb)	Indicator Sens. (lb)	Indicator Uncer. (lb)	Indicator Rel. Uncer. (%)	Mass Std. Rel. Uncer. (%)	Total Rel. Uncer. (%)
1	40,000	5.0	7.08	0.018	0.008	0.026
2	5,500	0.5	0.71	0.013	0.0002	0.013
3	1,800	0.1	0.14	0.008	0.0002	0.008
4	350	0.02	0.03	0.008	0.0002	0.008

Calculation of the Density of the Atmosphere and Its Uncertainty

The uncertainty in the buoyant effect of the atmosphere is dependent upon that of the air and water density values. Due to the magnitude of the ratio of the air density to the water density, the effect on the total uncertainty of the weighing process may be made acceptably small for the requirements of this work with only modest efforts in the determination of the individual values of the two. The atmospheric parameters of barometric pressure, air temperature, and relative humidity were measured for calculation of the density of air. The density of air was calculated using the relation developed by Jones [8], see eq (7) below. Temperature of the water in the collection tanks was also measured.

Calculation of the air density values was made using Jones' formula which is given below.

$$\rho_a = \frac{P m_a}{R T_a Z} \left\{ 1 - \left(1 - \frac{m_w}{m_a}\right) \frac{RH}{100} \frac{f_e P_s}{P} \right\}, \tag{7}$$

where ρ_a = density of air (kg/m^3),

P = barometric pressure (pascals),

Z = compressibility factor for air,

T_a = absolute air temperature (Kelvin),

RH = relative humidity (%),

P_s = saturation vapor pressure of water (pascals),

R = molar gas constant (8315.31 J/(K-kmole)),

m_a = 28.963 g/mole = molecular weight of air,

m_w = 18.0152 g/mole = molecular weight of water, and

f_e = enhancement factor.

The saturation vapor pressure is calculated from the following relation:

$$P_s = 1.7526 \times 10^{11} \exp\,(-5315.56/T_a).$$

The enhancement factor is calculated from the following relation:

$$f_e = 1.000 + 3.113 \times 10^{-8} P + 5.4 \times 10^{-7} T_a^2$$

The primary contributors to day-to-day uncertainty in the calculated air density value are the measured values of temperature, pressure, and relative humidity. The uncertainty in the air density value due to uncertainties in the molecular weights of water and air, the enhancement factor, and saturation vapor pressure of water, are thoroughly discussed by Jones and combined contribute less than 0.05% to uncertainty in the air density value.

Barometric pressure measurements were made using an aneroid barometer which was kept in the flow laboratory during the course of the experiment. This barometer was checked against an NBS transfer standard periodically and found to differ from the transfer standard by no more than 0.2 millimeters of mercury, or approximately 0.03% of the barometric pressure.

Air temperature measurement in the flow laboratory was made with a thermistor. This measurement and its uncertainty is discussed in more detail in part E of this section. Due to the very local nature of this measurement, the uncertainty of the measurement is estimated to be one degree Celsius. This value is considerably larger than that estimated from its calibration, and has been increased to include the effects of temperature gradients within the laboratory. This estimate corresponds to a relative uncertainty in the air density value of 0.3%.

Measurement of the relative humidity of the air in the flow laboratory was made with a hygrometer for which the estimated uncertainty was 5% relative humidity. The table below provides a means to estimate the effect of this uncertainty level. The density of air has been computed using eq (7) for both the wet and dry gas cases. The saturated gas case is given in the table and the percentage difference in the density calculated for the wet and dry gas case is listed for each relative humidity level. Inspection of the table for the relative humidity range from 30 to 50% shows that an error no greater than 0.1% in the air density value may result from an error in the relative humidity measurement of 5% RH.

Air Density Values at 1 Atmosphere (760 mm of Mercury) and 20 °C, Over the Range of Relative Humidity Values 0 to 100%, Showing the Effects of Neglecting Humidity in the Calculation

Relative Humidity (%)	Air Density (g/cm^3)	Difference (%)	Relative Humidity (%)	Air Density (g/cm^3)	Difference (%)
0	0.0012045	0.00			
10	0.0012034	-0.09	60	0.0011982	-0.53
20	0.0012024	-0.17	70	0.0011971	-0.62
30	0.0012013	-0.27	80	0.0011961	-0.70
40	0.0012003	-0.35	90	0.0011951	-0.79
50	0.0011992	-0.44	100	0.0011940	-0.88

The compressibility factor, Z, is dependent upon the barometric pressure and temperature and slightly dependent upon the CO_2 content of the air. Its value ranges from 0.9995 to 0.9998 for the ranges of pressure and temperature encountered in this work. The levels of uncertainty for the temperature and pressure discussed above are sufficiently small that uncertainty in the air density value due to uncertainty in the compressibility value may be neglected.

The pressure, temperature, relative humidity, and gas molecular weight error contributions are considered to be systematic in nature and are, therefore, combined additively. The summation of these is no larger than 0.5% in the air density value.

Uncertainty in the Value of the Density of Water

Calculation of the density of water uses the measured temperature of the water in the weigh tank to compute the density of water using the relation of Kell [9]. A discussion of this method is given later in part E of this section of this report and in Appendix B. The uncertainty in the value of the water density calculated from the observed temperature, including effects of dissolved minerals in the flowing water, is no greater than 0.02%.

Uncertainty in the Buoyancy Correction

The uncertainty in the buoyancy correction applied to the observed mass of water arises from uncertainties in the density of the air and the water. The relative uncertainty in the water density is given above as 0.02%, and that for the air density is 0.5%. Substituting eq (6) into eq (2) and taking the partial derivatives of eq (6) with respect to the density of the water, ρ_w, and of air, ρ_a, and dividing these by the resultant expression for mass flow rate, gives the following expressions. These expressions give the relative uncertainty values in the mass flow rate due to uncertainty in the buoyancy correction term of eq (6). Substitution of a nominal value for the density of air (0.00117 g/cm^3) and of water (1.0 g/cm^3) gives values for the relative magnitudes of these effects.

$$\frac{1}{\dot{m}}\frac{\partial \dot{m}}{\partial \rho_a} = \frac{1}{\rho_w - \rho_a} \quad ; \quad \frac{\Delta \dot{m}}{\dot{m}} = \frac{\rho_a}{\rho_w - \rho_a}\frac{\Delta \rho_a}{\rho_a}$$

$$\frac{1}{\dot{m}}\frac{\partial \dot{m}}{\partial \rho_w} = \left[\frac{-\rho_a}{\rho_w - \rho_a}\right]\frac{1}{\rho_w} \quad ; \quad \frac{\Delta \dot{m}}{\dot{m}} = \frac{\rho_a}{\rho_w - \rho_a}\frac{\Delta \rho_w}{\rho_w}$$

Water Density Contribution = 2.34×10^{-7}

Air Density Contribution = 5.8×10^{-6}

The magnitude of these effects combined additively or in quadrature are much less than the contribution of any of the other parameters affecting the determination of the true mass of water collected. The magnitudes given above will be combined additively to give a total relative uncertainty in the buoyancy correction for the mass of water as 6×10^{-6}, 6 parts per million (ppm) or 0.0006%.

The atmospheric parameters, i.e., barometric pressure, air temperature, relative humidity, may vary during an experimental run and there may be variable gradients within the laboratory. Thus the buoyancy correction may not correct precisely for their effects, and the atmospheric effects contribute to the random variations that are observed in differences between repeated runs.

5. Mass Flow Rate Measurement Uncertainty

The complete expression for the mass flow rate may be written

$$\dot{m} = M/[(1 - \rho_a/\rho_w)(t + \tau)]. \tag{8}$$

The uncertainty in the mass flow rate, $s_{\dot{m}}$, is the combination of uncertainties in its independent variables which will be represented in relative terms. Random and systematic uncertainties will be combined in quadrature and additively, respectively. Each of the contributing parameters in eq (8) has been discussed in preceding sections and is tabulated in the following table.

Summary of Mass Flow Rate Uncertainty Components

Contributing Variable	Random Component	Systematic Component
Observed Apparent Mass	s_I/M_t	s_w/M_s
Diversion Time		s_t/t
Diverter Correction	s_τ/t	
Buoyancy Correction	6 ppm	

With this separation of error components into random and systematic parts, the following expression may be written as the relative uncertainty in the observed mass flow rate.

$$\frac{s_{\dot{m}}}{\dot{m}} = [\,(s_I/M_t)^2 + (s_\tau/t)^2 + (6\ \text{ppm})^2\,]^{1/2} + \frac{s_w}{M_s} + \frac{s_t}{t} \tag{9}$$

where s_I = indication uncertainty, see table 10,

s_w = uncertainty in the mass standards, see table 10,

s_t = uncertainty in the diversion time measurement, taken as 0.0001 sec,

s_τ = uncertainty in the diverter valve correction, see table 7, three residual standard deviations are used for the value of s_τ,

M_t = total mass of water collected, and

M_s = mass of the standards used in calibrating the scale.

Substitution of numerical values for each term gives the following table for the measurement uncertainty of the NBS water mass flow rate measurement system. Each weighing system is treated individually with 30-, 90-, and 200-second diversion times used to give an estimate of the range of uncertainty values.

Table 11. Measurement Uncertainty of the NBS Water Flow Rate Measurement Facility[a]

Sys.	Collected Mass (lb)	Diversion Time (sec)	Random Uncertainty (lb)	Systematic Uncertainty (lb)	Total Uncertainty (lb)
1	41,700[b]	30	0.020	0.010	0.030
	50,000	90	0.015	0.010	0.025
	50,000	200	0.014	0.010	0.024
2	5,800[b]	30	0.017	0.0005	0.017
	6,000	90	0.012	0.0003	0.013
	6,000	200	0.012	0.0002	0.012
3	1,650[b]	30	0.030	0.0005	0.031
	2,000	90	0.012	0.0003	0.012
	2,000	200	0.008	0.0002	0.008
4	165[b]	30	0.034	0.0006	0.035
	400	90	0.012	0.0004	0.013
	400	200	0.009	0.0004	0.009

[a] Random variations due to unknown effects contribute indirectly as differences between repeated runs, e.g., the correction for atmospheric variations may not be precisely reflected by the buoyancy correction value. Also, the effective collection time is more variable than the measurement of time. The diverter correction provides only for an average diversion time. These contributions to uncertainty cannot be estimated separately, but are included in the final statistical analysis of observed discharge coefficients.

[b] Maximum collected mass at the highest flow rate for this system

D. Differential Pressure Measurements Systems and Standards

1. Differential Pressure Measurement Requirements

Measurement of the differential pressure at the orifice meter taps was one of the primary measurements made during this project. The criteria used in selecting the methods to be used for this measurement were:

(1) The method must significantly reduce or eliminate the need for manual transcription of data, and therefore, the error rate associated with it, and be compatible with the automated data acquisition and storage techniques.

(2) The method must incorporate working standards of pressure for in-situ calibration of differential pressure measurement devices.

(3) The method must be capable of an accuracy consistent with the capability to measure the mass flow rate of water passing through the orifice meter, or as best as can be achieved with state-of-the-art instrumentation.

(4) The transduction devices must have the capability to maintain this accuracy level between successive pressure calibrations.

2. Differential Pressure Transducers

Reduction of human error in the differential pressure measurement system required replacement of the traditional flow laboratory differential pressure measurement devices, i.e., water and mercury manometers, and substitution of differential pressure transducers. These provided compatibility with electronic data acquisition and storage technology. In order to reduce the calibration interval of the transducers, and satisfy requirement 3, high quality, laboratory type transducers were used. These transducers were selected for their sensitivity and stability of performance. Two types of transducers were used. Both utilized quartz as the pressure-sensing material which gives excellent stability and reproducibility in pressure measurements when applied properly. Pressure-sensitive electronic quartz oscillator-type transducers were connected to both the upper and lower pressure taps of the orifice meter. A quartz bourdon tube instrument was connected in parallel at the upper taps with the oscillator-type transducer. The quartz bourdon tube transducer was a Ruska DDR-6000 [3], and the quartz oscillator-type transducers were manufactured by Paros Scientific [3].

The maximum working, differential pressure of the transducers was approximately 28 psid (800 inches of water, 193 kilopascals). The quartz bourdon tube transducer utilizes a force balance servo technique and is capable of 100% overrange without damage. Due to this overranging capability, the range of this transducer is selected to be 28 psid. The quartz oscillator-type of transducers were capable of a 20% overrange without damage. To minimize the possibility of damage to these transducers the range was selected to be 40 psid. Both types of transducers were used over the range of 28 psid in the flow testing procedures.

In the initial stages of the project a second set of quartz oscillator type transducers were acquired and used, which had a range of 12 psid. These devices were destroyed due to overranging and were not used for the final data collection phase of the project.

3. Pressure Transducer Mounting and Fluid Isolation Interfaces

The differential pressure measurement system manifold is shown schematically in figure 5. Three transducers and two deadweight testers were incorporated in the final system. The two pneumatic deadweight testers were the working standards of pressure for the measurement system, and were used to calibrate the transducers used for measurement of differential pressure developed across the orifice meter.

Two mechanical gauges were incorporated in the system for operational purposes. The differential pressure gauge (marked ΔP gauge on the schematic in fig. 5) was used for gross setting of the flow rate values during flow testing, and a mechanical bourdon tube pressure gauge was used to maintain the back pressure at the downstream side of the orifice meter near 41-psig. This was done to eliminate the possibility of cavitation around the orifice itself. Previous experience at NBS had indicated that in the case of turbine flow meters, cavitation at the tips of the turbine blades causes erratic behavior of the turbine. Therefore, as a precaution, a relatively high and fixed backpressure was used throughout the tests performed in this project. The pumping system had the capability to produce a maximum of 90 to 100 psig. Therefore, a 41-psig pressure maintained at the downstream orifice tap was sufficiently low to attain the highest differential pressures planned for the flow testing, and still suppress cavitation around the orifice.

Each of the differential pressure transducers was filled with silicone oil to protect its sensing region from the corrosive effects of water. As a result considerable complexity was added to the connection manifold as is indicated in figure 5. Each transducer had to be connected both to the deadweight testers for calibration, requiring an oil to gas interface, and to the appropriate orifice meter taps, requiring an oil to water interface, for differential pressure measurement. As is shown in figure 5 each transducer was connected to the rest of the pressure transducer manifold through a five-valve manifold and a set of sight glasses in which the interfaces were contained. Detailed schematic diagrams of these manifolds are shown in figures 6 and 7 for the two types of transducers. The five-valve manifold allowed the transducer to be connected to pressures developed in either of the other two working fluids, and the transducer's test and reference pressure ports to be connected together, i.e., crossed over, to produce a zero differential pressure condition at the transducer. An oil reservoir was placed in one side of the five-valve manifold/piping connections to each transducer.

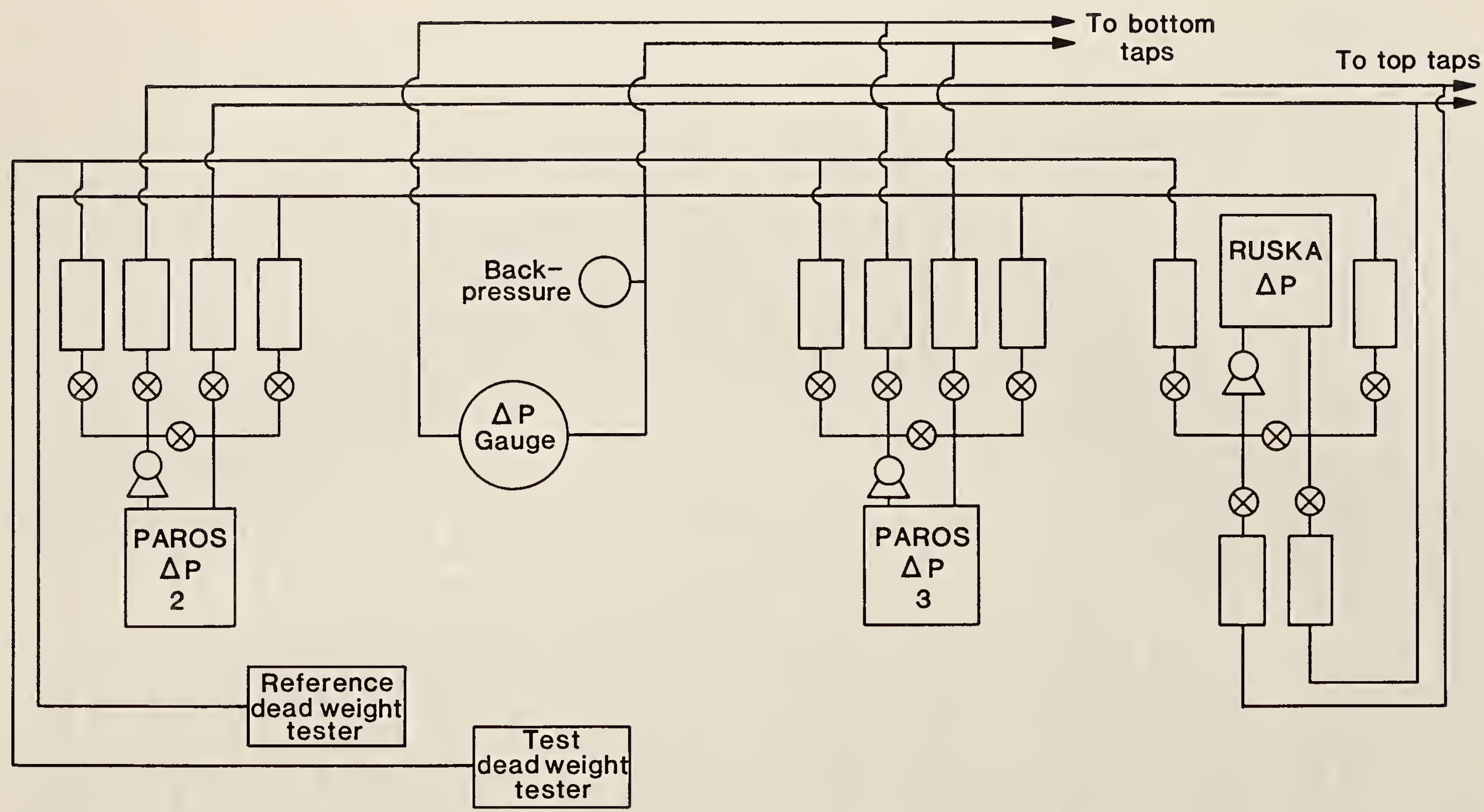


Figure 5. Differential Pressure Transducer Manifold Schematic Diagram

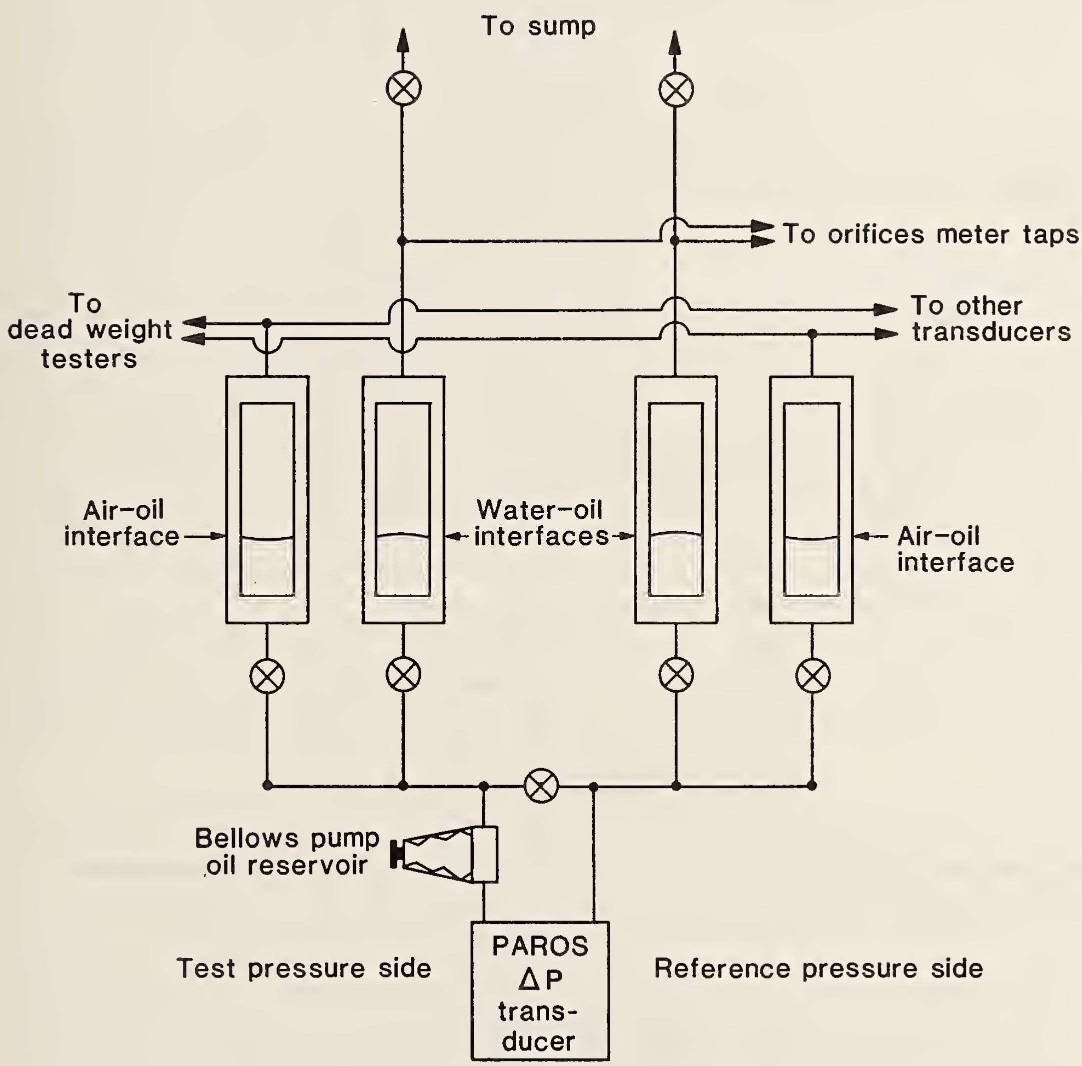


Figure 6. Schematic Diagram of Interface Sightglasses and Five-Valve Manifold for the Paros-Type Transducers

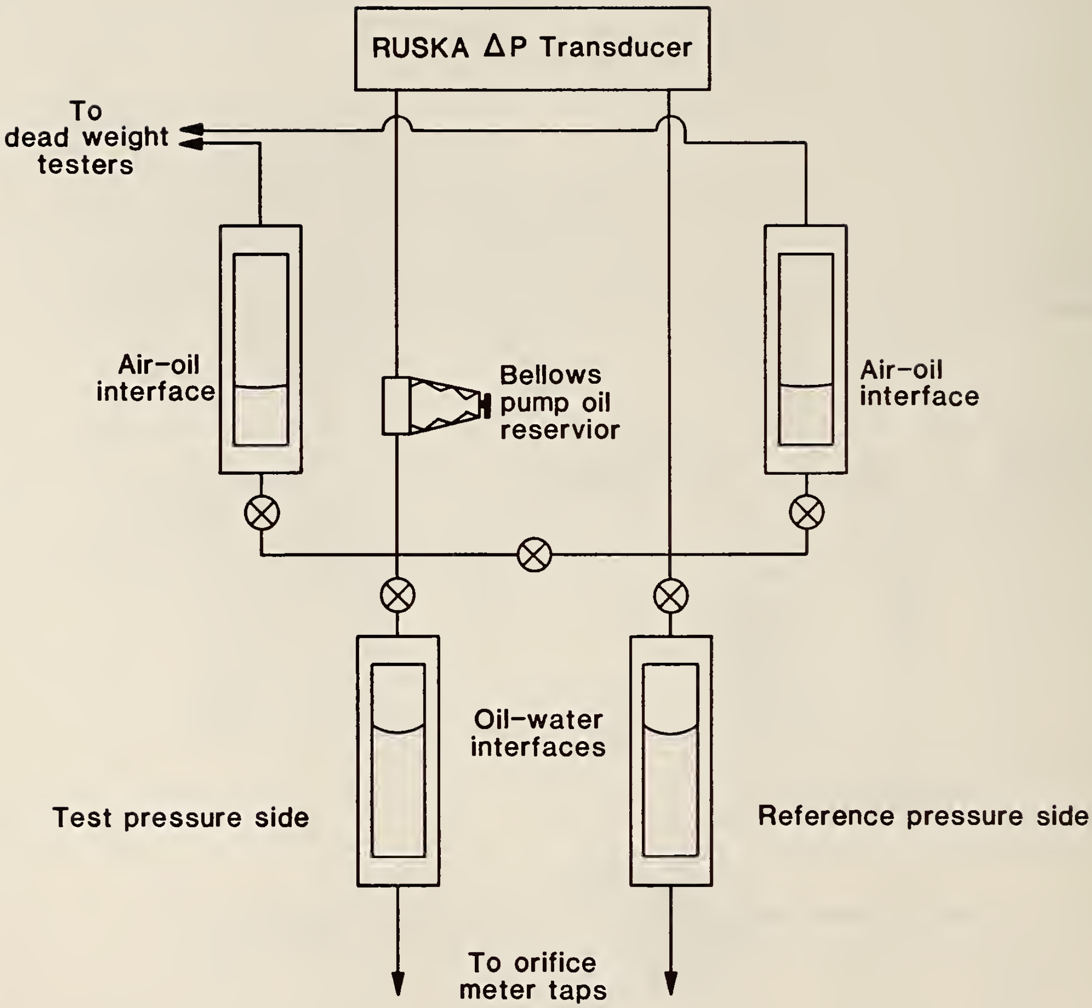


Figure 7. Schematic Diagram of Interface Sightglasses and Five-Valve Manifold for the Ruska Transducer

This reservoir is composed of a screw-driven bellows having a capacity of several cubic centimeters. Use of the reservoir with appropriate setting of the manifold valves allowed oil to be moved around the manifold/sightglass circuit to equalize the meniscuses in the two sets of sightglasses of each transducer. Two arrangements of this type of manifold were necessary to accommodate silicone oils of differing density. The silicone oil filling the Ruska transducer had a density less than water while that filling the Paros transducers had a density greater than that of water. Therefore, the requirements of stable oil/water menisci for the two required somewhat different physical arrangements for the sightglass pairs.

The presence of these interfaces provides for the possibility of the continuous introduction of systematic errors into the pressure measurement system through imbalance in the heights of columns of liquids of differing density on the two pressure ports of a transducer. Such an error could occur either during transducer calibration procedures or during orifice meter differential pressure measurements. To minimize or reduce such an effect, a method was necessary to provide a stable and reproducible horizontal reference plane relative to which each pair of menisci could be compared and equalized. A specially designed rack was built to mount the differential pressure transducers incorporating a telemicroscope mounted on a travelling carriage to provide the horizontal reference plane necessary to determine and set the heights of each pair of menisci. The carriage was mounted via ball bushings on two precision-ground rods rigidly attached to the rack. Screw adjustments of the rack allowed the rods to be maintained in a horizontal plane with sufficient accuracy to make negligible the cosine errors in the heights of the interfaces due to the separation of the two sightglasses forming a set. These separations were approximately 3 inches (7.5 cm) for the oil/water set and 6 inches (15 cm) for the oil/air set. The transducer rack with the telemicroscope carriage is shown in the photograph of figure 8. Precision machinists levels were used to maintain the plate carrying the ball bushings in the horizontal plane.

Balancing the height of a set of menisci for a transducer was achieved by adjusting the telemicroscope until its horizontal reticle was coincident with the bottom of the meniscus of the transducer's reference port. The telemicroscope's carriage was then moved until the meniscus of the transducer's test port was in the telemicroscope's field of view. Adjustment of the meniscus height to the telemicroscope's horizontal reticle reference was made with the bellows pump. These balancing procedures were used during both orifice meter testing and during transducer calibration. The telemicroscope was used frequently to monitor the positions of the interfaces during measurement operations.

The tubing used to construct the transducer manifold was nominal 3/8-inch-diameter polyethylene tubing compatible with compression fittings. As shown in figure 6, each side of the manifold could be bled through two valves located above the manifold. This allowed elimination of air bubbles in the manifold. Not shown were two 1/2-inch-diameter ball valves located at the ends of the tubing connecting the manifold to the

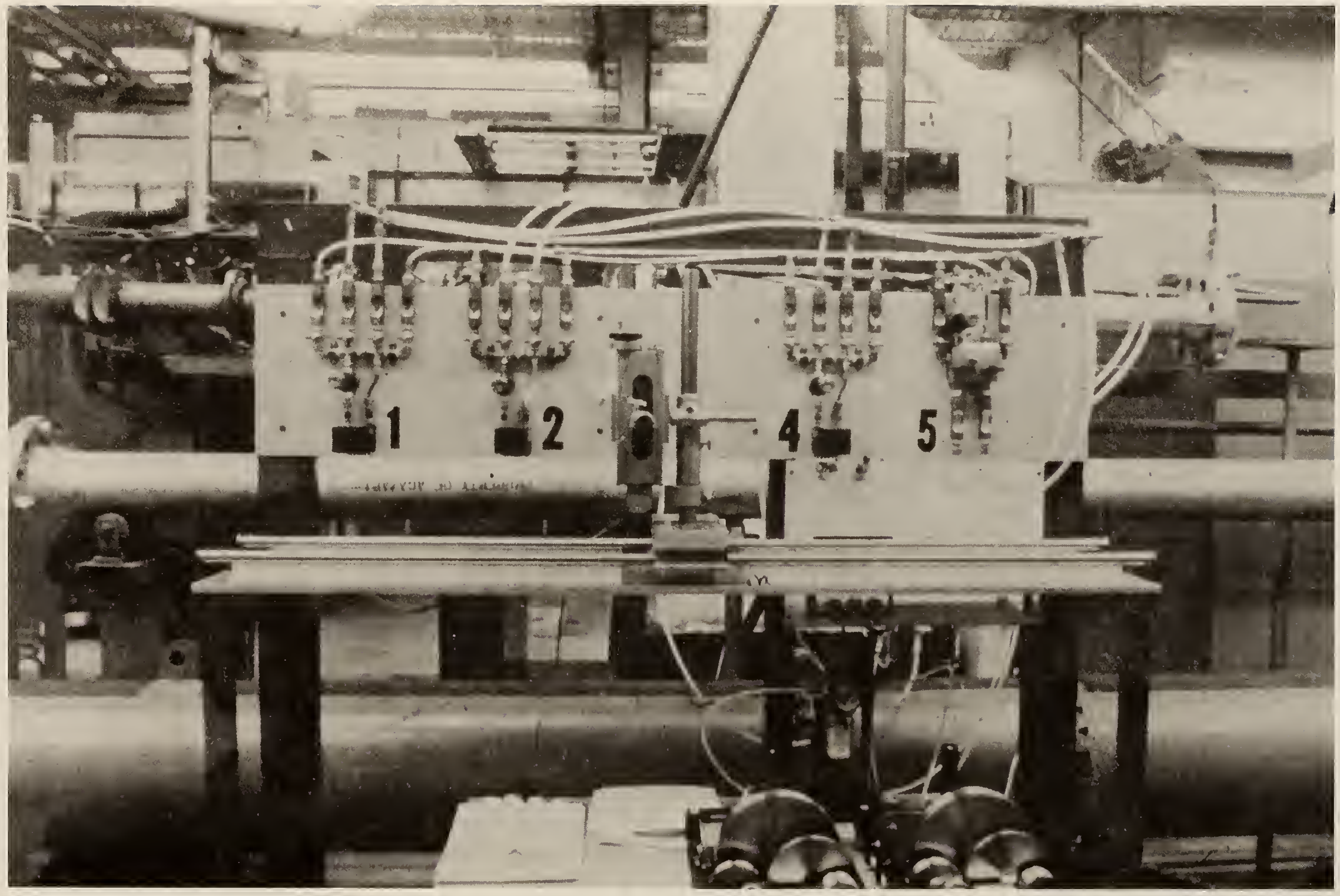


Figure 8. Meniscus Height Setting Telemicroscope System

orifice meter taps. These allowed the manifold to be isolated from the orifice meter until flow had been established through the orifice meter, producing a differential pressure near the desired flow rate set point. Approximately 10 feet of the 3/8-inch plastic tubing connected the manifold to the orifice meter.

4. Working Pressure Standards

To calibrate the differential pressure transducers, pressure standards were configured to match the use conditions of the transducers as closely as practicable. Since the downstream orifice meter taps were maintained as near 41 psig as possible during data collection procedures in flow tests, the working standards were configured to allow the accurate setting of the 41-psig back pressure value on the reference port of the transducers. This required two deadweight testers. These were of the ball type of pneumatic tester [10] and had the capability to develop pressures up to 300 psig, although they were not used above approximately 70 psig in this work.

Both deadweight testers were calibrated by the NBS pressure standards group on two or three occasions. These calibration data produced an effective area for the ball and an uncertainty in its value. The results of these calibrations showed the ball area values for the two testers to be stable with time and use. Additionally, no pressure dependence of the ball area was determined for either instrument. Mass values were assigned to the weights, the ball, and the weight carriers of each tester. These values coupled with the area of each ball, the local acceleration of gravity (9.801018 m/s^2) and the atmospheric parameters (barometric pressure, humidity, and air temperature) were used to compute the pressure value developed by the deadweight testers during transducer calibration procedures. Tables 12 and 13 list the mass values for the weights, balls and weight carriers for the two working pressure standards. These mass values are the result of several sets of weighings of each weight. The combined uncertainty in the mass standards and the weighing processes used was 1 part per million (ppm) or less. Therefore, the relative uncertainty in the mass values assigned is 1 ppm.

Computation of the pressure values developed by the testers involved computation of the density of the air using the measured atmospheric parameters, the assigned area of each ball, and the total mass of the weight stack. Since pressure is defined as the force developed per unit area, the force exerted on the deadweight tester's ball must be calculated for each stack of weights used in developing a particular pressure value. The apparent mass value of the weights is computed using eq (10). Equation (10) is similar in form to eq (6), discussed earlier in determining the true mass of water weighed by the flow facility's scales, but differs from it in that the apparent mass of the weight stack is required in computing the force acting on the dead weight tester's ball. The apparent mass is the mass value which includes the effect of the buoyant force of the atmosphere.

$$M_{app} = M_t (1 - \rho_a/d_w), \qquad (10)$$

Table 12. Pressure Gauge Mass Values, Maker Number 73520 (Assumed Stainless Steel Density of 7.8 g/cm^3)

		True Mass Value (lbm)
20 psi	# 6	4.423407
"	# 66	4.422113
10 psi	# 7	2.211872
"	# 8	2.211765
"	# 77	2.211138
"	# 88	2.311154
5 psi	# 9	1.105943
2	#10	.442358
"	#11	.442343
1 psi	#12	.221176
10 inches of H_2O	# 1	.079765
"	# 2	.079763
"	# 3	.079765
"	# 4	.079764
"	# 5	.079763
"	# 6	.079763
"	# 7	.079762
"	# 8	.079763
"	# 9	.079758
5 inches of H_2O	#10	.039880
2 inches of H_2O	#11	.015951
"	#12	.015951
1 inch of H_2O	#13	.007976
Weight carrier (2 1/2" long Al.)		.020886
Weight carrier (5 " long Al.)		.055851
Ring weight		.156839
Ceramic ball		.010796

Table 13. Pressure Gauge Mass Values, Maker Number 73521 (Assumed Stainless Steel Density of 7.8 g/cm^3)

		True Mass Value (lbm)
20 psi	#6	4.423528
10 psi	#7	2.211512
"	#8	2.211643
5 psi	#9	1.105800
2 psi	#10	.442344
"	#11	.442332
1 psi	#12	.221163
10 inches of H_2O	# 1	.079757
"	# 2	.079761
"	# 3	.079762
"	# 4	.079761
"	# 5	.079761
"	#65	.079757
"	#75	.079760
"	#85	.079763
"	#95	.079782
5 inches of H_2O	#10	.039880
2 inches of H_2O	#11	.015951
2 inches of H_2O	#12	.015952
1 inch of H_2O	#13	.007975
Weight carrier (2 1/4" long Al.)		.021084
Weight carrier (5" long Al.)		.052360
Ring weight		.158070
Ceramic ball		.010756

where M_t = true mass of the combined weight stack,
M_{app} = apparent mass,
d_w = density of the weight material, and
ρ_a = density of the air surrounding the weight.

The weights were stainless steel having an assigned density of 7.8 g/cm^3. However, the materials making up the weight stack and contributing to the generation of the force exerted on the ball were not only the stainless steel weights, although these were the majority of the mass, but also the ball itself and the weight carrier. The ceramic ball was assigned a density value of 4 g/cm^3 and the aluminum weight carrier a density of 2.7 g/cm^3. Once the apparent mass value, M_{app}, for the weight stack had been computed the pressure value was computed using the following relation,

$$P = M_{app}g/A(1 - \alpha(T - 23)),$$

where P = pressure,
g = local acceleration of gravity,
A = area of the ball,
α = area thermal expansion coefficient for the ceramic ball/stainless nozzle combination, and
T_a = temperature in degrees Celsius.

The relation includes a correction term for the thermal expansion effect of the stainless steel/ceramic ball combination. The reference temperature of 23 °C was the calibration temperature. Combining the above relation with eq (10) gives the working equation for computation of the pressure developed by a deadweight tester.

$$P = \frac{M_t g\ (1 - \rho_a/d_w)}{A(1 - \alpha(T_a - 23)} \tag{11}$$

Introduction of the appropriate units for each of the quantities in eq (11) results in eq (11a), which was used to compute the pressure developed by both deadweight testers.

$$P = \frac{M_{app}\ (\text{lb}) \times 0.4535924\ (\text{kg/lb}) \times 9.80102(\text{m/s}^2)}{A\ (\text{m}^2)\ (1 + 0.000010\ (T\text{-}23))} \tag{11a}$$

Equation (11a) provides pressure values in SI units of pascals. Many customary pressure units other than SI units are in use. In this report the pressure unit pound force per square inch (psi) is used. The following lists some factors for conversion between systems of units [11].

1 psi = 6894.757 pascals
1 atmosphere = 101325.0 pascals
1 atmosphere = 14.69595 psi

5. Uncertainty in the Differential Pressure Measurements

The uncertainty in the measurement of differential pressure is composed of several components. Each of the components will be discussed and used in developing an uncertainty statement for the measurement of the differential pressure developed across the orifice meter. These components are the following:

(1) The uncertainty associated with the pressure developed by a single deadweight tester;
(2) uncertainty due to fluid height differences in the two sides of the transducer manifold;
(3) the uncertainty in the pressure difference between the two deadweight testers;
(4) uncertainty due to the variability of the differential pressure transducers; and

a. Uncertainty in the Pressure Developed by a Single Deadweight Tester

The statement of uncertainty in one of the working pressure standards is composed of the following components:

(1) the uncertainty in the area assigned to the ball,
(2) the uncertainty in the buoyancy correction for the weight stack,
(3) the uncertainty in the mass value of the weight stack,
(4) the uncertainty in the value of the acceleration of gravity,
(5) the uncertainty in the value of the thermal expansion coefficient for the ceramic ball and the stainless steel nozzle/ball retainer.

The uncertainty in the area assigned to the ball is obtained from the calibration of each deadweight tester using the national working pressure standards. In addition to the assignment of an effective area value for the ball/nozzle combination, the relative uncertainty in the area value was assigned as part of the calibration procedure. Both working pressure standards were calibrated over the course of the work. One was calibrated three times and the other twice. The results of the calibrations are listed below for both instruments.

Areas and Associated Uncertainties for Ball Gauge S/N 73520

Date	Test No.	Area ($\times 10^{-4}$ m^2)	Random Variation	Uncertainty in Standards
June 1982	P-7802	1.425610	64 ppm	54 ppm
Jan. 1983	P-7869	1.425513	74 "	54 "
Jan. 1984	P-7933	1.425540	21 "	54 "
	Mean	1.425554		

Pooled Standard Deviation 58 ppm
Total Uncertainty in the Assigned Area 112 ppm = 1.60×10^{-8} m^2

Areas and Associated Uncertainties for Ball Gauge S/N 73521

Date	Test No.	Area ($\times 10^{-4}$ m^2)	Random Variation	Uncertainty in Standards
June 1982	P-7803	1.425512	50 ppm	54 ppm
Jan. 1984	P-7934	1.425650	25 "	54 "
	Mean	1.425581		

Pooled Standard Deviation 40 ppm
Total Uncertainty in the Assigned Area 94 ppm = 1.34×10^{-8} m^2

The random variation in the two working standards is ascribed to the inherent variation in the pressure generated during normal operation, and is assessed from their calibration measurement data. Three residual standard deviations of the fitting procedures used to determine the effective area of each working standard gives a 99% confidence interval for the estimate of the random uncertainty component in the area. Since several assignments of the areas were made, the individual random components of each assignment are pooled in quadrature. The total uncertainty in the pressure developed by a single deadweight tester is the sum of the random and systematic components. The systematic uncertainty in the calibration of each working standard is the uncertainty in the standard used to calibrate them. The relative uncertainty in the national working standard used to calibrate the deadweight testers is 54 parts per million of the assigned area value.

The uncertainty in the buoyancy correction for the weight stack arises from uncertainty in the density of the air and of the weights. The relative uncertainty in the density of the weights is taken to be 1%. The relative uncertainty in the density of the air is taken from the earlier discussion of air density calculation as 0.5%. Taking the partial derivatives of eq (11) with respect to the density of the weight material, d_w, and of air, ρ_a, and dividing these by the pressure leads to the following expressions:

$$\frac{\Delta P}{P} = \frac{-\rho_a}{(d_w - \rho_a)} \frac{\Delta \rho_a}{\rho_a}$$

$$\frac{\Delta P}{P} = \frac{\rho_a}{(d_w - \rho_a)} \frac{\Delta d_w}{d_w} .$$

These expressions give the relative uncertainty values in the deadweight tester pressure due to uncertainty in the buoyancy correction term of eq (11). Substitution of a nominal value for the density of air (0.00117 g/cm^3) and for stainless steel (7.8 g/cm^3) gives relative magnitudes of these effects shown in table 14. Since the majority of the parameters used to compute air densities are dominated by random observation effects, this component will be taken as a random one. The weight density uncertainty component is systematic.

The relative uncertainty in the local acceleration of gravity is obtained from Tate's [12] measurement, done at the NBS Gaithersburg site, and is stated as 1 part per million.

The effect of the uncertainty in the combined thermal expansion coefficient of the steel nozzle holding the ball and of the ball itself is estimated to be approximately 10% of its value [13]. Since operation of the deadweight testers was in the 20 to 25 °C range, the magnitude of this effect on the uncertainty in the pressure is estimated at the 1 part per million level.

Combination of these components into a statement of total uncertainty in the deadweight tester pressure will be done by combining the random contributions in quadrature and the systematic contributions additively.

Table 14. Relative Uncertainty in Individual Deadweight Tester Pressures

		Random (ppm)	Systematic (ppm)
Ball Area Assignment	(S/N 73520)	58	54
	(S/N 73521)	40	54
Bouyancy Correction - Air Density		0.4	
Bouyancy Correction - Weight Density			1.5
Weight Stack Mass Values			1
Acceleration of gravity			1
Thermal expansion coefficient			1
Total Component Uncertainty	(S/N 73520)	58	59
	(S/N 73521)	40	59
Relative Uncertainty	(S/N 73520)	58 + 59 = 117 ppm	
	(S/N 73521)	40 + 59 = 99 ppm	

These relative uncertainties correspond to uncertainty in the pressures ranging from 0.0047 to 0.0079 psig for the S/N 73520 instrument and from 0.0041 to 0.0069 psig for the S/N 73521 instrument. For the time period of the measurements reported in this report, June 1985 through February 1987, the reference pressure instrument was S/N 73521 and the test pressure instrument was S/N 73520.

b. Uncertainty in the Differential Pressure Developed by the Working Pressure Standards

The uncertainty in the pressure differential impressed upon the transducers as developed by the two deadweight testers is composed of two primary components: (1) uncertainty due to unequal heights of the fluid columns in the lines connecting the deadweight testers to the transducer manifold, and (2) the uncertainty in the pressure difference itself.

Uncertainty Due to Unbalanced Fluid Heights

The effect of unequal heights in the pressure fluids (silicone oil and nitrogen gas) connecting the transducers to the deadweight testers is treated independently for both fluids. The capability to set and monitor the height of the silicone oil levels in the sight glasses is determined by the capability of the operator to set the interface menisci using the telemicroscope, and the incline to the horizontal of the rails carrying the telemicroscope. The magnification and translational sensitivity of the telemicroscope was such that any of the operators could easily set the level of the menisci to 0.0005 centimeters. The sensitivity with which the telemicroscope was able to maintain a horizontal plane was determined by the level used to monitor and adjust the rail position relative to the horizontal plane. The sensitivity of this level was tested and found to be capable of reproducing the horizontal to within 0.002 inch per foot. The sightglasses were separated by a maximum of 6 inches, therefore the unbalanced height difference is taken as 0.001 inch (25×10^{-6} meters).

This value must be incorporated in the meniscus height setting uncertainty, and are considered to be systematic in their effect on the uncertainty in the meniscus height difference. The sum of these heights is 30×10^{-6} meters. Using a value of 950 and 1050 kg/m^3 for the density of the silicone oil filling the Paros and Ruska transducers, respectively, the pressures generated by these unbalanced heights are 0.28 and 0.31 pascals (0.000041 and 0.000045 psi) for the two oils.

The unbalanced heights of the nitrogen columns above the sightglasses were maintained to almost the same height. However, it was possible that a maximum separation of 1 centimeter could have occurred. A computation similar to that discussed for the unbalanced oil heights yields a value of 0.6 pascals (0.00008 psi) at the largest operating pressure value of 84 psia.

The sum of the two unbalanced fluid columns is 0.91 pascals (0.00013 psi) for the denser of the two silicone oils. To simplify the remainder of the uncertainty analysis, this value will be used for the final estimate of this component of uncertainty since the density difference between the two oils is only a 10% effect in this value. For a pressure difference of 0.4 psi the maximum relative uncertainty is 0.03%. At 28 psid this value is 0.0005% or 5 parts per million.

Uncertainty in the Difference Pressure Between the Deadweight Testers

The pressure difference, ΔP_s, between the two working standards is

$$\Delta P_s = P_t - P_r.$$

The reference pressure P_r is maintained at a constant value during transducer calibration procedures. The test pressure, P_t, varies to cover the differential pressure range desired for the transducer calibration. For the tests discussed here the reference pressure was always set to a nominal value of 41 psig and the test pressure values ranged from 41 to 69 psig to cover the 28-psid operating range. Each pressure contributes a component to the uncertainty in the difference pressure.

The uncertainty in the reference pressure is that contributed by the reference deadweight tester. During the period over which the data reported here were collected, the deadweight tester having serial number 73521 provided the reference pressure. The total uncertainty in the reference pressure of 41 psig is 0.0041 psi.

The uncertainty in the test pressure is similar to that in the reference pressure. Since the two instruments were calibrated at differing times, i.e., not simultaneously, it is assumed here that the systematic uncertainty component of the national working standard could have been in full effect, i.e., the systematic component of the uncertainty in the national working standard is wholly a day-to-day effect. Therefore, combination of the uncertainty components of the test and reference instruments is done in the usual manner by combining both the random components in quadrature and the systematic components additively. The uncertainty in the differential pressure produced by the working pressure standards, $s_{\Delta Ps}$, is computed in the following manner.

$$s_{\Delta Ps} = [\,(58 \times 10^{-6} P_t)^2 + (40 \times 10^{-6} P_r)^2]^{1/2} + 59 \times 10^{-6}(P_r + P_t)$$

For the nominal values of the five differential pressures used in the flow testing, $s_{\Delta Ps}$ is evaluated below.

Uncertainty in the Differential Pressure
Due to the Working Standards for Nominal Flow Test Pressures

Differential Pressure (psid)	Random (psid)	Syst. (psid)	$s_{\Delta Ps}$ (psid)	Relative Uncertainty (%)
0.4	0.0029	0.0048	0.0077	1.9
1.0	0.0029	0.0049	0.0078	0.78
3.0	0.0030	0.0050	0.0080	0.27
10.0	0.0034	0.0054	0.0088	0.088
28.0	0.0043	0.0065	0.0108	0.039

Total Uncertainty in the Working Pressure Standards

The effect of unbalanced heights of fluid in the lines connecting the transducers to the working standards is much smaller than any of the other components contributing to the uncertainty in the calibrating differential pressure, ΔP_c, by approximately an order of magnitude. However, for the sake of completeness, it is included in the estimate of the total uncertainty in calibrating differential pressure, $s_{\Delta P_c}$. This is expressed as follows:

$$s_{\Delta Pc} = s_{\Delta Ps} + 0.00013.$$

6. Differential Pressure Transducer Calibration Procedures

Calibration of all operational transducers (at times the quartz bourdon tube transducer was out of service due to periodic destruction of the meniscuses) was generally done at the beginning of each day or each data block. (For some of the testing associated with pipe wall surface roughness effects, a data block extended over several days for which a single calibration was used. See Appendix A for a discussion of the work and its results.) In this way the transducers were characterized frequently, thereby reducing the impact of an undetected transducer malfunction on the data base. Transducer calibration procedures were incorporated in the software of the data acquisition system's microprocessor, to maintain a fixed and complete calibration procedure over the period of data collection.

The calibration procedures were designed to emulate the operational conditions of the differential pressure measurement system during flow testing as closely as practicable. Since the downstream pressure taps of the orifice were maintained as near 41 psig as possible, the transducers were calibrated at 41 psig. Early in the project it was observed that all of the transducers showed small hysteresis effects after they had been quiescent at zero differential pressure, i.e., with the crossover valves opened, between measurement sessions. Also, during measurement procedures, the transducers sensed time-varying pressures (the inherent fluctuations of the differential pressure developed by the orifice meter and the changes in differential pressure with flow rate setting change) and the transducers were valved off and crossed over between flow rate settings during the flow testing to obtain zero differential pressure response values. To simulate these use conditions calibration procedures were begun by exercising the transducers. Transducer exercising consisted of placing approximately the full range of differential pressure (28 psid) across the transducer manifold (at 41 psig static pressure), and manipulating each transducer's manifold valves to alternately place zero or full range differential pressure across all transducers.

The procedures for a transducer calibration are given below.

1. To begin transducer calibration both deadweight testers (DWT) were loaded with weight stacks which produced nominally equal pressures of 41 psig. The pneumatic pressure developed by each of the testers was placed on one leg of the manifold as shown in figure 6. The crossover valve and the reference leg valve for each transducer were then opened. This placed the 41 psig base pressure on both inlets of each transducer. This response value was recorded as the zero differential pressure value for the calibration.

2. The crossover valves were closed for the remainder of the procedure and the test inlet valves were opened for each transducer placing the DWT pressure difference across the transducers. The transducer response values were recorded. This value was the initial differential pressure calibration point for the transducers. The pressure developed by the

deadweight testers was slightly different for nominally the same weight stack composition due to small differences in the ball areas and in the true mass values of the weights.

3. The remainder of the differential pressure values (except for the last point which was identical to that of step 2) were developed by adding or removing additional weights on the DWT connected to the test-port side of the manifold. The DWT of the manifold's reference side remained at 41 psig throughout the calibration procedure. Between each observation the transducer's test and reference inlet valves were closed and the crossover valves were opened to simulate transducer operation during flow testing.

The pressure schedule for differential pressure transducer calibration was ordered such that half the procedure consisted of successive increases in the differential pressure value until the maximum value of 28 psid was reached. The remainder of the points successively decreased the differential pressure until the near zero differential pressure point of step 2 was reached. Several schedules were used during the project. The number of points in them ranged from 14 to 31. Table 15 gives the menu displayed for the operators during a 20-point calibration sequence. The menu listed the weights comprising the weight stack of the test port DWT, the pressure developed on the transducer's test ports, and the differential pressure for nominal atmospheric conditions.

Variation in the number of points comprising a calibration pass was made to determine a minimum number consistent with minimal degradation in the procedure's quality. This quality was judged by the residual standard deviations of the least squares fitting procedures used to determine each transducer's calibration relation. During the period of time in which the data on the nickel-plated meter tubes was collected, the 14-point schedule was used. This required approximately 45 minutes to complete. The barometric pressure and air temperature were recorded at the beginning of the calibration observation sequence and stored with the transducer calibration data base.

Table 15. 20-Point Transducer Calibration Schedule

Obs. No.	Test Port DWT Weight Designation	Diff. Press. (psid)	Test Press. (psig)
1	66 77 88	0.00137	41.00708
2	66 77 88 13W	0.03744	41.04315
3	66 77 88 10W	0.18173	41.18744
4	66 77 88 10W 1W	0.54246	41.54817
5	66 77 88 10W 1W 2W	0.90318	41.90889
6	66 77 88 10W 1W 2W 3W 4W	1.62464	42.63114
7	66 77 88 10W 10 1W 2W	2.90372	43.90943
8	66 77 88 10W 10 12 1W 2W 3W 4W	4.62543	45.63114
9	66 77 88 10W 9 1W 2W	5.90474	46.91045
10	66 77 88 10W 7 1W 2W	10.90617	51.91188
11	66 77 88 10W 6 9 10 1W 2W	27.90986	68.91557
12	66 77 88 10W 6 10	22.18685	63.19256
13	66 77 88 10W 9 1W	5.54402	46.54973
14	66 77 88 10W 10 12 1W 2W 3W	4.26471	45.27042
15	66 77 88 10W 10 1W 2W 3W	3.26445	44.27016
16	66 77 88 10W 1W 2W 3W	1.26392	42.26963
17	66 77 88 10W 1W	0.54246	41.54817
18	66 77 88 10W 11W	0.25387	41.25958
19	66 77 88 12W	0.07351	41.07922
20	66 77 88	0.00137	41.00708

Early in this project it was found that a characteristic of the operation of the deadweight testers with the weight stacks stationary, i.e., not spinning at a slow rate, was a small oscillation in the pressure value. Due to the high sensitivity of these transducers, this variation was easily detectable. This change in pressure was also audible. The oscillation was minimized or eliminated by slowly spinning the weight stacks. Once the weight stacks were placed on the testers and the instruments were in a steady state, each weight stack was spun and remained spinning through the time required for observation of the differential pressure response of all transducers. Details of the recording and storing of these values is given in the data acquisition section of this report, section IV.

7. Transducer Response Functions and Coefficient Values

Upon completion of the observation sequence, the sets of response values of each transducer were combined with the differential pressure values to form the data pairs used in a least squares fitting procedure. Generally a polynomial model having the response variables as the independent variable and the differential pressure as the dependent variable was used for interpolating through the range of the calibration data. In the case of the quartz bourdon tube transducer a linear dependence between its analog output voltage (V) and the applied differential pressure (ΔP) was found to best represent its response.

The relation is

$$\Delta P = C_1 + C_2 V.$$

The response variable used in this fitting procedure was the voltage difference $V_i - V_o$, where V_o is the voltage observed with the transducer at zero differential pressure immediately before the first observation of the calibration procedure is taken, and V_i is the voltage observed at the ith step in the procedure.

A second order polynomial was used for the quartz oscillator-type transducers. It includes a reduced range variable of the oscillator period (T_o) at zero differential pressure and the period at the sensed differential pressure (T). This relation is,

$$\Delta P = Y_o + Y_1 x + Y_2 x^2,$$
$$\text{where } x = 1 - T_o/T.$$

Higher order polynomials were investigated for modelling the response of the two types of transducers, but it was found that polynomials of the first and second orders, respectively, were the best choice based on simultaneous minimization of the order and the residual standard deviation of the least squares fit. The coefficient values and residual standard deviations obtained from the least squares fitting procedures for each transducer's response are tabulated in Appendix C.

8. Estimation of the Uncertainty in the Mean Differential Pressure Over the Period of a Flow Rate Measurement

For each flow test, differential pressure observations were made with an observation period of slightly less than 1 second. The differential pressure varies with time due to the fluid dynamic effects of the test fluid passing through the orifice meter and to small changes in the flow rate setting caused by slight changes in the flow control valve mechanisms. The transducers sense these variations with a frequency response characteristic to each transducer. The amplitudes of the fluctuations were generally several percent of the mean differential pressure. The transducers are read sequentially over the diversion period and the observed values stored in the data base. To obtain the best estimate of the mean differential pressure, one would like to have the capability to measure the differential pressure with a temporal resolution much smaller than the fluctuation period and with high accuracy. Unfortunately the state-of-the-art in differential pressure sensing does not allow both of these characteristics to be found in a single transducer. In this particular work it was decided to use transducers which had good measurement stability and sensitivity at the expense of reduced frequency response characteristics. As a result the frequency response of the transducers and associated connection lines is of the order of several hertz.

Specifically, the quartz bourdon tube transducer (the Ruska transducer) utilizes a servo loop which has a corner frequency near four hertz which limits its frequency response. Its frequency response is further limited by the silicone oil filling it. The analog output voltage is digitized for use by the data acquisition systems by a digital voltmeter at 3 hertz. The quartz oscillator transducers (the Paros transducers) had a similar digitization rate of four per second. The data acquisition system was limited to transfer rates of approximately one set of observations per second, where a set of observations consisted of a single value from each of the transducers. This limit was imposed by software execution speed and was the controlling factor for data acquisition rate.

In obtaining an observation set, the two Paros transducers were digitized simultaneously and the values transferred to the microprocessor. The quartz bourdon tube transducer's output voltage was then digitized and transferred to the microprocessor. Although the approximately 1-second data transfer/storage rate is thought to be slower than the higher frequency, fluid dynamically-induced, differential pressure fluctuations in the orifice meter, it is sufficient to record low frequency components, and has considerably greater temporal resolution than traditional manometry techniques.

An example data set for the three differential pressure transducers is shown in figures 9 through 13. The data for these figures were taken from a single day's observations on the 4-inch meter tube, PE-5ABC, with the 2B orifice plate which has a beta ratio of approximately 0.37. Each figure contains a time series plot of the differential pressure data taken by the three transducers for the indicated test run. The five nominal differential pressure values normally used in the testing, 0.4, 1, 3, 10, and 28 psid, are shown to illustrate the level of fluctuation in the differential pressure data. A linear fit of differential pressure as a function of observation time is shown as the curve through the data for each plot. The differential pressure axis of each plot has the same range to illustrate the difference in frequency response between the quartz bourdon tube and quartz oscillator transducers. It is quite evident that the bourdon tube transducer has a higher frequency response then the other type of transducer. The amplitude of the bourdon tube transducer is larger and its temporal variation suggests that the frequency of the differential pressure signal may be higher than the transducer's ability to follow it. The quartz oscillator transducers have a lower frequency response than the bourdon tube transducer. Inspection of the shapes of the three pressure signals shows a close similarity between the Ruska and upper Paros indicating that the transducers have similar capability to sense the low frequency components of the differential pressure signal at the upper orifice meter taps. The signal sensed at the lower taps has a similar shape in the larger features.

Computation of discharge coefficient values from differential pressure data arrays requires a mean value for the differential pressure. Computation of the uncertainty in the discharge coefficient due to uncertainty in the mean differential pressure requires an estimate of the uncertainty in the differential pressure as sensed by each transducer. The mean differential pressure is obtained in the usual manner. Computation of the standard deviation is based on time series analysis methods in order to properly account for any autocorrelation

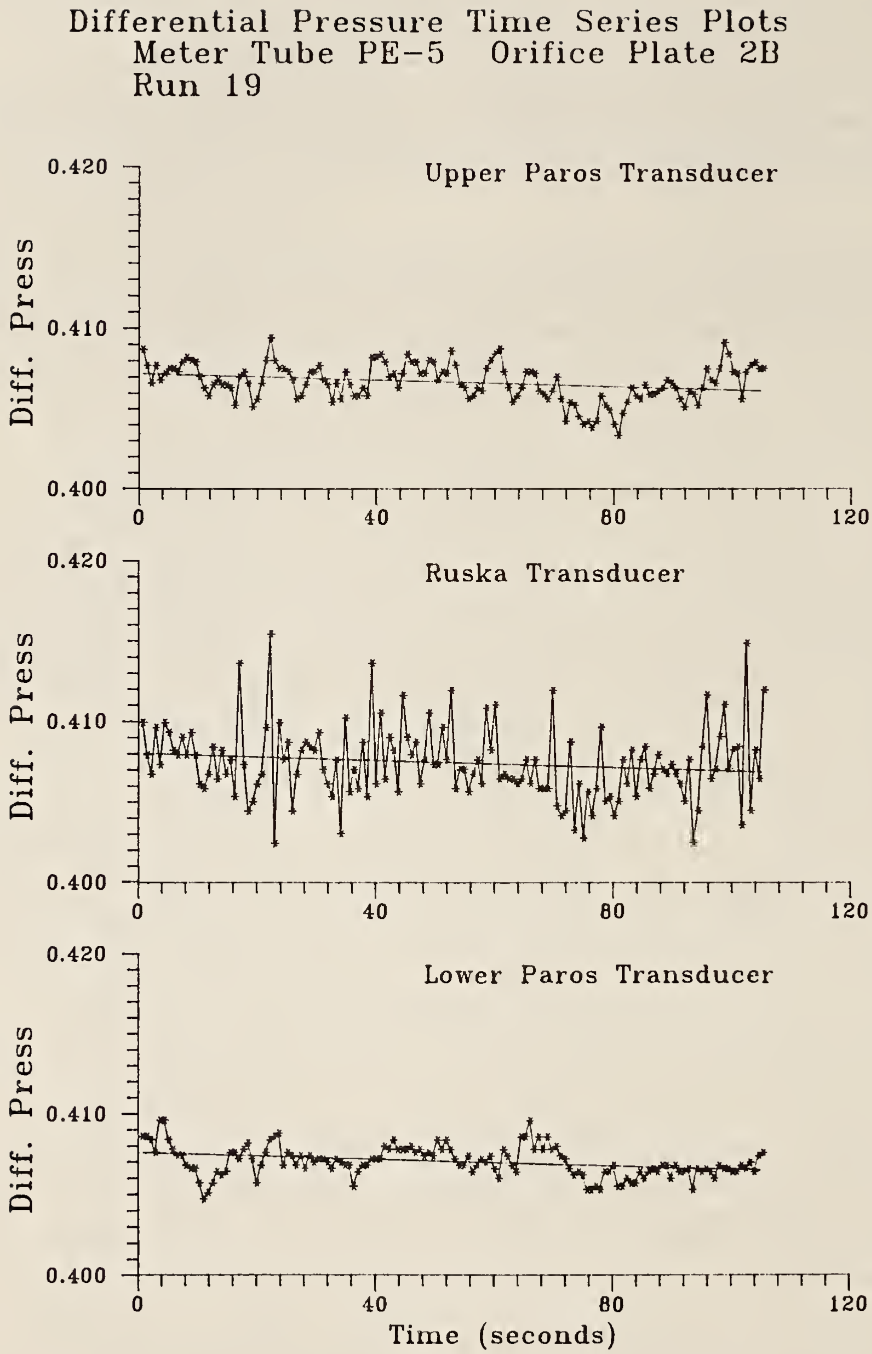


Figure 9. Transducer Time Series Plots at 0.4 psid

Differential Pressure Time Series Plots
Meter Tube PE-5 Orifice Plate 2B
Run 22

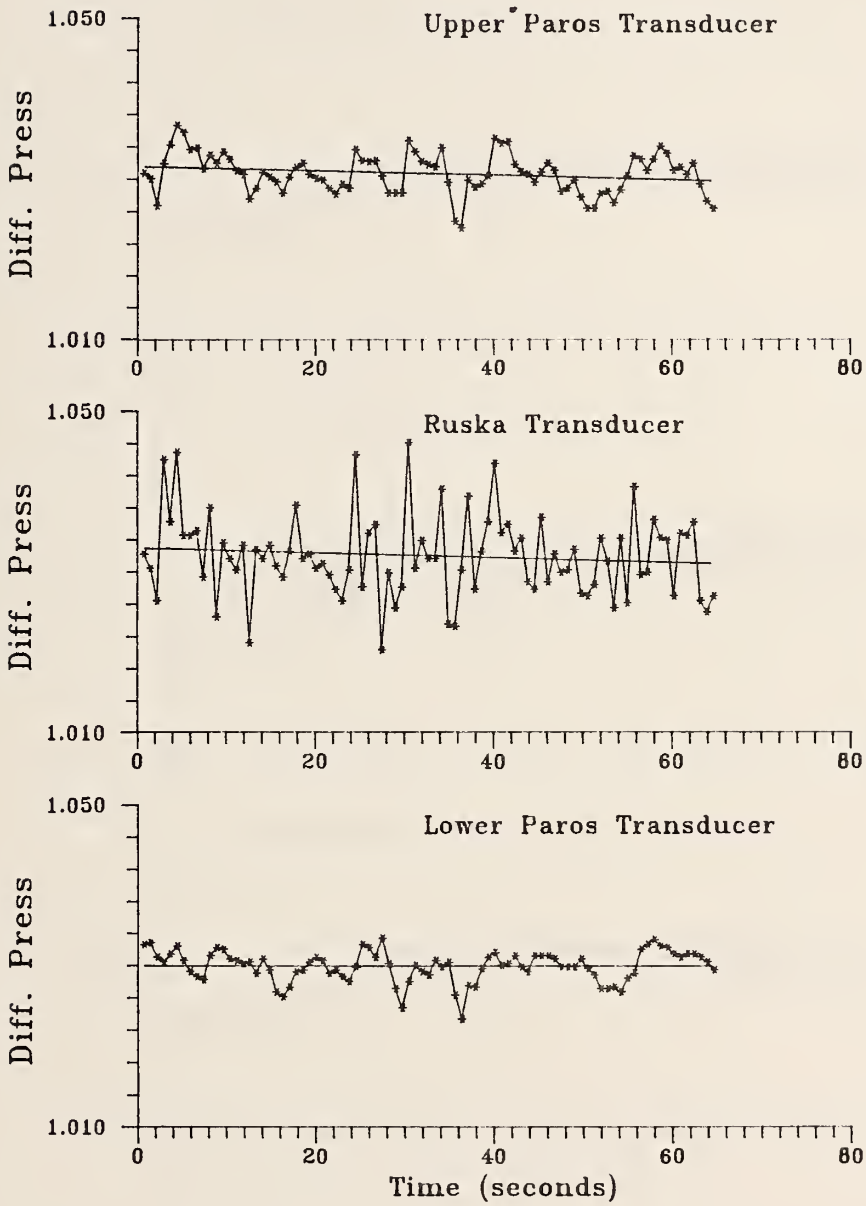


Figure 10. Transducer Time Series Plots at 1 psid

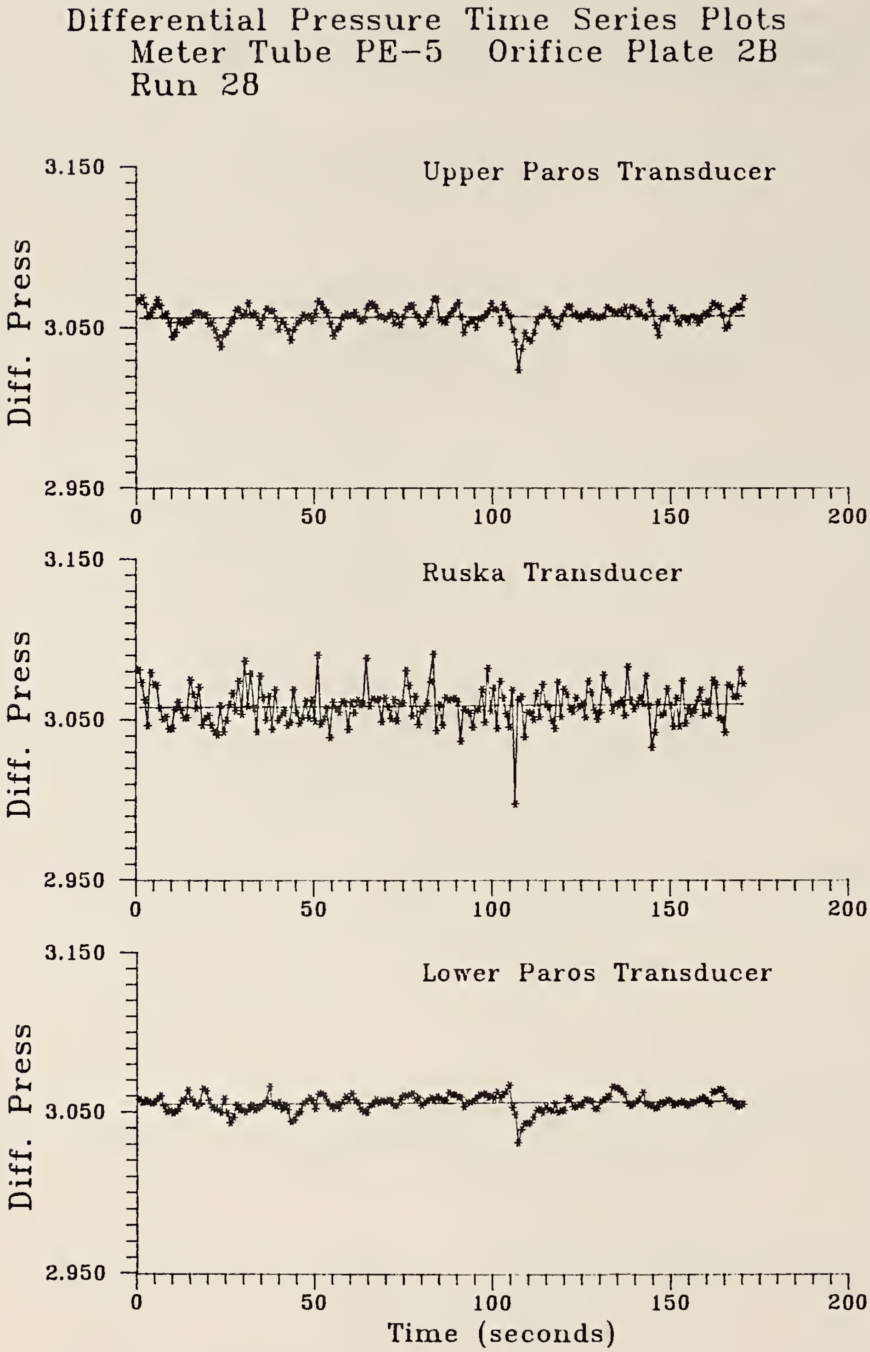


Figure 11. Transducer Time Series Plots at 3 psid

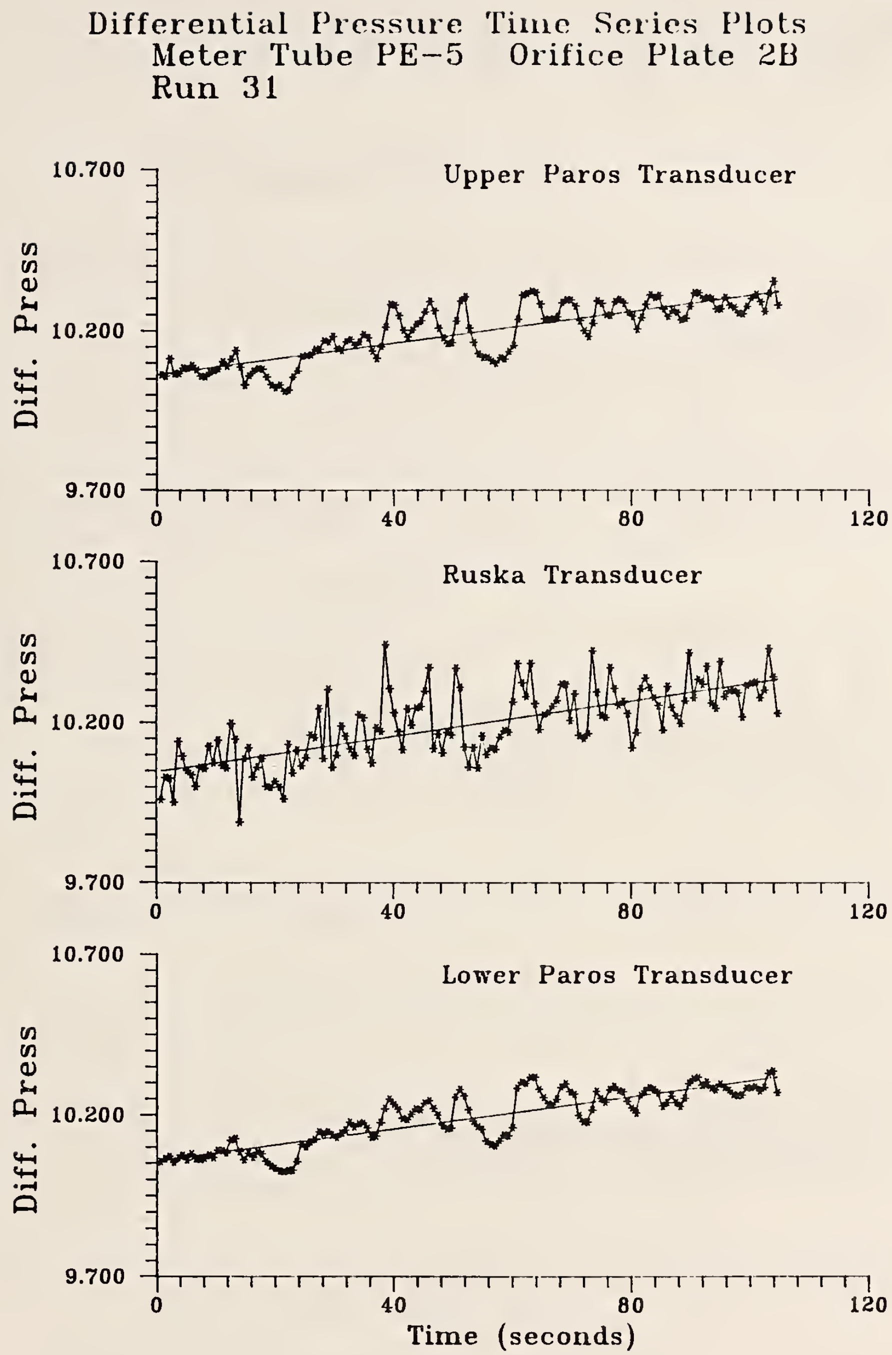


Figure 12. Transducer Time Series Plots at 10 psid

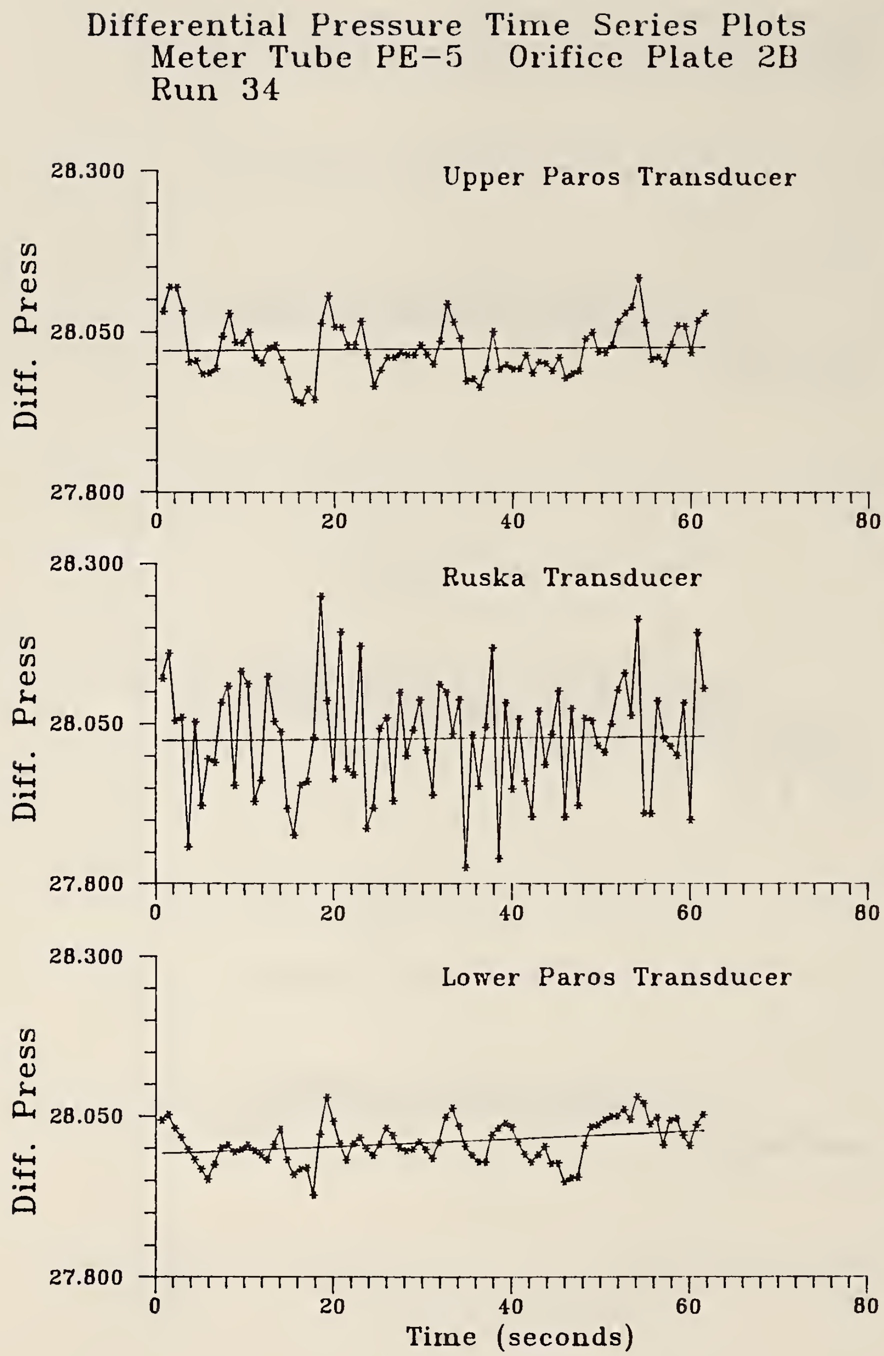


Figure 13. Transducer Time Series Plots at 28 psid

effects in the data of each transducer. Autocorrelation effects are expected to be induced by the inability of the transducers to fully respond to the full spectrum of frequencies in the differential pressure signal. The method of Heidelberger and Welch [14] has been used to compute the standard deviation of the mean, $s_{\Delta Pm}$.

9. Uncertainty in the Measurement of Orifice Meter Differential Pressures

Descriptions of the methods used to compute the uncertainty in the various components of the differential pressure values were developed above. The uncertainty in observing the differential pressure developed across the orifice meter with the differential pressure transducers is the sum of the uncertainty in the working pressure standards used to calibrate the transducers and the stability of transducer response to calibration procedures. The estimate of the variation in the transducer's response during calibration and use is given as the residual standard deviation to the fit of the response functions to the data for each calibration. In order not to underestimate the magnitude of this variation, three residual standard deviations of the least squares fit are used (99% confidence level).

The uncertainty in the estimate of the mean differential pressure value for a differential pressure transducer is the sum of uncertainty components due to the following:

1. $s_{\Delta P_c}$, the uncertainty in the differential pressure values developed by the working standards used in calibrating the transducers.

2. $s_{\Delta Pf}$, the variability in the computed differential pressure value due to random variation in each transducer (see Appendix C).

3. $s_{\Delta Pm}$, the uncertainty in the mean differential pressure value for each transducer over the interval of a test run.

Computation of the total uncertainty, $s_{\Delta P}$, in the mean observed differential pressure for each transducer is the combination of the random components in quadrature and the systematic components additively. The mathematical expression for $s_{\Delta P}$ is given in eq (12).

$$s_{\Delta P} = [(58\text{x}10^{-6}P_t)^2 + (0.0016 \text{ psid})^2 + (3s_{\Delta Pf})^2 + (3s_{\Delta Pm})^2]^{1/2} + 0.0048 \text{ psid} + 59\text{x}10^{-6}\Delta P \qquad (12)$$

10. Transducer Surveillance Measurements

A surveillance procedure was used to periodically test the transducer performance data acquisition system during orifice meter data acquisition. These procedures were performed at the beginning of flow testing data collection passes; each time that an orifice plate was inserted into the meter flange, a surveillance check of the transduction systems was made. These checks were incorporated in the data acquisition software to maintain a record of the transducer performance. Surveillance of the differential pressure transducer performance was done using the deadweight testers in a manner similar to that of calibration. A nominal 5.2 psi differential pressure was generated at 41-psig static pressure, the weight stacks spun, and an observation sequence initiated by the operator. The means of the observed values were converted to pressure units, using the most recently determined set of transducer coefficients, and the results stored in the data base. This procedure checked several things: (1) the computer/transducer interface hardware and software, (2) the values of the coefficients determined in the calibration procedures and used in the calculation software for run-time values of differential pressure, and (3) the stability of the transducer response after calibration and over the period of data collection. The computed differential pressure value for each transducer was displayed on the console of the data acquisition system. This gave the operator an immediate check of transducer operation with the option of stopping the data collection procedures should there be a large discrepancy between the values displayed and the known differential pressure. A number of the results of these checks are listed in table 16. The value of the differential pressure supplied by the two deadweight testers is given for comparison. This value has been computed for the atmospheric conditions present shortly after the observations were made and stored. The level of agreement between the pressure values for each transducer is within the sums of the residual standard deviations for the fits of the transducer response and agrees with the calculated value of the differential pressure within approximately 0.003 psi.

Table 16. Differential Pressure Transducer Surveillance Measurements

Date	Time	DWT Pressure (psid)	Upper Paros (psid)	Lower Paros (psid)	Ruska (psid)
06/03/85	04:33:36	5.1789	5.1786	5.1800	--[a]
06/03/85	06:49:14	5.1789	5.1818	5.1830	--
06/03/85	13:31:32	5.1789	5.1776	5.1805	--
06/03/85	17:29:17	5.1789	5.1770	5.1799	--
06/03/85	21:18:41	5.1789	5.1766	5.1796	--
06/04/85	01:09:01	5.1789	5.1797	5.1826	--
06/04/85	02:37:20	5.1789	5.1786	5.1817	--
06/04/85	05:31:58	5.1789	5.1808	5.1829	--
07/02/85	09:57:38	5.1789	5.1810	5.1820	5.1820
07/05/85	11:30:49	5.1789	5.1796	5.1807	5.1818
07/05/85	14:16:24	5.1788	5.1804	5.1806	5.1834
07/08/85	09:24:50	5.1789	5.1806	5.1815	5.1823
07/08/85	10:34:10	5.1788	5.1790	5.1804	5.1816
07/08/85	14:18:55	5.1788	5.1799	5.1805	5.1821
07/09/85	08:49:36	5.1788	5.1810	5.1819	5.1826
07/09/85	13:17:44	5.1788	5.1793	5.1804	5.1826
07/09/85	17:22:42	5.1788	5.1797	5.1810	5.1838
07/12/85	09:30:17	5.1789	5.1804	5.1816	5.1821
07/12/85	11:38:36	5.1789	5.1806	5.1822	5.1829
07/12/85	14:34:41	5.1789	5.1797	5.1812	5.1818
07/15/85	16:28:14	5.1788	5.1801	5.1808	5.1815
07/16/85	11:10:59	5.1789	5.1806	5.1819	5.1824
07/16/85	13:45:39	5.1788	5.1812	5.1815	5.1829
07/17/85	13:12:00	5.1788	5.1790	5.1805	5.1815
07/17/85	15:33:32	5.1788	5.1796	5.1805	5.1824
07/18/85	10:51:43	5.1789	5.1800	5.1810	5.1816
07/18/85	15:13:49	5.1788	5.1782	5.1786	5.1813

[a] Ruska transducer not in use.

E. Temperature Measurement Instruments and Standards

Temperature measurements were made of the flowing fluid and of the atmosphere surrounding the weighing apparatus using calibrated thermistor probes. The calibration of each probe has been tied to the International Practical Temperature Scale of 1968 through a calibrated platinum resistance thermometer (PRT). These comparisons were made using a small, thermostatically controlled bath filled with mineral oil in which the PRT and the thermistor probes were immersed. The bath was made of brass with copper tubing soldered to its sides. Water from a temperature controlled bath was passed through the copper tubing to stabilize the temperature in the oil bath. Observations of the PRT resistance and the thermistor indications were made in a short time interval of several minutes. The stability of the bath over such a time was approximately 0.002 °C or less. The PRT resistance was measured using a Leeds and Northrup [3] Model G2 DC resistance bridge which has been calibrated by the NBS Electrical Measurements Group. The PRT had been calibrated by the NBS Pressure and Temperature Division. The maximum error in the temperature measured by the PRT was 0.0015 °C.

Table 17 lists the temperature values for the PRT and those indicated for the eight probes tested. All probes were calibrated over the range 15 to 40 °C. This range represents the major portion of the range of operation of the flow rate measurement facility during the work reported here. The indicator for the array of probes displayed directly the temperature value in units of degrees Celsius and was interfaced to the data acquisition microprocessor, allowing selection of one of eight probes.

The representation of the calibration information for each probe is a polynomial in the indicated value. An investigation of the proper functional form was made by fitting the PRT temperature to a linear function of the thermistor indication. Inspection of the shape of the residuals to this fit, plotted against the temperature, indicated that a third-order polynomial would best fit the calibration data. Subsequent fits to third-order polynomials showed that the third order fit minimized both the residual standard deviation and the order of the fit. The four polynomial coefficients, B_i, the residual standard deviation of the fit, and the location of the probe during the flow rate measurement phase of this work are given in table 18. The thermistor labeled 775006 was not used since its behavior was not consistent with the third-order model.

1. Extension Cable Connection Effects

Each thermistor probe was physically separated from the indicator location by as much as 50 feet. Extension cables were used to connect the probes to the indicator. The effect of these extensions was assessed by using one probe immersed in a constant temperature bath, and successively connecting the probe through each of the extension cables and directly to the indicator. The temperature differences observed did not exceed 0.01 °C for any of the extension cables. A systematic uncertainty of 0.01 °C for the observed temperature values is assigned based on the use of the extension cables.

Table 17. Thermistor Temperature Indication Relative to the Calibrated Platinum Resistance Thermometer

PRT TEMP (°C)	775001 Ind. (°C)	Diff. (°C)	775002 Ind. (°C)	Diff. (°C)	775003 Ind. (°C)	Diff. (°C)	775004 Ind. (°C)	Diff. (°C)
20.91	20.85	-0.06	*21.05	0.14	21.23	0.32	*22.12	1.21
25.42	25.52	0.10	25.41	-0.01	25.92	0.50	25.43	0.01
30.50	30.72	0.22	30.53	0.03	31.21	0.71	30.53	0.03
34.96	35.25	0.29	35.02	0.06	35.80	0.84	34.93	-0.03
40.23	40.52	0.29	40.31	0.08	41.17	0.94	40.12	-0.11
34.93	35.22	0.29	34.97	0.04	35.75	0.82	34.91	-0.02
30.05	30.26	0.21	30.06	0.01	30.71	0.66	30.06	0.01
25.03	25.11	0.08	25.06	0.03	25.49	0.46	25.01	-0.02
20.87	20.81	-0.06	20.93	0.06	21.19	0.32	20.90	0.03
16.41	16.22	-0.19	16.44	0.03	16.57	0.16	16.47	0.06
16.40	16.22	-0.18	16.44	0.04	16.59	0.19	16.48	0.08
39.34	39.61	0.27	*39.30	-0.04	*40.19	0.85	*39.05	-0.29

PRT TEMP (°C)	775005 Ind. (°C)	Diff. (°C)	775006 Ind. (°C)	Diff. (°C)	775007 Ind. (°C)	Diff. (°C)	775008 Ind. (°C)	Diff (°C)
20.91	20.90	-0.01	20.99	0.08	20.85	-0.06	20.85	-0.06
25.42	25.41	-0.01	25.42	-0.00	25.52	0.10	25.52	0.10
30.50	30.48	-0.02	30.66	0.16	30.71	0.21	30.70	0.20
34.96	34.89	-0.07	35.14	0.18	35.25	0.29	35.22	0.26
40.23	40.06	-0.17	40.39	0.16	40.51	0.28	40.47	0.24
34.93	34.86	-0.07	35.11	0.18	35.21	0.28	35.18	0.25
30.05	30.03	-0.02	30.16	0.11	30.26	0.21	30.25	0.20
25.03	25.01	-0.02	*24.97	-0.06	25.11	0.08	25.10	0.07
20.87	20.87	0.00	21.06	0.19	20.81	-0.06	20.81	-0.06
16.41	16.43	0.02	16.85	0.44	16.23	-0.18	16.23	-0.18
16.40	16.44	0.04	16.87	0.47	16.22	-0.18	16.22	-0.18
39.34	39.15	-0.19	*38.54	-0.80	39.60	0.26	39.56	0.22

*Data points judged to be outliers and omitted from the final least squares fits.

Table 18. Thermistor Coefficients, Residual Standard Deviations, and Experimental Locations

Thermistor Number	Location	B_o (°C)	B_1 (°C)	$B_2 \times 10^{-3}$ $(°C)^{-2}$	$B_3 \times 10^{-5}$ $(°C)^{-3}$	Res. Std. Dev. (°C)
775001	16" Line	0.237	1.031737	-2.84753	4.32345	0.010
775002	Air Temp.	-0.240	0.993186	0.50974	-0.93988	0.021
775003	Tank #3	-0.277	1.049786	-3.33100	4.20485	0.015
775004	Tank #2	-1.130	1.125176	-4.63631	5.70436	0.018
775005	Tank #1	-0.776	1.091856	-3.61436	4.80412	0.014
775007	8" Line	0.194	1.035789	-2.97816	4.47874	0.011
775008	4" Line	0.263	1.027828	-2.71054	4.26491	0.012

2. Uncertainty in Measured Temperature Values

The components of uncertainty in the temperature values measured by each thermistor are:

(1) Uncertainty in the platinum resistance thermometer temperature. This value represents the combined effects of the resistance bridge and the PRT itself and is taken as 0.0015 °C.

(2) The effects of extension cable connections (taken as 0.01 °C).

(3) The random uncertainty component in the temperature measurement, characterized by the residual standard deviations of the fit for each thermistor.

The three thermistors used for measurement of the flowing water temperature, immediately downstream of the orifice meters, have residual standard deviations no larger than 0.012 °C. Therefore, for the flowing water temperature values, the uncertainty in that value is taken to be the sum of three times the largest residual standard deviation (0.036 °C), the uncertainty in the calibration temperatures determined by the PRT (0.0015 °C), and the effect of the extension cable connection (0.01 °C). The total uncertainty value in temperature measurement for the flowing water temperature is 0.0475 °C. The residual standard deviation is the only random error component with the other two taken as systematic.

The uncertainty in the air temperature is computed similarly and is 0.0645 °C. The air temperature measurement did not involve cable extensions and this error is not included.

3. Measurement and Calculation of Water Density

The density of water was calculated using the formulation of Kell [9] at atmospheric pressure. The values calculated with Kell's formulation (eq (16) in [9]) relate exclusively to the density of distilled water. Kell's relation for computation of the distilled water density is the following; the units of the density value are kg/m^3 and those of the coefficients are chosen accordingly.

$$\rho_w = (a_0 + a_1T + a_2T^2 + a_3T^3 + a_4T^4 + a_5T^5)/(1 + CT),$$

where T = temperature on the Celcius scale,

a_0 = 999.83952, a_4 = 105.56302 x 10^{-9},

a_1 = 16.945176, a_5 =-208.54253 x 10^{-12}, and

a_2 = -7.9870401 x 10^{-3}, C = 16.87985 x 10^{-3}.

a_3 = -46.170461 x 10^{-6},

The water used in this experimental program was not distilled, but drawn from the municipal water supply and placed in the facility reservoir. Due to dissolved minerals in the water, the density values are offset somewhat from that of distilled water. Periodically samples were drawn from the reservoir of the system and their densities were measured near 20 °C. See Appendix B for a description of the measurement principle, a listing of the data collected, the results obtained and an analysis of the uncertainty in the resulting values. The results of these observations are given in table 19. The difference between the measured values of the mineral-laden water samples and the distilled water density values are uniform for all samples. The standard deviation of these difference values is 0.039 kg/m^3 with a mean value of 0.194 kg/m^3. This value will be taken as a constant offset to the density of distilled water as computed using the Kell formula. The density of the water flowing in the flow measurement facility is calculated using the Kell density correlation with the offset value added to it to reflect its mineral content. This method will be used for any other flowing fluid density values given in this document.

Table 19. Measured Water Density Values

Sample Type	Period Value (sec)	PRT Resistance (ohms)	Temperature (°C)	Density (kg/m^3)	Diff. (kg/m^3)
Dist. Water	38.67970	1086.06	22.191	997.728	
Xylene	37.37086	1086.04	22.186	865.555	
8/02/85	38.68136	1086.03	22.184	997.898	0.182
7/18/85	38.68145	1086.03	22.184	997.910	0.170
6/25/85	38.68142	1086.00	22.176	997.908	0.178
8/02/85	38.68142	1086.05	22.189	997.905	0.177
1/09/85	38.68109	1086.05	22.189	997.871	0.143
10/20/83	38.68174	1086.04	22.186	997.938	0.209
7/24/85	38.68140	1086.05	22.186	997.903	0.175
12/27/84	38.68212	1086.05	22.186	997.977	0.250
4/05/86	38.68224	1086.06	22.191	997.989	0.262

Computed Instrument Constant = 1.3278645

Average Diff. 0.194
Std. Dev. of the Diff. 0.039

The uncertainty in the flowing fluid density is the sum of the random effects, which are dominated by the variation in the tap-water sample densities, and the systematic effects largely due to the 0.12 kelvin uncertainty in the thermometer used for temperature measurement. This uncertainty contributes 0.034 kg/m^3 systematically to give a total uncertainty in the water density of (0.034 + 0.117) kg/m^3. Since the variation in the water density is relatively small around a value of 1000 kg/m^3, the relative uncertainty in the water density is taken as 0.015%.

F. Dimensional Measurements

1. Orifice Meter Installation

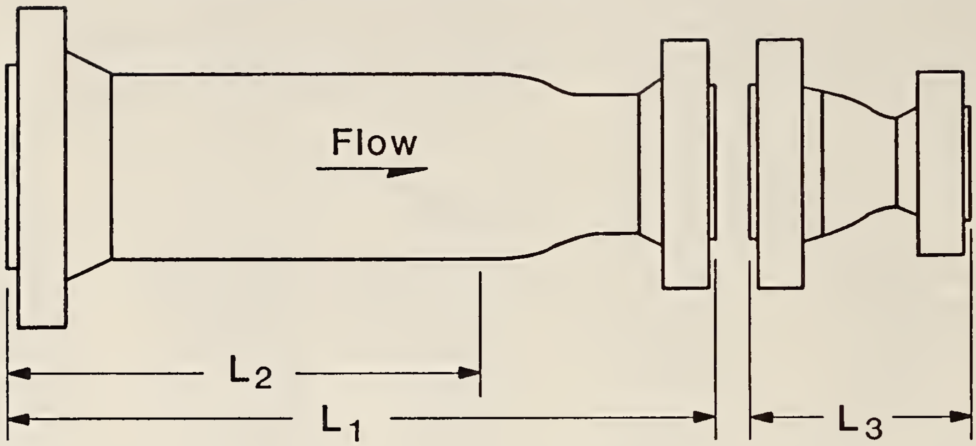
There are three sizes of test sections in the water flow facility. These are designated by the nominal pipe size comprising the test section. The total usable length is approximately 55 feet (18 meters) and varies somewhat with test section. The test section nominal pipe diameters are 4, 8, and 16 inches (100, 200, and 400 millimeters). The five sizes of orifice meters tested were installed in the test sections as shown in table 20.

Table 20. Test Section/Orifice Meter Installation Chart (nominal sizes in inches)

Orifice Meter Diameter (inch)	Test Section (inch)	Manifold/Sprenkle Separation (Pipe Diameters)
2	4	60
3	4	30
4	4	20
6	8	10
10	16	1

The general installation of the orifice meter tubes and flow conditioner in a flow facility test section was shown in figure 2. Conditioning of the flow immediately upstream of the meter tube assembly was done using Sprenkle [15] flow conditioners. Location of the flow conditioner/meter tube assembly was arranged so that the maximum distance downstream from the pump discharge manifold was obtained. In the case of the 10-inch orifice meters, a specially constructed container for the Sprenkle flow conditioner was required since the normal casing would have made the installed length longer than the available length in the 16-inch test section. The 16-inch flow conditioner casing consisted of a cylindrical spool piece two pipe diameters long with a conical 16- by 10-inch reducing section fitted with appropriately sized flanges. A schematic diagram of the normal casing is shown in figure 14. The schematic of the Sprenkle flow conditioner is shown in figure 15. The flow conditioner consists of three plates spaced one pipe diameter apart. Each plate is perforated with a hexagonal pattern of holes. The hole diameters and spacing depended upon the line size of flow conditioner. Hole diameters and spacings for each line size are listed below.

Line Size	Orifice Meter Size	Hole Diameter (inch)	Hole Spacing (inch)
4-inch	2, 3	0.242	0.330
6-inch	4	0.410	0.470
10-inch	6	0.406	0.469
16-inch	10		



Flow Conditioner Casing Specifications

Size	Flange Sizes		Lengths	
	Upstream	Downstream	L_1(Inches)	L_2(Inches)
4-inch	4-inch	3-inch	19-5/8	12
6-inch	6-inch	4-inch	26-7/16	16-1/2
10-inch	10-inch	6-inch	38	26
16-inch	16-inch	16-inch	33	-

Reducer Specifications

Size	Lengths
3x2	10-3/8 inch
4x3	11-7/8 inch
16x10	14-inch

Figure 14. Sprenkle Flow Conditioner Casing

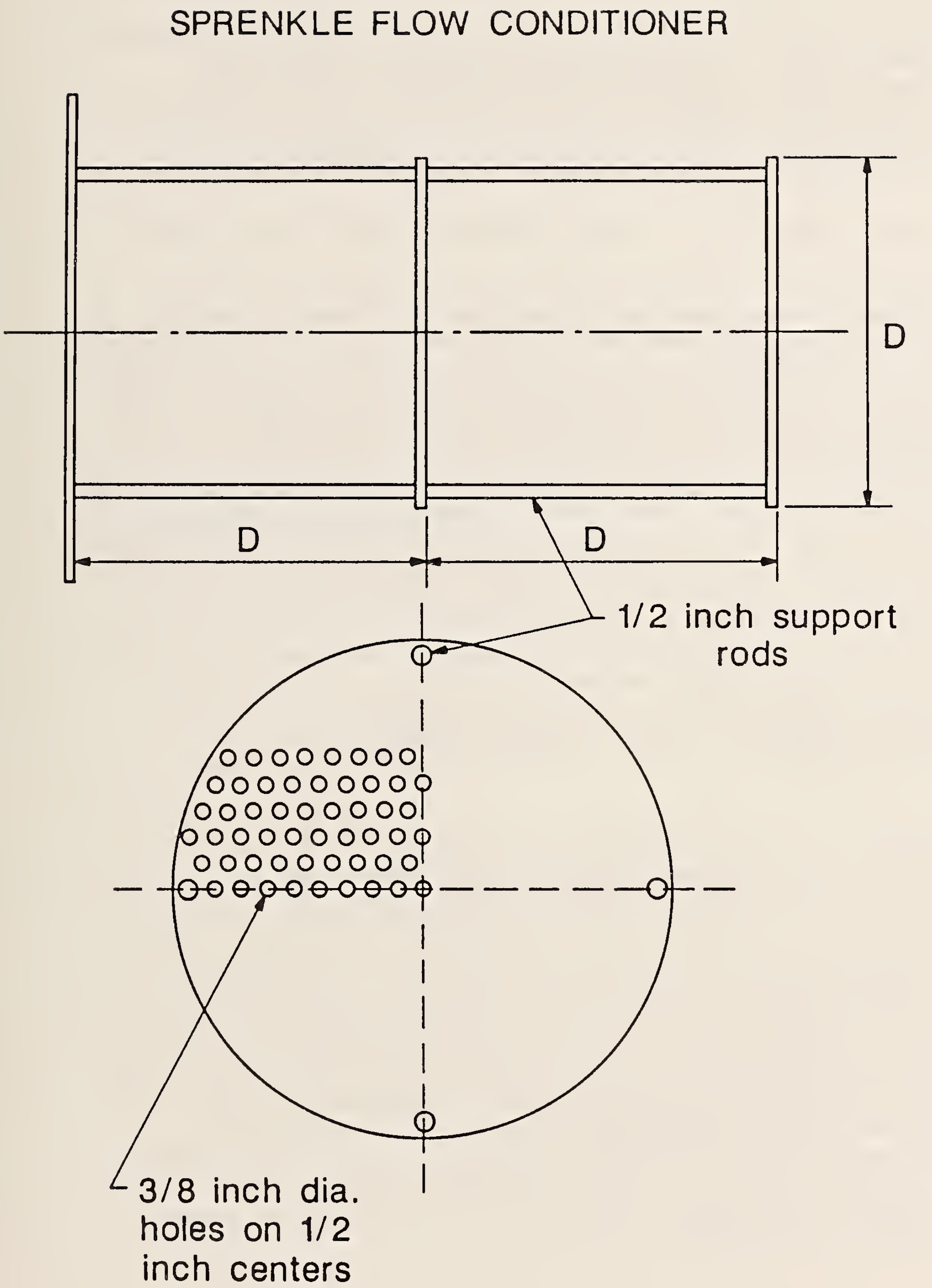


Figure 15. Sprenkle Flow Conditioner Schematic Diagram

The flow conditioners were oversized relative to the orifice meters used with them, as shown above. The plates were welded to four rods symmetrically spaced around the circumference of the plates. The diameter of the plate/rod assembly was made such that the assembly fit closely in its respective casing forcing the flow through the plate perforations.

2. Orifice Meter Tube Geometry and Dimensional Measurements

The general geometry of each set of orifice meter tubes was the same. Three sections formed a set comprising a single meter tube. In all cases 600-pound ANSI flanges were used in all meter tubes. The Sprenkle flow conditioner was bolted to the upstream flange of the approach tube section, which was bolted to the upstream meter tube itself. (For the 3-inch meter tube a 4 by 3 reducer was placed between the flow conditioner and the approach tube.) The orifice plates were pinned between the downstream flange of the upstream meter tube and the upstream flange of the downstream meter tube. These two flanges will be referred to as the orifice meter flanges in the remainder of this report. The arrangement of an orifice meter tube is shown schematically in figure 16. Also one of the flange/meter tube sections is shown schematically in figure 16. This diagram is labeled with several reference positions which were used for measurements of the meter tube diameters. As shown, two dowel pins were drilled in each orifice meter flange. Additionally, the flange's joining the approach tube and the upstream meter tube were fitted with dowel pins which aligned the centerlines of the tube sections. In this way any step between these tubes was minimized or eliminated.

The dowel pins in the orifice flanges provided mechanical constraint on the position of the orifice plate centerline when installed between them. The flange pairs joining sections A and B, and B and C (the orifice flanges) were fitted with O-ring seals. These are not shown in the diagram. This was done to eliminate any interference that a normal insertion type gasket may have caused should it not be positioned correctly. Also the distances between the orifice tap holes and the orifice plate faces were much more reproducible than would have been the case with gaskets which would have been used repeatedly and would have changed thickness with time, thereby causing a continual change in the distance between the plate faces and the tap holes. As will be discussed in the operational procedures section of this report, the separation between the dowel pins and the orifice plate was held to a small value throughout the project through the use of feeler gauges during orifice plate installation.

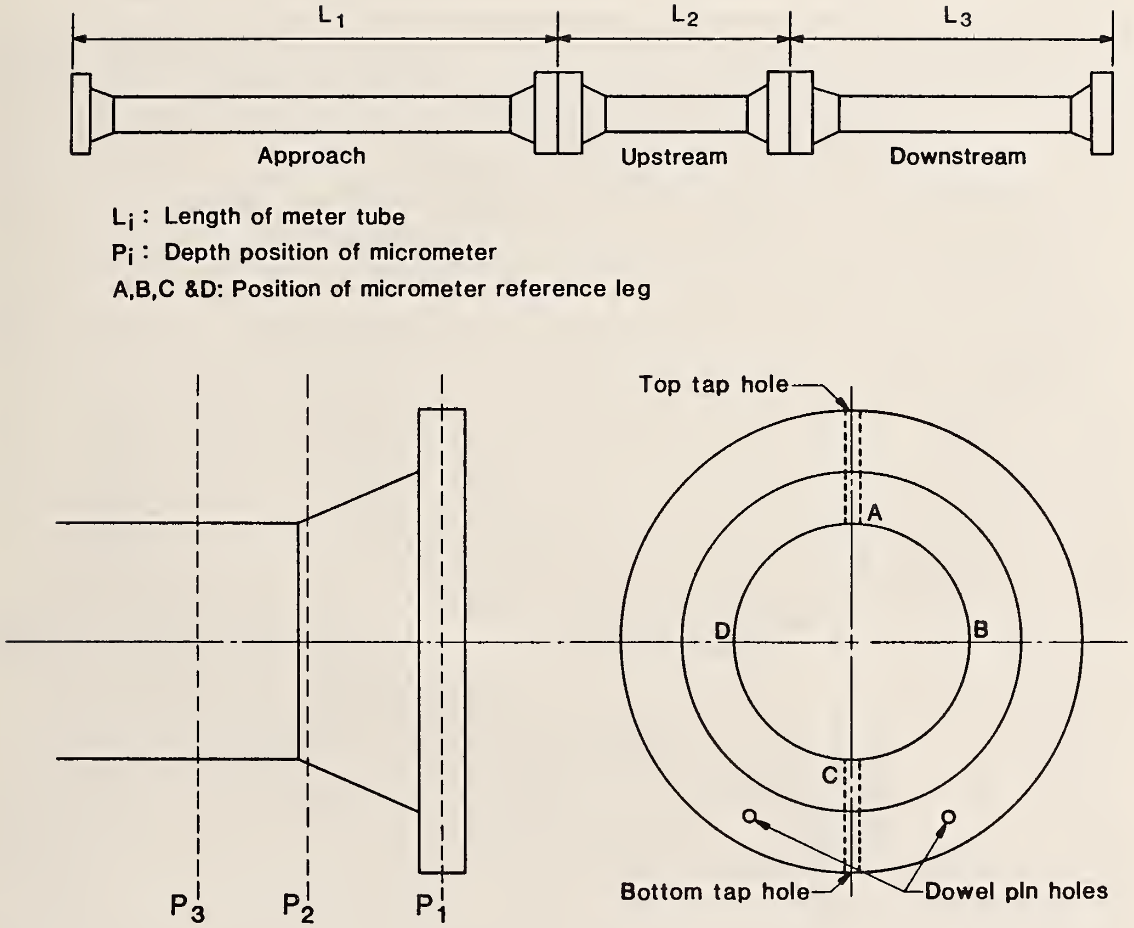


Figure 16. Orifice Meter Tube Assembly

Dimensional Measurements of the Orifice Meter Tubes

The schematic diagrams in figure 16 indicate several reference positions and lengths associated with a meter tube set: the lengths of the three tube sections and reference positions associated with the diameter measurements. Diameter measurements were made with a set of internal micrometers of the type shown in the photograph in figure 17. This type of micrometer, especially designed for the measurement of cylindrical hole diameters, consists of three arms which center the micrometer in the cylinder to be measured. The readability of each of the micrometers was 0.0001 inches (2.54 micrometers). Each micrometer of the set was adjusted to read directly using proving rings traceable to NBS length standards. The proving rings were also used to determine the reproducibility of diameters using the micrometers once these were properly adjusted. Typical reproducibilities between operators was 0.0003 inches (7.62 micrometers) for diameters up to 6 inches. This decreased somewhat (0.0002 inches (5 micrometers)) for the smaller diameter meter tubes. For the 10-inch diameter meter tube the reproducibility of diameter measurements increased to approximately 0.001 inches (25 micrometers) due to the considerably increased difficulty in setting the micrometer lands in the meter tube.

The procedure used for measurement of the diameter of the meter tube sections at the orifice flanges involved the four circumferential positions labelled A through D and the three axial positions labelled P_1 through P_3 in figure 16. Although only the diameter near the centerline of the tap holes (position 1) was used in the calculation of discharge coefficients (this being the customary position for stating the meter tube diameter), three positions along the length of each section were measured to characterize the contour of the tube near the orifice plate. Both the upstream and downstream sections were measured. Position 2 was located in the region of the weld between the flange and tubing/pipe forming the tube section. Position 3 was located approximately one pipe diameter toward the interior of the meter section, from the weld. In several cases this position was approximately two pipe diameters from the flange face.

Four measurements of the diameter were made at each of the three axial positions, except for the 10-inch meter tubes. Diameters were measured for the 10-inch meter tubes only at positions 1 and 2 because the micrometer could not be read reliably when placed in the third position. At each of these depth positions four observations of the diameter were made. One of the three arms of the micrometer was designated as the reference arm and was aligned with one of the four circumferential positions for each measurement. In this way an indication of the out-of-roundness of the meter tube diameter may be detected in addition to obtaining four independent measurements of the diameter for that depth position. Position 1 coincided with the centerline of the tap holes. To avoid the tap holes, measurements made at positions A and C were made with the micrometer's reference arm positioned near the 1 and 7 o'clock positions respectively. The results of these measurements are tabulated in tables 21 through 24.

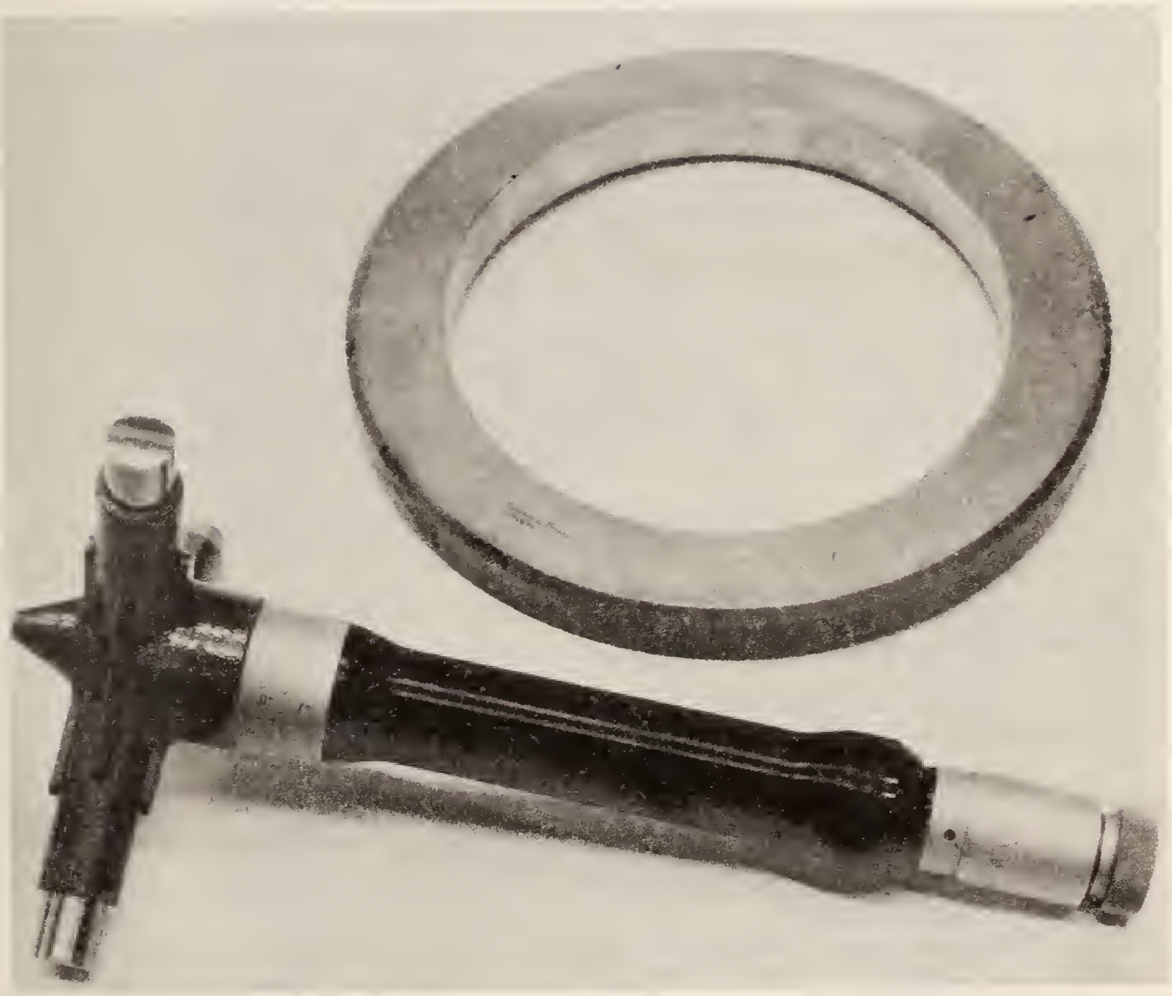


Figure 17. Internal Micrometer Used for Measurement of Orifice Meter Tube Diameters

Table 21A. Orifice Meter Tube Diameter Measurements Before Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-1ABC
Surface Condition - BARE Observer - SW Date 05/17/85
Meter Tube Section Lengths
FE-1A 69.750 in. FE-1B 17.938 in. FE-1C 39.938 in.

Diameter Measurements - Meter Section - FE-1B

Position	A	B	C	D	Mean
1	2.0726	2.0725	2.0723	2.0721	2.0724
2	2.0713	2.0709	2.0722	2.0722	2.0716
3	2.0732	2.0673	2.0767	2.0742	2.0728

Diameter Measurements - Meter Section - FE-1C

Position	A	B	C	D	Mean
1	2.0709	2.0706	2.0708	2.0713	2.0709
2	2.0718	2.0727	2.0717	2.0700	2.0715
3	2.0689	2.0725	2.0737	2.0678	2.0707

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-2ABC
Surface Condition - BARE Observer - GPB Date 07/17/85
Meter Tube Section Lengths
FE-2A 69.750 in. FE-2B 17.988 in. FE-2C 41.938 in.

Diameter Measurements - Meter Section - FE-2B

Position	A	B	C	D	Mean
1	2.0721	2.0714	2.0716	2.0714	2.0716

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-3ABC
Surface Condition - BARE Observer - SW Date 05/17/85

Meter Tube Section Lengths
FE-3A 104.750 in. FE-3B 26.875 in. FE-3C 53.875 in.

Diameter Measurements - Meter Section - FE-3B

Position	A	B	C	D	Mean
1	3.0735	3.0727	3.0732	3.0734	3.0732
2	3.0742	3.0712	3.0737	3.0750	3.0735

Diameter Measurements - Meter Section - FE-3C

Position	A	B	C	D	Mean
1	3.0755	3.0759	3.0756	3.0754	3.0756
2	3.0721	3.0738	3.0754	3.0736	3.0737

Table 21B. Orifice Meter Tube Diameter Measurements
Before Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-4ABC
Surface Condition - BARE Observer - SW Date 06/04/85

Meter Tube Section Lengths
FE-4A 104.875 in. FE-4B 27.063 in. FE-4C 54.000 in.

Diameter Measurements - Meter Section - FE-4B

Position	A	B	C	D	Mean
1	3.0783	3.0778	3.0780	3.0783	3.0781
2	3.0790	3.0800	3.0731	3.0784	3.0776
3	3.0846	3.0825	3.0781	3.0828	3.0820

Diameter Measurements - Meter Section - FE-4C

Position	A	B	C	D	Mean
1	3.0767	3.0765	3.0769	3.0770	3.0768
2	3.0754	3.0760	3.0757	3.0737	3.0752
3	3.0802	3.0724	3.0761	3.0801	3.0772

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-5ABC
Surface Condition - BARE Observer - GPB Date 09/17/85

Meter Tube Section Lengths
FE-5A 139.750 in. FE-5B 35.875 in. FE-5C 65.875 in.

Diameter Measurements - Meter Section - FE-5B

Position	A	B	C	D	Mean
1	4.0485	4.0473	4.0498	4.0456	4.0478
2	4.0503	4.0508	4.0515	4.0478	4.0501
3	4.0381	4.0393	4.0382	4.0366	4.0381

Diameter Measurements - Meter Section - FE-5C

Position	A	B	C	D	Mean
1	4.0368	4.0380	4.0402	4.0364	4.0378
2	4.0306	4.0320	4.0322	4.0351	4.0325
3	4.0321	4.0284	4.0346	4.0339	4.0322

Table 21C. Orifice Meter Tube Diameter Measurements
Before Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-6ABC
Surface Condition - BARE Observer - SW Date 05/17/85

Meter Tube Section Lengths
FE-6A 139.750 in. FE-6B 35.875 in. FE-6C 66.000 in.

Diameter Measurements - Meter Section - FE-6B

Position	A	B	C	D	Mean
1	4.0326	4.0349	4.0296	4.0351	4.0331
2	4.0320	4.0349	4.0335	4.0368	4.0343
3	4.0270	4.0396	4.0399	4.0367	4.0358

Diameter Measurements - Meter Section - FE-6C

Position	A	B	C	D	Mean
1	4.0327	4.0313	4.0315	4.0351	4.0327
2	4.0284	4.0287	4.0275	4.0302	4.0287
3	4.0307	4.0334	4.0329	4.0346	4.0329

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-7ABC
Surface Condition - BARE Observer - GPB Date 08/22/85

Meter Tube Section Lengths
FE-7A 209.750 in. FE-7B 54.000 in. FE-7C 90.000 in.

Diameter Measurements - Meter Section - FE-7B

Position	A	B	C	D	Mean
1	6.1200	6.1200	6.1200	6.1200	6.1200
2	6.1197	6.1196	6.1196	6.1197	6.1197
3	6.1198	6.1198	6.1198	6.1200	6.1198

Diameter Measurements - Meter Section - FE-7C

Position	A	B	C	D	Mean
1	6.1183	6.1185	6.1182	6.1184	6.1184
2	6.1195	6.1194	6.1195	6.1197	6.1195
3	6.1200	6.1198	6.1194	6.1198	6.1197

Table 21D. Orifice Meter Tube Diameter Measurements Before Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-8ABC
Surface Condition - BARE   Observer - GPB   Date 07/01/85

Meter Tube Section Lengths
FE-8A 209.75 in. FE-8B 53.875 in. FE-8C 90.00 in.

Diameter Measurements - Meter Section - FE-8B

Position	A	B	C	D	Mean
1	6.0833	6.0833	6.0841	6.0861	6.0842
2	6.0823	6.0928	6.1039	6.0884	6.0918

Diameter Measurements - Meter Section - FE-8C

Position	A	B	C	D	Mean
1	6.0790	6.0846	6.0837	6.0838	6.0828
2	6.0860	6.0891	6.0812	6.0914	6.0869

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-9ABC
Surface Condition - BARE   Observer - GPB   Date 05/13/85

Meter Tube Section Lengths
FE-9A 349.750 in. FE-9B 89.875 in. FE-9C 143.750 in.

Diameter Measurements - Meter Section - FE-9B

Position	A	B	C	D	Mean
1	10.0829	10.0829	10.0830	10.8290	10.0829

Orifice Meter Diameter Measurements For Meter Tube Assembly - FE-0ABC
Surface Condition - BARE   Observer - GPB   Date 09/24/85

Meter Tube Section Lengths
FE-0A 349.625 in. FE-0B 89.875 in. FE-0C 143.750 in.

Diameter Measurements - Meter Section - FE-0B

Position	A	B	C	D	Mean
1	10.0246	10.0254	10.0266	10.0267	10.0258

Tables 21A through 21D tabulate the diameter measurements made on each mild steel meter tube before electroless nickel plating [16] with a thickness of between 0.0005 and 0.001 inches (12 to 25 micrometers). The measurements given in these tables were abbreviated in several cases, although all tubes had at least one measurement set at position 1 of the upstream meter tube section. Table 22 tabulates the diameter measurements for the 4-inch (100 mm) stainless meter tube which was used as a check standard for the testing program after nickel plating of the mild steel meter tubes. Tables 23A through 23E tabulate the diameter measurements taken on the meter tubes after nickel plating. For these the full number of measurements were made. Table 24 tabulates the means of the position 1 measurements on the upstream meter tube section. These values were used in the calculation of the discharge coefficient. The length of each meter section is given in both sets of tables.

The diameter measurements tabulated here are those taken after approximately 4 years of effort in this project and represent the culmination of considerable work to identify and eliminate the spurious effect of surface roughness on the measurement of the discharge coefficient (see Appendix A). During the course of these efforts numerous measurements of the diameters of the meter tubes were made. The results of these observations are described in Appendix G for the purpose of completeness of documentation for this project.

Table 22. Orifice Meter Tube Diameter Measurements for the 4-Inch Stainless Steel Orifice Meter Tube Check Standard

Orifice Meter Diameter Measurements For Meter Tube Assembly - DAN-4SS
Surface Condition - BARE Observer - GPB Date 09/24/85

Meter Tube Section Lengths
DAN-4SS 239.875 in. DAN-4SS 40.0

Diameter Measurements - Meter Section - DAN-4SS-U

Position	A	B	C	D	Mean
1	4.0309	4.0302	4.0302	4.0310	4.0306
2	4.0274	4.0283	4.0268	4.0309	4.0283
3	4.0262	4.0254	4.0258	4.0256	4.0258

Diameter Measurements - Meter Section - DAN-4SS-D

Position	A	B	C	D	Mean
1	4.0238	4.0220	4.0225	4.0237	4.0230
2	4.0271	4.0209	4.0281	4.0269	4.0258
3	4.0258	4.0264	4.0244	4.0284	4.0263

Table 23A. Orifice Meter Tube Diameter Measurements After Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-1ABC
Surface Condition - PLATED Observer - GS Date 07/29/85

Meter Tube Section Lengths
PE-1A 69.750 in. PE-1B 17.938 in. PE-1C 41.938 in.

Diameter Measurements - Meter Section - PE-1B

Position	A	B	C	D	Mean
1	2.0717	2.0723	2.0716	2.0711	2.0717
2	2.0711	2.0708	2.0709	2.0705	2.0708
3	2.0683	2.0651	2.0752	2.0732	2.0705

Diameter Measurements - Meter Section - PE-1C

Position	A	B	C	D	Mean
1	2.0694	2.0693	2.0689	2.0694	2.0692
2	2.0670	2.0678	2.0680	2.0676	2.0676
3	2.0672	2.0711	2.0694	2.0665	2.0686

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-2ABC
Surface Condition - PLATED Observer - GPB Date 08/02/85

Meter Tube Section Lengths
PE-2A 69.750 in. PE-2B 17.938 in. PE-2C 41.938 in.

Diameter Measurements - Meter Section - PE-2B

Position	A	B	C	D	Mean
1	2.0696	2.0694	2.0694	2.0696	2.0695
2	2.0680	2.0676	2.0671	2.0655	2.0671
3	2.0621	2.0620	2.0613	2.0601	2.0614

Diameter Measurements - Meter Section - PE-2C

Position	A	B	C	D	Mean
1	2.0645	2.0648	2.0646	2.0648	2.0647
2	2.0630	2.0644	2.0652	2.0655	2.0645
3	2.0642	2.0620	2.0642	2.0617	2.0630

Table 23B. Orifice Meter Tube Diameter Measurements After Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-3ABC
Surface Condition - PLATED Observer - GS Date 07/23/85

Meter Tube Section Lengths
PE-3A 104.750 in. PE-3B 26.875 in. PE-3C 53.875 in.

Diameter Measurements - Meter Section - PE-3B

Position	A	B	C	D	Mean
1	3.0707	3.0716	3.0729	3.0721	3.0718
2	3.0705	3.0689	3.0713	3.0713	3.0705
3	3.0826	3.0648	3.0678	3.0817	3.0742

Diameter Measurements - Meter Section - PE-3C

Position	A	B	C	D	Mean
1	3.0723	3.0719	3.0725	3.0722	3.0722
2	3.0722	3.0712	3.0721	3.0722	3.0719
3	3.0740	3.0737	3.0741	3.0742	3.0740

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-4ABC
Surface Condition - PLATED Observer - GS Date 07/24/85

Meter Tube Section Lengths
PE-4A 104.875 in. PE-4B 27.063 in. PE-4C 54.000 in.

Diameter Measurements - Meter Section - PE-4B

Position	A	B	C	D	Mean
1	3.0739	3.0751	3.0746	3.0751	3.0747
2	3.0747	3.0741	3.0719	3.0751	3.0739
3	3.0850	3.0814	3.0782	3.0833	3.0820

Diameter Measurements - Meter Section - PE-4C

Position	A	B	C	D	Mean
1	3.0741	3.0740	3.0746	3.0745	3.0743
2	3.0735	3.0736	3.0745	3.0726	3.0736
3	3.0762	3.0721	3.0768	3.0791	3.0760

Table 23C. Orifice Meter Tube Diameter Measurements After Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-5ABC
Surface Condition - PLATED Observer - SW Date 10/08/85

Meter Tube Section Lengths
PE-5A 139.750 in. PE-5B 35.875 in. PE-5C 65.875 in.

Diameter Measurements - Meter Section - PE-5B

Position	A	B	C	D	Mean
1	4.0426	4.0365	4.0472	4.0416	4.0420
2	4.0485	4.0495	4.0458	4.0460	4.0475
3	4.0375	4.0374	4.0351	4.0344	4.0361

Diameter Measurements - Meter Section - PE-5C

Position	A	B	C	D	Mean
1	4.0473	4.0365	4.0376	4.0366	4.0395
2	4.0337	4.0291	4.0359	4.0372	4.0340
3	4.0332	4.0263	4.0334	4.0328	4.0314

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-6ABC
Surface Condition - PLATED Observer - GPB Date 06/24/85

Meter Tube Section Lengths
PE-6A 139.750 in. PE-6B 35.875 in. PE-6C 66.000 in.

Diameter Measurements - Meter Section - PE-6B

Position	A	B	C	D	Mean
1	4.0325	4.0324	4.0332	4.0342	4.0331
2	4.0292	4.0350	4.0346	4.0344	4.0333
3	4.0267	4.0323	4.0367	4.0309	4.0316

Diameter Measurements - Meter Section - PE-6C

Position	A	B	C	D	Mean
1	4.0318	4.0311	4.0315	4.0332	4.0319
2	4.0279	4.0292	4.0289	4.0310	4.0293
3	4.0296	4.0312	4.0314	4.0325	4.0312

Table 23D. Orifice Meter Tube Diameter Measurements
After Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-7ABC
Surface Condition - PLATED Observer - GPB Date 12/04/85

Meter Tube Section Lengths
PE-7A 209.75 in. PE-7B 54.0 in. PE-7C 90.0 in.

Diameter Measurements - Meter Section - PE-7B

Position	A	B	C	D	Mean
1	6.1236	6.1238	6.1237	6.1237	6.1237
2	6.1234	6.1236	6.1233	6.1233	6.1234

Diameter Measurements - Meter Section - PE-7C

Position	A	B	C	D	Mean
1	6.1223	6.1223	6.1222	6.1221	6.1222
2	6.1238	6.1237	6.1237	6.1235	6.1237

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-8ABC
Surface Condition - PLATED Observer - GPB Date 08/15/85

Meter Tube Section Lengths
PE-8A 209.75 in. PE-8B 53.875 in. PE-8C 90.00 in.

Diameter Measurements - Meter Section - PE-8B

Position	A	B	C	D	Mean
1	6.0830	6.0815	6.0824	6.0847	6.0829
2	6.0809	6.0938	6.0774	6.0885	6.0851
3	6.0850	6.0883	6.0893	6.0823	6.0862

Diameter Measurements - Meter Section - PE-8C

Position	A	B	C	D	Mean
1	6.0778	6.0835	6.0843	6.0823	6.0820
2	6.0828	6.0895	6.0797	6.0891	6.0853
3	6.0911	6.0885	6.0829	6.0925	6.0888

Table 23E. Orifice Meter Tube Diameter Measurements After Electroless Nickel Plating

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-9ABC
Surface Condition - PLATED Observer - GPB Date 11/04/85

Meter Tube Section Lengths
PE-9A 349.750 in. PE-9B 89.875 in. PE-9C 143.750 in.

Meter Section - PE-9B

Position	A	B	C	D	Mean
1	10.0814	10.0805	10.0814	10.0816	10.0812
2	10.0822	10.0817	10.0815	10.0825	10.0820

Meter Section - PE-9C

Position	A	B	C	D	Mean
1	10.0909	10.0907	10.0907	10.0911	10.0908
2	10.0894	10.0900	10.0897	10.0902	10.0898

Orifice Meter Diameter Measurements For Meter Tube Assembly - PE-0ABC
Surface Condition - PLATED Observer - GPB Date 11/04/85

Meter Tube Section Lengths
PE-0A 349.625 in. PE-0B 89.875 in. PE-0C 143.750 in.

Diameter Measurements - Meter Section - PE-0B

Position	A	B	C	D	Mean
1	10.0240	10.0240	10.0244	10.0245	10.0242
2	10.0189	10.0272	10.0096	10.0174	10.0183

Diameter Measurements - Meter Section - PE-0C

Position	A	B	C	D	Mean
1	10.0286	10.0304	10.0332	10.0352	10.0318
2	10.0401	10.0485	10.0456	10.0429	10.0443

Table 24. Orifice Meter Tube Mean Diameters in the Plane of the Tap Hole Center Lines (Axial Position 1)

Meter Tube	Diameter (inches)	Meter Tube	Diameter (inches)
PE-1ABC	2.0717	FE-1ABC	2.0724
PE-2ABC	2.0695	FE-2ABC	2.0716
PE-3ABC	3.0718	FE-3ABC	3.0732
PE-4ABC	3.0747	FE-4ABC	3.0781
PE-5ABC	4.0420	FE-5ABC	4.0478
PE-6ABC	4.0331	FE-6ABC	4.0331
PE-7ABC	6.1237	FE-7ABC	6.1200
PE-8ABC	6.0829	FE-8ABC	6.0842
PE-9ABC	10.0812	FE-9ABC	10.0829
PE-0ABC	10.0242	FE-0ABC	10.0258
DAN-4SS	4.0306		

3. Meter Tube Surface Roughness Measurements

Meter tube surface roughness measurements were made to characterize the condition of the interior surfaces of the meter tubes. Measurements were made of the surface roughness before and after nickel plating. Two instruments were used: a Profilometer Peak Counter (PPC) manufactured by Bendix, Sheffeld Division [3] was used for some of the initial measurements, and a Surtronic 3 (S3) manufactured by Rank Precision [3] was used for the final measurements. Both instruments were compared with a tablet of known surface roughness as a check of the instrument indication.

For consistency, measurements were made at two locations. These were at the 5 and 11 o'clock positions with respect to the pressure tappings in the orifice flange. The upper tap hole defines the 12 o'clock position. Since this type of measurement is obtained from a stylus-type of instrument which averages the roughness over a finite length, the position of the middle of the stylus stroke was positioned near the plane of the tap holes. The Surtronic 3 instrument was compensated for long-period fluctuations in the surface roughness with three ranges of stylus movement and signal averaging, 0.010, 0.030, and 0.100 inch period length filtering settings. All three of these settings were recorded when using this instrument and are listed in table 25. The Profilometer Peak Counter did not have this feature and only the single observation is given. In each case for this device a range is given for the roughness measurement as indicated by the values separated by a slash (/). All values are given as the RMS fluctuation in the surface profile in units of microinches. Measurements were made on both meter tubes comprising the orifice meter itself, i.e., Sections B and C.

4. Orifice Plate Dimensional Measurements

Orifice plate dimensional measurements were made using a 3-axis coordinate measuring machine having a sensitivity of 0.0001 inch. The measuring machine was operated in a room maintained at 20 °C +/- 0.5 °C. A computer controlled data acquisition system allowed reduction of coordinate data to yield various types of results.

<u>Orifice Diameter and Plate Concentricity</u>

The orifice diameter and the position of its center relative to the physical center of the orifice plate were measured. This procedure used observation of at least three coordinate points approximately equally

Table 25. Orifice Meter Tube Interior Surface Roughness Measurements

Meter Tube	Instrum.	Date	Surface Roughness 5 O'CLOCK .100	5 O'CLOCK .030	5 O'CLOCK .010	11 O'CLOCK .100	11 O'CLOCK .030	11 O'CLOCK .010
			(microinches RMS)					
FE-1B	PPC	05/17/85		109/135			144/138	
PE-1B	S3	08/23/85	195	155	108	189	136	93
FE-1C	PPC	05/17/85		150/155			174/155	
PE-1C	S3	08/23/85	169	144	81	199	192	95
FE-2B	PPC	05/23/85		151/159			160/136	
PE-2B	S3	08/23/85	206	194	212	319	268	214
FE-2C	PPC	05/23/85		236/227			205/175	
PE-2C	S3	08/23/85	219	248	191	260	184	112
FE-3B	PPC	05/17/85		135/149			55/54	
PE-3B	S3	08/23/85	169	122	55	88	38	38
FE-3C	PPC	05/17/85		172/168			143/140	
PE-3C	S3	08/23/85	176	153	142	171	124	50
FE-4B	PPC	05/17/85		52/52			39/39	
PE-4B	S3	08/23/85	126	96	49	165	101	52
FE-4C	PPC	05/17/85		140/155			236/226	
PE-4C	S3	08/23/85	276	150	97	349	261	121
FE-5B	S3	09/17/85	179	77	41	143	109	45
PE-5B	S3	10/18/85	435	240	172	331	203	106
FE-5C	S3	09/17/85	109	73	54	143	102	40
PE-5C	S3	10/18/85	325	289	184	238	166	91
FE-6B	PPC	05/17/85		152/174			220/215	
PE-6B	S3	08/23/85	246	180	118	248	231	172
FE-6C	PPC	05/17/85		245/246			170/173	
PE-6C	S3	08/23/85	248	230	120	207	138	86
FE-7B	S3	08/22/85	58	63	42	57	32	23
PE-7B	S3	11/04/85	23	34	41	29	69	198
FE-7C	S3	08/22/85	56	38	36	63	46	34
PE-7C	S3	11/04/85	112	100	184	20	50	129
FE-8B	PPC	05/23/85		147/150			91/89	
PE-8B	S3	08/22/85	184	158	91	141	113	75
FE-8C	PPC	05/23/85		189/177			225/219	
PE-8C	S3	08/22/85	239	223	112	230	281	161

Table 25. Orifice Meter Tube Interior Surface Roughness Measurements -- Continued

Meter Tube	Inst.	Date	Surface Roughness ----- 5 O'CLOCK ------ .100	.030	.010	----- 11 O'CLOCK ------ .100	.030	.010
			(microinches RMS)					
FE-9B	PPC	05/23/85		27/30			35/31	
PE-9B	S3	11/04/85	42	36	23	76	53	29
FE-9C	PPC	05/23/85		23/24			21/20	
PE-9C	S3	11/04/85	93	61	85	224	230	137
FE-0B	S3	09/26/85	257	257	154	242	195	130
PE-0B	S3	11/04/85	335	206	108	246	212	230
FE-0C	S3	09/26/85	264	201	155			
PE-0C	S3	11/04/85	244	240	173	384	293	176

spaced around the plate outer circumference. The data acquisition system fit these points to a circle to calculate the plate diameter value and to determine the circle's origin. The measuring machine's coordinate axes were then reset to coincide with this origin. Next the orifice circumference was obtained by making several (3 to 8) observations around the outer plate edge at equally spaced points. The position of the orifice center relative to the coordinate machine axes origin and its diameter were then computed.

Of course, this measure of the concentricity of the orifice is relative to the plate geometry only. Determination of the position of the orifice relative to the meter tube axis relies on the two dowel pins located in the orifice meter flanges against which the plate edge rests when installed. Therefore, the positions of these dowel pins were measured. The measured values of the separation of each dowel pin mounting hole's surface nearest the meter tube center and the inner edge of the meter tube are listed in table 26. The orientation of the orifice meter is as if one were viewing the upstream face of the orifice plate with the two dowel pins disposed to the left and right of the orifice center.

The measured diameter values for the plated meter tubes were used to express the position of the locating surfaces of the dowel pins as the diameter of a circle centered at the meter tube axis. (This is similar in concept to the bolt hole circle dimension commonly used in locating the bolt holes in the orifice flange.) These diameter values are listed in table 26 as the dowel surface diameter as are approximate means of the orifice plates for comparison purposes. The concentricity tolerance band prescribed by commercial practice [17] is also given for reference. It is clear that the construction of the orifice meter flanges and their locating pins was well within the prescribed acceptance band.

The dowel pin tap surfaces were designed to be in contact with the orifice plate in the installed condition, thereby locating the center of the orifice at the meter tube axis. In practice a maximum gap between the plate edge and the dowel pin of 0.0015 inches was allowed when installing a plate. Procedures used to achieve this are described later in this report.

Table 26. Orifice Flange Center to Dowel Pin Inner Surface Radii

Meter Tube Section	Nom. Dia. (in.)	Right Dowel (in.)	Left Dowel (in.)	Dowel Surface Diameter (in.)		Plate Nom. Dia. (in.)	Conc. Band (in.)
FE-1B-D	2	1.150	1.153	4.372	4.378	4.372	0.06
FE-1C-U	2	1.157	1.155	4.386	4.382		0.06
FE-3B-D	3	1.410	1.405	5.892	5.882	5.872	0.09
FE-3C-U	3	1.410	1.401	5.892	5.874		0.09
FE-4B-D	3	1.402	1.400	5.879	5.875	5.872	0.09
FE-4C-U	3	1.403	1.399	5.877	5.872		0.09
FE-5B-D	4	1.537	1.534	7.116	7.110	7.122	0.12
FE-5C-U	4	1.540	1.538	7.122	7.118		0.12
FE-6B-D	4	1.542	1.538	7.117	7.109	7.122	0.12
FE-6C-U	4	1.544	1.544	7.121	7.121		0.12
FE-7C-U	6	1.881	1.888	9.886	9.990	9.873	0.18
FE-7B-D	6	1.879	1.886	9.882	9.896		0.18
FE-8C-U	6	1.896	1.902	9.875	9.887	9.873	0.18
FE-8B-D	6	1.895	1.897	9.873	9.877		0.18
FE-9B-D	10	2.087	2.084	14.255	14.249	14.250	0.30
FE-9C-U	10	2.099	2.102	14.279	14.285		0.30
FE-0B-D	10	2.112	2.111	14.248	14.246	14.250	0.30
FE-0C-U	10	2.109	2.116	14.242	14.256		0.30

Orifice Plate Flatness Measurements

Measurement of the plate flatness was done using the coordinate measuring machine. The measurement procedure involved the observation of the z or height position of the top surface of the plate at 12 points. All observation patterns were referenced to a line generally bisecting the orifice and handle of the plate as shown in figure 18. The z-axis origin of the measuring machines' coordinate system was reset to an arbitrary position at the top of one of the two machinists parallels supporting the orifice plate. Four sets of three observations were made. These are illustrated in figure 18 by the numbered points.

The measure of flatness accepted in industrial practice [17] utilizes the dam height of the orifice as installed. The dam height is that portion of the plate which influences the performance of the orifice meter defined as follows,

$$\text{Dam Ht.} = (D \cdot d)/2$$

where D - meter tube diameter, and
d - orifice diameter.

Limits of acceptance for the plate flatness [17] correspond to 0.010 inches per inch of dam height. This upper limit is expressed as

$$\text{Flatness Limit} = 0.010\ (D - d)/2.$$

This criterion is used as the basis for expressing the measured flatness of the plates. The 12 observed position values taken on each plate were segregated into groups as shown in figure 18. A straight line was fit to each set of values to determine the slope of the line over the width of the plate measured. These slope values were then multiplied by the dam height to obtain the flatness measure. Comparison with the flatness limit of all plates for which the 12 point observation sequence was performed showed that all were within acceptable limits.

Measurement of the orifice plates were made through the course of the project. In the large majority of the cases the initial measurements performed on the orifice plates were made before the plate was involved in flow tests. In a few cases this occurred after flow testing. These initial measurements of the orifice diameters were the values used in computing the results of the tests. In the initial round of observations the orifice diameter was always measured, but the concentricity, flatness, and plate outer diameter were not always measured. Table 27 lists the results of the initial dimensional measurements on the orifice plates, including

1. the orifice diameter,
2. the plate outer diameter,
3. the concentricity of the orifice relative to the plate's outside diameter expressed as x,y coordinates,
4. the flatness of the plate using the eight point observation method, and
5. the thickness of the plate.

For those parameters which were not measured, the table entry is zero or marked appropriately.

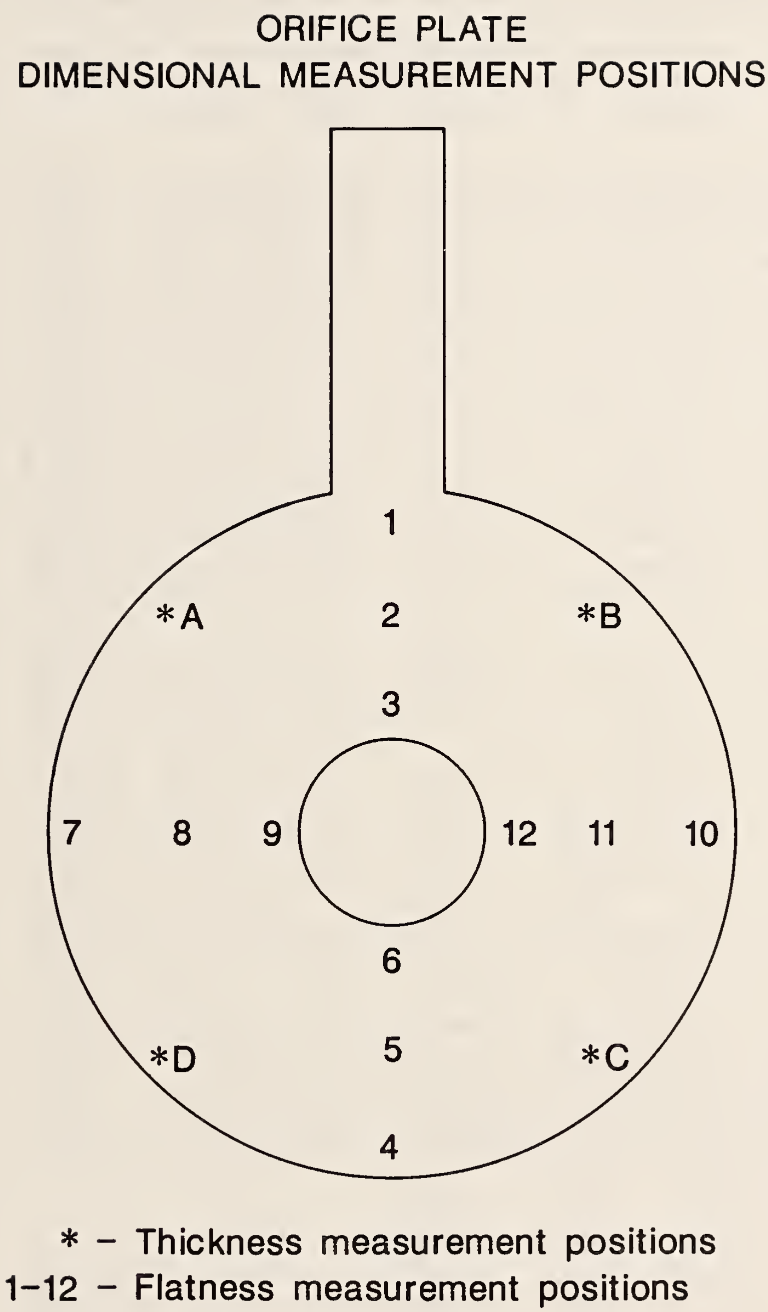


Figure 18. Orifice Plate Flatness and Thickness Measurement Positions

Table 27. Orifice Plate Initial Dimensional Measurements

Plate Desig.	Date	Orifice Dia. (in.)	Num. Obs.	Plate Dia. (in.)	Concentricity X (in.)	Concentricity Y (in.)	Flatness	Num. Obs.
FE-1/2-1A	08/20/84	0.5000	8	4.3722	0.0040	0.0006	0.0000	0
FE-1/2-2A	08/20/84	0.7502	8	4.3721	0.0040	-0.0002	0.0000	0
FE-1/2-3A	08/20/84	0.9996	8	4.3719	0.0030	-0.0004	0.0000	0
FE-1/2-4A	08/20/84	1.1244	8	4.3729	0.0042	0.0004	0.0000	0
FE-1/2-5A	08/20/84	1.3750	8	4.3727	0.0039	-0.0004	0.0000	0
FE-1/2-6A	08/20/84	1.5002	8	4.3722	0.0036	-0.0006	0.0000	0
FE-1/2-7A	07/19/84	0.2498	3	0.0000	0.0000	0.0000	0.0000	0
FE-1/2-1B	09/25/84	0.5004	8	4.3712	-0.0110	0.0010	0.0000	0
FE-1/2-2B	09/25/84	0.7502	8	4.3728	-0.0040	0.0006	0.0000	0
FE-1/2-3B	09/25/84	0.9998	8	4.3719	-0.0040	0.0003	0.0000	0
FE-1/2-4B	09/25/84	1.1248	8	4.3722	-0.0032	-0.0003	0.0000	0
FE-1/2-5B	09/25/84	1.3746	8	4.3723	-0.0040	0.0005	0.0000	0
FE-1/2-6B	09/25/84	1.5004	8	4.3727	0.0000	0.0000	0.0000	0
FE-1/2-7B	07/19/84	0.2504	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-1A	08/20/84	0.6248	8	5.8728	-0.0046	-0.0001	0.0000	0
FE-3/4-2A	08/20/84	1.1250	8	5.8709	-0.0045	-0.0040	0.0000	0
FE-3/4-3A	08/20/84	1.5000	8	5.8715	-0.0045	-0.0021	0.0000	0
FE-3/4-4A	08/20/84	1.7508	8	5.8707	-0.0053	-0.0011	0.0000	0
FE-3/4-5A	08/20/84	2.0006	8	5.8730	-0.0049	-0.0008	0.0000	0
FE-3/4-6A	08/20/84	2.2492	8	5.8719	-0.0023	-0.0004	0.0000	0
FE-3/4-7A	--	0.3757	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-8A	04/23/86	0.2510	3	5.8780	0.0000	0.0010	0.0025	12
FE-3/4-1B	07/19/84	0.6247	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-2B	07/19/84	1.1251	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-3B	07/19/84	1.4997	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-4B	07/19/84	1.7496	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-5B	07/19/84	2.0001	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-6B	07/17/84	2.2499	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-7B	07/19/84	0.3756	3	0.0000	0.0000	0.0000	0.0000	0
FE-3/4-8B	04/23/86	0.2506	3	5.8731	0.0000	0.0000	-0.0009	12

Table 27. Orifice Plate Initial Dimensional Measurements -- Continued

Plate Desig.	Date	Orifice Dia. (in.)	Num. Obs.	Plate Dia. (in.)	Concentricity X (in.)	Concentricity Y (in.)	Flatness	Num. Obs.
FE-5/6-1A	--	0.8750	8	7.1223	0.0189	-0.0033	0.0000	0
FE-5/6-2A	--	1.4991	8	7.1224	0.0179	-0.0024	0.0000	0
FE-5/6-3A	--	1.9988	8	7.1207	0.0057	-0.0198	0.0000	0
FE-5/6-4A	--	2.2491	8	7.0000	0.0202	-0.0013	0.0000	0
FE-5/6-5A	--	2.6242	8	7.1222	-0.0044	0.0042	0.0000	0
FE-5/6-5A	08/20/84	2.6244	8	7.1221	-0.0035	0.0017	0.0000	0
FE-5/6-6A	--	2.9998	10	7.1214	0.0000	0.0000	0.0000	0
FE-5/6-6A	08/20/84	2.9998	8	7.1210	0.0166	-0.0017	0.0000	0
FE-5/6-7A	07/18/84	0.3740	3	0.0000	0.0000	0.0000	0.0000	0
FE-5/6-8A	10/25/85	0.2513	3	0.0000	0.0000	0.0000	0.0014	12
FE-5/6-1B	10/28/82	0.8752	3	7.1219	0.0000	-0.0088	0.0000	0
FE-5/6-2B	10/28/82	1.5002	1	7.1238	0.0006	-0.0110	0.0000	0
FE-5/6-3B	10/28/82	1.9995	1	7.1185	0.0067	-0.0020	0.0000	0
FE-5/6-4B	10/28/82	2.2496	1	7.1244	-0.0009	-0.0130	0.0000	0
FE-5/6-5B	10/28/82	2.6249	1	7.1225	-0.0014	0.0014	0.0000	0
FE-5/6-6B	10/28/82	3.0000	1	7.1208	0.0010	-0.0079	0.0000	0
FE-5/6-7B	10/28/82	0.3737	1	7.1228	0.0044	0.0154	0.0000	0
FE-5/6-8B	10/25/85	0.2476	3	0.0000	0.0000	0.0000	0.0034	12
FE-5/6-1C	06/03/85	0.8747	3	0.0000	0.0000	0.0000	0.0027	12
FE-5/6-2C	06/03/85	1.5012	3	0.0000	0.0000	0.0000	-0.0018	12
FE-5/6-3C	06/03/85	2.0005	3	0.0000	0.0000	0.0000	0.0014	12
FE-5/6-4C	06/03/85	2.2503	3	0.0000	0.0000	0.0000	0.0014	12
FE-5/6-5C	06/03/85	2.6247	3	0.0000	0.0000	0.0000	0.0008	12
FE-5/6-6C	06/03/85	2.9998	3	0.0000	0.0000	0.0000	0.0011	12
FE-5/6-7C	06/03/85	0.3754	3	0.0000	0.0000	0.0000	-0.0025	12
FE-7/8-1A	05/11/84	1.2494	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-2A	05/11/84	2.2498	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-2A	--	2.2501	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-3A	--	3.0001	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-3A	05/11/84	3.0005	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-4A	05/11/84	3.4979	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-4A	--	3.4990	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-5A	05/11/84	3.9997	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-6A	05/11/84	4.4992	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-7A	02/07/84	0.6252	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-7A	05/11/84	0.6250	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-8A	--	1.2503	1	0.0000	0.0000	0.0000	0.0000	0

Table 27. Orifice Plate Initial Dimensional Measurements -- Continued

Plate Desig.	Date	Orifice Dia. (in.)	Num. Obs.	Plate Dia. (in.)	Concentricity X (in.)	Concentricity Y (in.)	Flatness	Num. Obs.
FE-7/8-1B	--	1.2496	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-2B	--	2.2499	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-3B	--	3.0004	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-4B	--	3.4999	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-5B	--	4.0002	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-6B	--	4.4997	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-7B	02/07/84	0.6254	1	0.0000	0.0000	0.0000	0.0000	0
FE-7/8-8B	06/13/86	0.6234	3	9.8731	0.0000	0.0017	0.0055	12
FE-7/8-1C	09/03/85	1.2499	3	0.0000	0.0000	0.0000	0.0037	12
FE-7/8-3C	09/03/85	2.9994	3	0.0000	0.0000	0.0000	0.0018	12
FE-7/8-5C	09/03/85	3.9994	3	0.0000	0.0000	0.0000	-0.0008	12
FE-9/0-1A	05/03/84	1.9987	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-2A	05/03/84	3.7480	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-3A	05/03/84	4.9985	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-4A	05/03/84	5.7488	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-5A	05/03/84	6.6241	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-6A	05/03/84	7.4996	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-7A	05/03/84	1.0001	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-1B	05/03/84	1.9983	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-2B	05/03/84	3.7480	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-3B	05/03/84	4.9976	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-4B	05/03/84	5.7488	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-5B	05/03/84	6.6239	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-6B	05/03/84	7.4997	1	0.0000	0.0000	0.0000	0.0000	0
FE-9/0-7B	05/03/84	0.9995	1	0.0000	0.0000	0.0000	0.0000	0

Orifice Plate Confirmatory Measurements

In order to obtain a set of complete and uniform measurements describing the geometric parameters of the orifice plates and to more fully document their geometrical characteristics, a confirmatory set of measurements was made on all plates. These measurements were performed using a uniform set of procedures and the 3-axis measuring machine used in the original measurements. The results of these measurements are contained in table 28. Descriptions of the procedures used in making the measurements for each characterizing parameter are given below.

1. Inner Diameter (ID) - The diameter of the orifice was measured using either three or four observation points of the position of the circumference.

2. Outer Diameter (OD) - The outer diameter of an orifice plate was measured using procedures similar to that of the orifice.

3. Plate ID to OD Concentricity - The difference in the positions of the centers of the circles representing the OD and ID of the orifice plate relative to one another gives the concentricity of the two. The measurement procedures defined the horizontal or xy origin of the measuring machine's space coordinate system as the plate center from its outer circumference position observations. The position of the center of the orifice in the space coordinate system expressed in x and y coordinates is listed in the concentricity column of table 28.

4. Plate Flatness - Measurement of the flatness of the plate used the 12 point method described above.

5. Plate Thickness - Measurement of the plate thickness was done using a conventional micrometer having a resolution of 0.0001 inches. Thickness measurements were made along the outer edge of the plate at approximately equally spaced positions marked A through D in figure 18. These observations are listed under the thickness columns in table 28.

6. Ring Diameter - As a check of the performance of the measuring machine during the period of the measurements, observations of the inner diameter of a gauge ring were made as the initial and final measurements of each series. The same ring was used for all plates. Its diameter was 3.3999 inches at 20 degrees Celsius. The mean of the observed diameters is 3.39988 inches with a standard deviation for a single observation of 0.0001 inch.

Tap Hole Geometry

Measurements of the distance from the orifice flange face to the tap hole center line and the tap hole diameters were made using a dial caliper, a telescoping type hole-gauge and a micrometer. The distance from the tap hole edge nearest the flange face was measured with the caliper. This value was added to half the measured tap hole diameter to determine the distance of the hole center line from the flange face at the inner surface of the meter tube. These values are tabulated in table 29. The stainless meter tube was also measured and was found to not satisfy the API standard 2530 requirements. However, this meter tube was used only for statistical control purposes in this project and is not presented as conforming with the normal industry specifications for orifice meter tubes. The B meter tube section orifice flange is upstream of the orifice plate and the corresponding flange of the C section is downstream of the plate. The stainless steel meter tube flanges are labeled U and D appropriately.

Table 28. Confirmatory Plate Diameter and flatness Measurements
(All dimensional values given in units of inches)

Plate Design.	Date	ID	No. Obs.	OD	No. Obs.	Concentricity X	Concentricity Y	Flat-ness	No. Obs.	Thickness 1	Thickness 2	Thickness 3	Thickness 4	Ring Diameter		No. Obs.
FE-1/2-1A	07/14/86	0.4995	3	4.3737	3	0.0001	-0.0019	0.0004	12	0.1230	0.1235	0.1245	0.1250	3.3998	3.4000	4
FE-1/2-2A	07/14/86	0.7498	3	4.3685	3	-0.0024	-0.0027	-0.0005	12	0.1200	0.1230	0.1230	0.1220	3.3998	3.3999	4
FE-1/2-3A	07/14/86	0.9990	3	4.3738	3	-0.0009	-0.0013	0.0005	12	0.1190	0.1220	0.1220	0.1200	3.3999	3.3999	4
FE-1/2-4A	07/14/86	1.1240	3	4.3734	3	-0.0005	-0.0006	-0.0005	12	0.1220	0.1230	0.1240	0.1230	3.3998	3.4000	4
FE-1/2-5A	07/14/86	1.3740	3	4.3722	3	-0.0019	-0.0007	-0.0003	12	0.1210	0.1220	0.1230	0.1185	3.3999	3.4000	4
FE-1/2-6A	07/14/86	1.4999	3	4.3739	3	-0.0004	-0.0006	0.0004	12	0.1204	0.1215	0.1225	0.1215	3.4000	3.3999	4
FE-1/2-7A	07/14/86	0.2492	3	4.3747	3	0.0006	-0.0032	0.0035	12	0.1270	0.1250	0.1260	0.1260	3.3999	3.4000	4
FE-1/2-1B	07/14/86	0.4993	3	0.0000	0	0.0007	-0.0027	0.0013	12	0.1170	0.1210	0.1200	0.1170	3.3998	3.4000	4
FE-1/2-2B	07/14/86	0.7498	4	4.3738	4	-0.0003	-0.0010	0.0007	12	0.1210	0.1230	0.1220	0.1200	3.4000	3.4000	4
FE-1/2-3B	07/14/86	0.9985	4	4.3733	4	-0.0008	-0.0011	0.0001	12	0.1230	0.1235	0.1235	0.1230	3.3999	3.3999	4
FE-1/2-4B	07/14/86	1.1241	4	4.3732	4	-0.0011	-0.0016	0.0007	12	0.1225	0.1230	0.1225	0.1230	3.3999	3.4000	4
FE-1/2-5B	07/14/86	1.3736	4	4.3741	4	-0.0010	-0.0011	0.0004	12	0.1240	0.1240	0.1245	0.1245	3.3998	3.3998	4
FE-1/2-6B	07/14/86	1.4994	4	4.3740	4	-0.0003	-0.0009	0.0001	12	0.1220	0.1220	0.1235	0.1235	3.3998	3.3998	4
FE-1/2-7B	07/14/86	0.2500	4	4.3762	4	0.0010	-0.0031	0.0022	12	0.1310	0.1305	0.1305	0.1305	3.3999	3.4000	4
FE-3/4-1A	07/14/86	0.6237	4	5.8751	4	0.0006	0.0021	-0.0025	12	0.1240	0.1250	0.1240	0.1240	3.4000	3.4000	4
FE-3/4-2A	07/14/86	1.1250	4	5.8725	4	0.0015	0.0018	0.0049	12	0.1220	0.1230	0.1220	0.1230	3.3999	3.4000	4
FE-3/4-3A	07/14/86	1.4995	4	5.8740	3	0.0005	0.0026	0.0020	12	0.1240	0.1250	0.1245	0.1230	3.3999	3.3999	4
FE-3/4-4A	07/14/86	1.7497	4	5.8726	3	0.0008	0.0026	0.0010	12	0.1250	0.1245	0.1250	0.1240	3.4000	3.3999	4
FE-3/4-5A	07/14/86	2.0004	4	5.8731	4	-0.0001	0.0036	0.0002	12	0.1250	0.1240	0.1255	0.1250	3.3999	3.3998	4
FE-3/4-6A	07/14/86	2.2487	4	5.8736	4	0.0004	0.0022	-0.0007	12	0.1240	0.1245	0.1235	0.1230	3.3999	3.4000	4
FE-3/4-7A	07/14/86	0.3744	4	5.8740	4	-0.0009	0.0058	0.0009	12	0.1270	0.1280	0.1280	0.1280	3.3999	3.3998	4
FE-3/4-8A	07/14/86	0.2495	4	5.8791	4	-0.0007	0.0023	-0.0004	12	0.1220	0.1230	0.1230	0.1220	3.3998	3.3997	4

Table 28. Confirmatory Plate Diameter and flatness Measurements -- Continued
(All dimensional values given in units of inches)

Plate Design.	Date	ID	No. Obs.	OD	No. Obs.	Concentricity X	Concentricity Y	Flat-ness	No. Obs.	Thickness 1	Thickness 2	Thickness 3	Thickness 4	Ring Diameter		No. Obs.
FE-3/4-1B	07/15/86	0.6243	4	5.8747	3	0.0024	0.0005	-0.0001	12	0.1255	0.1250	0.1240	0.1250	3.3999	3.3999	4
FE-3/4-2B	07/14/86	1.1242	4	5.8740	3	0.0014	0.0011	-0.0014	12	0.0000	0.0000	0.0000	0.0000	3.3998	3.3999	4
FE-3/4-3B	07/14/86	1.4988	4	5.8750	3	0.0000	0.0012	0.0003	12	0.1230	0.1220	0.1230	0.1230	3.3999	3.3999	4
FE-3/4-4B	07/14/86	1.7492	4	5.8749	3	0.0013	0.0009	-0.0024	12	0.1245	0.1245	0.1250	0.1240	3.3999	3.3999	4
FE-3/4-5B	07/14/86	1.9993	4	5.8739	3	0.0011	0.0009	-0.0011	12	0.1240	0.1240	0.1240	0.1240	3.4000	3.4001	4
FE-3/4-6B	07/14/86	2.2496	4	5.8722	3	0.0002	0.0002	0.0002	12	0.1200	0.1225	0.1220	0.1220	3.3997	3.3998	4
FE-3/4-7B	07/14/86	0.3751	4	5.8760	3	0.0021	0.0024	-0.0006	12	0.1272	0.1272	0.1272	0.1272	3.3998	3.3999	4
FE-3/4-8B	07/14/86	0.2494	3	5.8746	3	-0.0003	0.0017	0.0013	12	0.1260	0.1250	0.1245	0.1245	3.4000	3.3997	4
FE-5/6-1A	07/17/86	0.8743	4	7.1234	4	0.0011	-0.0083	0.0002	12	0.1225	0.1225	0.1225	0.1220	3.4000	3.3997	4
FE-5/6-2A	07/17/86	1.4987	4	7.1230	4	0.0014	-0.0087	-0.0002	12	0.1210	0.1205	0.1210	0.1210	3.3999	3.4000	4
FE-5/6-3A	07/17/86	1.9983	4	7.1208	4	0.0104	-0.0017	0.0008	12	0.1210	0.1210	0.1210	0.1205	3.4000	3.3997	4
FE-5/6-4A	07/17/86	2.2485	4	7.1233	4	-0.0004	-0.0096	0.0004	12	0.1215	0.1212	0.1215	0.1215	3.3998	3.3999	4
FE-5/6-5A	07/17/86	2.6239	4	7.1231	4	-0.0011	0.0019	0.0004	12	0.1200	0.1190	0.1200	0.1200	3.3998	3.3998	4
FE-5/6-6A	07/17/86	2.9995	4	7.1217	4	0.0009	-0.0079	-0.0000	12	0.1200	0.1205	0.1190	0.1190	3.3999	3.3998	4
FE-5/6-7A	07/17/86	0.3732	4	7.1221	4	0.0038	0.0146	-0.0031	12	0.1230	0.1220	0.1235	0.1230	3.3998	3.4000	4
FE-5/6-8A	07/17/86	0.2462	3	7.1200	4	-0.0001	0.0014	-0.0010	12	0.1235	0.1245	0.1230	0.1220	3.4000	3.3999	4
FE-5/6-1B	07/17/86	0.8742	4	7.1227	4	0.0018	-0.0080	-0.0014	12	0.1210	0.1210	0.1205	0.1200	3.4000	3.3999	4
FE-5/6-2B	07/17/86	1.4994	4	7.1246	4	0.0016	-0.0082	-0.0014	12	0.1200	0.1200	0.1200	0.1205	3.3999	3.3998	4
FE-5/6-3B	07/17/86	1.9988	4	7.1221	4	0.0097	-0.0027	-0.0014	12	0.1210	0.1210	0.1210	0.1210	3.3998	3.4000	4
FE-5/6-4B	07/17/86	2.2490	4	7.1248	4	-0.0021	-0.0103	0.0007	12	0.1220	0.1220	0.1220	0.1213	3.3999	3.3998	4
FE-5/6-5B	07/17/86	2.6243	4	7.1248	4	-0.0011	0.0021	-0.0012	12	0.1205	0.1195	0.1185	0.1190	3.3999	3.3998	4
FE-5/6-6B	07/17/86	2.9982	4	7.1231	4	0.0013	-0.0083	-0.0003	12	0.1205	0.1195	0.1205	0.1210	3.3999	3.3999	4
FE-5/6-7B	07/17/86	0.3740	4	7.1225	4	0.0039	0.0138	0.0027	12	0.1250	0.1230	0.1235	0.1250	3.3999	3.4000	4
FE-5/6-8B	07/17/86	0.2499	4	7.1199	4	0.0023	0.0003	-0.0032	12	0.1235	0.1240	0.1235	0.1230	3.4001	3.3999	4

Table 28. Confirmatory Plate Diameter and flatness Measurements -- Continued
(All dimensional values given in units of inches)

Plate Design.	Date	ID	No. Obs.	OD	No. Obs.	Concentricity X	Concentricity Y	Flat-ness	No. Obs.	Thickness 1	Thickness 2	Thickness 3	Thickness 4	Ring Diameter		No. Obs.
FE-5/6-1C	07/17/86	0.8742	4	7.1191	4	0.0008	-0.0008	0.0013	12	0.1200	0.1220	0.1220	0.1200	3.4000	3.3999	4
FE-5/6-2C	07/17/86	1.5009	4	7.1190	4	-0.0022	0.0016	0.0015	12	0.1200	0.1210	0.1220	0.1205	3.3998	3.3998	4
FE-5/6-3C	07/17/86	2.0001	4	7.1185	4	-0.0017	0.0022	0.0001	12	0.1220	0.1230	0.1225	0.1225	3.3998	3.3999	4
FE-5/6-4C	07/17/86	2.2498	4	7.1195	4	-0.0021	0.0020	0.0015	12	0.1225	0.1230	0.1225	0.1220	3.3997	3.3999	4
FE-5/6-5C	07/17/86	2.6243	4	7.1185	4	-0.0001	0.0019	-0.0005	12	0.1220	0.1230	0.1230	0.1215	3.3998	3.3999	4
FE-5/6-6C	07/17/86	2.9994	4	7.1179	4	0.0015	0.0026	-0.0002	12	0.1240	0.1280	0.1290	0.1270	3.3998	3.3998	4
FE-5/6-7C	07/17/86	0.3746	4	7.1187	4	-0.0011	0.0016	0.0004	12	0.1220	0.1220	0.1230	0.1235	3.3999	3.3998	4
FE-7/8-8A	07/17/86	1.2494	4	9.8701	4	0.0016	-0.0027	0.0004	12	0.1270	0.1270	0.1255	0.1250	3.3999	3.3998	4
FE-7/8-2A	07/17/86	2.2491	4	9.8746	4	-0.0034	-0.0125	0.0011	12	0.1170	0.1140	0.1175	0.1160	3.3999	3.3999	4
FE-7/8-3A	07/17/86	2.9984	4	9.8716	4	-0.0044	-0.0119	0.0170	12	0.1185	0.1175	0.1185	0.1190	3.3998	3.3999	4
FE-7/8-4A	07/17/86	3.4987	4	9.8737	4	-0.0033	-0.0129	-0.0002	12	0.1185	0.1180	0.1190	0.1195	3.4001	3.3999	4
FE-7/8-5A	07/17/86	3.9996	4	9.8726	4	-0.0026	-0.0132	0.0014	12	0.1170	0.1170	0.1170	0.1170	3.3999	3.3999	4
FE-7/8-6A	07/17/86	4.4988	4	9.8737	4	-0.0040	-0.0124	0.0014	12	0.1190	0.1180	0.1175	0.1160	3.3998	3.3998	4
FE-7/8-7A	09/09/86	0.6238	3	9.8732	4	0.0005	0.0010	0.0076	12	0.1250	0.1260	0.1250	0.1240	0.0000	0.0000	0
FE-7/8-8B	07/17/86	0.6241	4	9.8727	4	-0.0010	0.0010	-0.0057	12	0.1215	0.1220	0.1230	0.1220	3.3999	3.4000	4
FE-7/8-1C	07/17/86	1.2488	4	9.8730	4	0.0000	0.0030	0.0016	12	0.1210	0.1215	0.1220	0.1215	3.4000	3.3999	4
FE-7/8-2B	07/17/86	2.2488	4	9.8726	4	-0.0029	-0.0122	-0.0029	12	0.1190	0.1175	0.1180	0.1180	3.3999	3.3999	4
FE-7/8-3C	07/17/86	2.9989	4	9.8663	4	-0.0005	0.0069	-0.0026	12	0.1210	0.1210	0.1210	0.1210	3.4000	3.3998	4
FE-7/8-4B	07/17/86	3.4985	4	9.8713	4	-0.0049	-0.0119	0.0019	12	0.0000	0.0000	0.0000	0.0000	3.3999	3.3999	4
FE-7/8-5B	07/17/86	3.9989	4	9.8741	4	-0.0021	-0.0133	-0.0029	12	0.1170	0.1175	0.1187	0.1190	3.3999	3.3999	4
FE-7/8-6B	07/17/86	4.4990	4	9.8728	4	-0.0047	-0.0121	0.0058	12	0.1170	0.1175	0.1160	0.1175	3.3999	3.3999	4
FE-7/8-5C	07/17/86	3.9990	4	9.8673	4	-0.0011	0.0067	-0.0005	12	0.1220	0.1235	0.1260	0.1230	3.3997	3.3999	4

Table 28. Confirmatory Plate Diameter and flatness Measurements -- Continued
(All dimensional values given in units of inches)

Plate Design.	Date	ID	No. Obs.	OD	No. Obs.	Concentricity X	Concentricity Y	Flat-ness	No. Obs.	Thickness 1	Thickness 2	Thickness 3	Thickness 4	Ring Diameter	No. Obs.
FE-9/0-1A	07/17/86	1.9991	4 1	4.2478	4	-0.0036	0.0005	-0.0029	12	0.2700	0.2690	0.2680	0.2730	3.3998 3.3998	4
FE-9/0-2A	07/17/86	3.7485	4 1	4.2485	4	-0.0045	0.0022	0.0048	12	0.2615	0.2640	0.2630	0.2640	3.4000 3.3998	4
FE-9/0-3A	07/17/86	4.9980	4 1	4.2477	4	-0.0043	0.0020	-0.0029	12	0.2625	0.2575	0.2580	0.2605	3.3997 3.3998	4
FE-9/0-4A	07/17/86	5.7492	4 1	4.2493	4	-0.0044	0.0014	-0.0084	12	0.2625	0.2575	0.2610	0.2630	3.3999 3.3996	4
FE-9/0-5A	07/17/86	6.6239	4 1	4.2481	4	0.0047	-0.0052	0.0033	12	0.2635	0.2675	0.2650	0.2675	3.3998 3.3996	4
FE-9/0-6A	07/17/86	7.4995	4 1	4.2481	4	0.0032	-0.0045	0.0019	12	0.2675	0.2670	0.2645	0.2640	3.3998 3.4000	4
FE-9/0-7A	07/17/86	0.9999	4 1	4.2512	4	-0.0021	-0.0028	0.0030	12	0.2600	0.2610	0.2625	0.2640	3.3999 3.3998	4
FE-9/0-7AR	07/17/86	0.9997R	4 1R	4.2479R	4	-0.0009R	0.0015R	0.0078	12	0.2550R	0.2570	R0.2580R	0.2565	3.3999 3.3996	4
FE-9/0-1B	07/17/86	1.9980	4 1	4.2490	4	-0.0049	0.0007	-0.0067	12	0.2625	0.2545	0.2670	0.2680	3.3999 3.3998	4
FE-9/0-2B	07/17/86	3.7481	4 1	4.2492	4	-0.0047	0.0001	0.0045	12	0.2720	0.2670	0.2675	0.2665	3.3999 3.3999	4
FE-9/0-3B	07/17/86	4.9977	4 1	4.2508	4	-0.0056	0.0005	0.0037	12	0.2580	0.2570	0.2610	0.2590	3.3999 3.3999	4
FE-9/0-4B	07/17/86	5.7483	4 1	4.2504	4	-0.0065	0.0015	-0.0036	12	0.2650	0.2620	0.2650	0.2650	3.3998 3.3999	4
FE-9/0-5B	07/17/86	6.6229	4 1	4.2509	4	0.0031	-0.0052	0.0015	12	0.2630	0.2570	0.2650	0.2660	3.3998 3.3998	4
FE-9/0-6B	07/17/86	7.4987	4 1	4.2504	4	0.0041	-0.0054	-0.0029	12	0.2600	0.2580	0.2600	0.2600	3.3999 3.3999	4
FE-9/0-7B	07/17/86	0.9994	4 1	4.2516	4	-0.0032	-0.0019	0.0043	12	0.2630	0.2650	0.2670	0.2640	3.3998 3.3998	4

Table 29. Tap Hole Diameters and Center Line Separation with Respect to the Orifice Meter Flange Face

Meter Tube	Tap Hole Diameters (inches)		Flange Face to Tap Hole Center Line Separation (inches)	
	Top	Bottom	Top	Bottom
FE-1B	0.376	0.375	1.013	1.014
FE-1C	0.376	0.375	1.010	1.008
FE-3B	0.378	0.378	1.008	1.003
FE-3C	0.374	0.374	0.997	1.015
FE-4B	0.381	0.380	1.017	1.011
FE-4C	0.378	0.376	1.013	1.013
FE-5B	0.522	0.506	1.013	1.004
FE-5C	0.511	0.500	1.002	1.004
FE-6B	0.492	0.501	0.998	1.010
FE-6C	0.502	0.506	1.003	1.006
FE-7B	0.507	0.505	1.002	1.000
FE-7C	0.507	0.508	1.010	1.004
FE-8B	0.495	0.508	1.004	1.006
FE-8C	0.508	0.506	1.006	1.008
FE-9B	0.500	0.499	0.995	0.996
FE-9C	0.501	0.503	0.998	1.006
FE-0B	0.514	0.513	1.011	1.008
FE-0C	0.500	0.499	1.002	1.002
DAN-4U	0.501	0.503	1.002	1.030
DAN-4D	0.500	0.502	1.015	0.996

G. Propagation of Error Analysis of Discharge Coefficient Values

The uncertainty in the discharge coefficient values is the result of the combination of the uncertainties in the measured parameter values. The analysis of the contributions of the parameter components contributing to the uncertainty in C_d was given in part B of this section. Equation (1) is reproduced here for convenience in discussion of the contribution of the various parameters to the uncertainty statement for the coefficient of discharge.

$$C_d = \dot{m}(1 - \beta^4)^{1/2} / [Nd^2 F_a (\rho \Delta P)^{1/2}], \tag{1}$$

where C_d = discharge coefficient,
$\dot{m}$ = mass flow rate,
F_a = orifice thermal expansion factor
N = a constant whose value depends upon the units of the measured parameters,
ρ = density of the flowing fluid, water in this project,
ΔP = the differential pressure developed across the orifice meter,
β = d/D, the beta ratio, and
d = diameter of the orifice,

Analysis of the uncertainty of the various measurands in the previous sections has been done using the relative uncertainty in each. These components will be combined here to develop a relation for the relative uncertainty in the discharge coefficient resulting from the propagation of errors in the observed parameters. For most parameters the numerical value of the uncertainty is dependent upon the flow rate, orifice, or meter tube diameter, or flowing fluid temperature value of each test. The relative uncertainty in each parameter has been given as a simple mathematical formula. These will be combined to obtain an expression for the relative uncertainty in discharge coefficient which may be used to compute the uncertainty in the discharge coefficients calculated for each test run in the data base reported in this document. As has been the case in the development of the relations for the uncertainty for each observed parameter, the random error components will be combined in quadrature and the systematic error components will be combined additively. The general expression for this combination of error components is the following.

$$\frac{s_{C_d}}{C_d} = \left\{ \sum_n \left[\frac{1}{C_d} \frac{\partial C_d}{\partial x_n} \right]^2 s_{nr}^{\;2} \right\}^{1/2} + \sum_n \left[\frac{1}{C_d} \frac{\partial C_d}{\partial x_n} \right] s_{ns}, \tag{13}$$

where x_n = nth parameter in eq (1)
s_{nr} = random uncertainty component for the nth component,
s_{ns} = systematic uncertainty component for the nth component, and
s_{C_d} = uncertainty in the discharge coefficient value.

The following gives the uncertainty expressions, random and systematic, for each parameter from which the expression for relative uncertainty in the discharge coefficient will be developed.

1. Uncertainty in the Mass Flow Rate, $s_{\dot{m}}$

Equation (9) gives the relative uncertainty in the observed mass flow rate of water through the orifice meter, $s_{\dot{m}}/\dot{m}$.

$$\frac{s_{\dot{m}}}{\dot{m}} = \left[(s_I/M_t)^2 + (s_\tau/t)^2 + (6\ \text{ppm})^2 \right]^{1/2}$$

$$+ \frac{s_w}{M_s} + \frac{s_t}{t} \qquad (9)$$

where s_I = indication uncertainty of the scale, see table 10,
M_t = total mass of water collected in the weigh tank,
s_τ = uncertainty in the diversion time interval measurement, 0.0001 sec is taken as the value,
s_t = uncertainty in the diversion time measurement,
t = diversion time interval,
s_w = uncertainty in the mass standards, see table 10.

2. Uncertainty in the Differential Pressure, $s_{\Delta P}$

The three contributions to the uncertainty in differential pressure are dependent upon the differential pressure value itself, and to some extent the conditions of the test. Both types of uncertainty components are present. These components are given as the actual uncertainty in eq (12) which is reproduced below.

$$s_{\Delta P} = [(58 \times 10^{-6} P_t)^2 + (0.0016\ \text{psid})^2 + (3s_{\Delta Pm})^2$$

$$+ (3s_{\Delta Pf})^2]^{1/2} + 0.0048\ \text{psi} + 59 \times 10^{-6} \Delta P \qquad (12)$$

3. Uncertainty in the Flowing Fluid Density, s_ρ.

The contribution of this component is taken to be systematic with a magnitude of 0.00015 g/cm^3. The relative uncertainty value may be estimated by assuming that the density of water is 1 g/cm^3. Therefore, the relative uncertainty in the density of the flowing fluid is approximately 0.015%. In computing this uncertainty component the actual flowing fluid density is used.

4. Uncertainty of the Orifice and Meter Tube Diameters, s_d and s_D.

Both of these uncertainties are taken as systematic and have identical magnitudes of 0.0002 inches, with the exception of the 10-inch meter tubes where the value is 0.001 inch.

Expansion of the summations of eq (13) for the uncertainty in the discharge coefficient using the appropriate partial derivatives, and recognizing that those components having only a systematic or random portion remove terms from the corresponding summation term, yields the following expression:

$$\frac{s_{Cd}}{C_d} = \left\{\left(\frac{1}{C_d}\frac{\partial C_d}{\partial \dot{m}}\right)^2 s_{\dot{m}_r}^2 + \left(\frac{1}{C_d}\frac{\partial C_d}{\partial \Delta P}\right)^2 s_{\Delta P_r}^2\right\}^{1/2}$$

$$+ \frac{1}{C_d}\frac{\partial C_d}{\partial \dot{m}} s_{\dot{m}_s} + \frac{1}{C_d}\frac{\partial C_d}{\partial \Delta P} s_{\Delta P_s} + \frac{\partial C_d}{\partial \rho} s_\rho$$

$$+ \frac{1}{C_d}\frac{\partial C_d}{dd} s_d + \frac{1}{C_d}\frac{\partial C_d}{\partial D} s_D$$

where the subscripts s and r refer to the systematic and random parts of the uncertainty for the two parameters having both, i.e., the mass flow rate and differential pressure. The other terms are systematic only and appear only in that portion of the expression. Evaluation of the derivatives in the expression given above yields the following:

$$\frac{s_{Cd}}{C_d} = \left\{\left(\frac{s_{\dot{m}_r}}{\dot{m}}\right)^2 + \left(\frac{1}{2}\frac{s_{\Delta P_r}}{\Delta P}\right)^2\right\}^{1/2}$$

$$+ \frac{s_{\dot{m}_s}}{\dot{m}} + \frac{s_{\Delta P_s}}{2\Delta P} + \frac{s_\rho}{2\rho} + \left(\frac{2}{1-\beta^4}\right)\left(\frac{s_d}{d} + \beta^4 \frac{s_D}{D}\right)$$

Substitution of eqs (9) and (12) and appropriate terms discussed in the preceding sections yields the following expression for the relative uncertainty in the discharge coefficient value:

$$\frac{s_{Cd}}{C_d} = \left\{\left(\frac{s_I}{M_t}\right)^2 + \left(\frac{s_\tau}{t}\right)^2 + (6\text{x}10^{-6})^2 + \frac{1}{4\Delta P^2}\left[(58\text{x}10^{-6}P_t)^2\right.\right.$$

$$\left.\left. + (2.56\text{x}10^{-6}\text{psi}^2) + (3s_{\Delta Pm}^2)^2 + (3s_{\Delta Pf})^2\right]\right\}^{1/2} \tag{14}$$

$$+ \left(\frac{s_w}{M_s} + \frac{s_t}{t}\right) + \frac{1}{2\Delta P}(0.0049\text{ psi} + 59\text{x}10^{-6}\Delta P)$$

$$+ 0.00015(\text{g/cm}^3)/2\rho + \frac{2}{1-\beta^4}\left\{\frac{1}{d} + \frac{\beta^4}{D}\right\} 0.0002(\text{in}).$$

A tabulation of the various components contributing to the random and systematic uncertainties in the discharge coefficient allows an analysis of their relative magnitude. The results of such a set of computations of these uncertainty components for selected test runs are given in table 30. The major contributing parameters to uncertainty in the discharge coefficient are the mass flow rate and the differential pressure. Uncertainty components derived from the density and the orifice/meter tube diameters also contribute, but are smaller in magnitude.

Table 30 lists various components contributing to uncertainty in the discharge coefficient, and contains four sections, one for each weighing system. Each section contains examples covering the normal ranges of collection times and differential pressures used in developing the data base. (A detailed description of the operational and computational methods used in collecting and analyzing the data base is given in succeeding sections of this report.) Each line of table 30 is identified by the meter tube and orifice plate used and a test run number. Column label notation is consistent with that used in uncertainty analysis.

The top tabulation of each table section lists the parameter values contributing to the random and systematic uncertainty components of the mass flow rate measurement for one scale/diverter system. These values are given in terms of the uncertainty in the discharge coefficient, i.e., the values listed are individual or groupings of terms given in eq (14) multiplied by the value of the discharge coefficient. The two columns labeled S_t and S_t/Time contain the diversion uncertainty and its relative magnitude respectively. This notation departs somewhat from that used above. Where appropriate, parameters are labeled with the proper units. The uncertainties in the discharge coefficient value due to random and systematic uncertainty in the mass flow rate are listed in the two right most columns.

The mass flow rate uncertainty is dominated by its random component, which contains the effects of scale indication sensitivity and variability in the diversion valve. In systems 1 and 2 the indication sensitivity dominates. For systems 3 and 4 the random uncertainty in the diversion valve is comparable to that contributed by the scale indicator. Generally, the uncertainty contribution to the discharge coefficient from the mass flow rate is expected to be of the order of 1 to 2 parts in 10,000 or less.

As an example of the effect of overlap in the capabilities of the mass flow rate measurement, a flow rate crossover, i.e., observations taken at the same nominal flow rate but using different scales, is given. These two runs are test runs 44 (weigh system 2) and 25 (weigh system 3) taken on meter tube PE-6ABC with orifice plate 6C at mass flow rate of approximately 47 pounds/second. For run 25 the diversion time is near the desired minimum of 30 seconds, which results in a larger relative uncertainty in the diversion variability. Switching to the larger scale reduced this component by a factor of 4, reducing the random component of the discharge coefficient by approximately 30%.

The second portion of each table section tabulates the uncertainty components arising from the differential pressure measurement. The values listed in the table are taken from the observations of the quartz oscillator-type transducer connected to the top orifice taps. The primary contributors to uncertainty in the differential pressure are the components associated with the deadweight testers used in their calibration, i.e., the first two random terms of eq (12) and the two systematic terms. The relative magnitude of this contribution is listed in the Cal. Press. column and is given as a percentage of the differential pressure mean value.

The last three columns of the second portion of each table section give the discharge coefficient value for each test run and its random and systematic components of uncertainty as derived from propagation of error analysis. For the table entry on meter tube PE-0ABC with orifice plate FE-9/0-6A, test run 8, the random uncertainty in the discharge coefficient is 0.00098. In relative terms this component's magnitude is 0.16% of the discharge coefficient value of 0.6006. The total uncertainty in the discharge coefficient is the algebraic sum of the random and systematic components. For the first table entry the total relative uncertainty is 0.55%. This value reflects the capability to measure the discharge coefficient at the lowest differential pressure of 0.4 psi. At the highest differential pressure values the total relative uncertainty in the discharge coefficient measurement decreases to approximately 0.1% for the examples given in table 30 and is typical of the data base generally.

The API has selected ANSI/ASME MFC-2M-1983, "Measurement Uncertainty for Fluid Flow in Closed Conduits," as a reference standard for calculating uncertainty of orifice flow discharge coefficients. However, in this report the authors have chosen the propagation of errors method (to estimate uncertainty in discharge coefficients) which differs from the API recommended procedure. Additionally, the authors have performed a statistical analysis of the discharge coefficient/Reynolds number data that are described in section VI.D.

Table 30. Tabulation of Uncertainty Components
Uncertainty Components for Mass Flow Rate Measurment Using Weigh System No. 1

Tube	Plate	Beta	Run No.	Mass (lb)	Divert Time (sec)	Mass Flow Rate (lb/s)	S_I (lb)	S_I/M_W	S_t (sec)	S_t/Time	Mass Flow Rate Uncert. in C_d Random	Mass Flow Rate Uncert. in C_d System
PE-0ABC	FE-9/0-6A	0.75	8	42130.9	249.801	168.74	7.08	0.000168	0.003	0.000012	0.000037	0.000017
PE-0ABC	FE-9/0-4A	0.57	61	45329.4	299.990	151.16	7.08	0.000156	0.003	0.000010	0.000035	0.000018
PE-0ABC	FE-9/0-4A	0.57	64	41579.3	150.213	276.99	7.08	0.000170	0.003	0.000020	0.000040	0.000018
PE-0ABC	FE-9/0-4A	0.57	67	46107.6	99.816	462.28	7.08	0.000154	0.003	0.000030	0.000039	0.000018

Tube	Plate	Run No.	Differential Pressure Mean	SD Mean (psi)	RSD	No. Obs.	Cal. Press. (%)	Random	System.	Discharge Coefficient C_d	Random	System.
PE-0ABC	FE-9/0-6A	8	1.000	0.00082	0.0004	155	0.387	0.00098	0.00146	0.60060	0.000982	0.001610
PE-0ABC	FE-9/0-4A	61	2.966	0.00324	0.0006	149	0.134	0.00048	0.00051	0.60606	0.000492	0.000653
PE-0ABC	FE-9/0-4A	64	9.996	0.01013	0.0006	186	0.044	0.00033	0.00016	0.60494	0.000345	0.000307
PE-0ABC	FE-9/0-4A	67	27.889	0.01309	0.0006	136	0.019	0.00015	0.00007	0.60446	0.000185	0.000214

\- ** -

Tube	Plate	Beta	Run No.	Mass (lb)	Divert Time (sec)	Mass Flow Rate (lb/s)	S_I (lb)	S_I/M_W	S_t (sec)	S_t/Time	Mass Flow Rate Uncert. in C_d Random	Mass Flow Rate Uncert. in C_d System
PE-0ABC	FE-9/0-4A	0.57	55	6142.2	110.175	55.736	0.71	0.000116	0.004	0.000032	0.000034	0.000001
PE-0ABC	FE-9/0-4A	0.57	52	6082.5	69.491	87.496	0.71	0.000117	0.004	0.000050	0.000043	0.000001
PE-6ABC	FE-5/6-6C	0.74	44	6131.2	129.182	47.452	0.71	0.000116	0.004	0.000027	0.000032	0.000001
PE-6ABC	FE-5/6-6C	0.74	41	6382.0	74.391	85.759	0.71	0.000111	0.004	0.000047	0.000040	0.000001
PE-6ABC	FE-5/6-6C	0.74	38	6332.9	44.158	143.33	0.71	0.000112	0.004	0.000079	0.000059	0.000001

Tube	Plate	Run No.	Differential Pressure Mean	SD Mean (psi)	RSD	No. Obs.	Cal. Press. (%)	Random	System.	Discharge Coefficient C_d	Random	System.
PE-0ABC	FE-9/0-4A	55	0.401	0.00042	0.0006	154	0.958	0.00255	0.00366	0.60791	0.002548	0.003756
PE-0ABC	FE-9/0-4A	52	0.991	0.00123	0.0006	97	0.390	0.00109	0.00149	0.60685	0.001100	0.001586
PE-6ABC	FE-5/6-6C	44	3.054	0.00311	0.0011	192	0.130	0.00054	0.00050	0.60776	0.000547	0.000686
PE-6ABC	FE-5/6-6C	41	10.016	0.00448	0.0011	119	0.043	0.00020	0.00016	0.60651	0.000225	0.000354
PE-6ABC	FE-5/6-6C	38	28.024	0.01589	0.0011	67	0.019	0.00018	0.00007	0.60598	0.000242	0.000261

Table 30. Tabulation of Uncertainty Components -- Continued
Uncertainty Components for Mass Flow Rate Measurment Using Weigh System No. 1

Tube	Plate	Beta	Run No.	Mass (lb)	Divert Time (sec)	Mass Flow Rate (lb/s)	S_I (lb)	S_I/M_w	S_t (sec)	S_t/Time	Mass Flow Rate Uncert. in C_d Random	Mass Flow Rate Uncert. in C_d System
PE-6ABC	FE-5/6-6C	0.74	19	1841.0	105.120	17.515	0.14	0.000076	0.009	0.000083	0.000060	0.000001
PE-6ABC	FE-5/6-6C	0.74	22	1911.3	69.694	27.429	0.14	0.000073	0.009	0.000125	0.000087	0.000001
PE-6ABC	FE-5/6-6C	0.74	25	1866.0	39.649	47.077	0.14	0.000075	0.009	0.000219	0.000149	0.000001
PE-6ABC	FE-5/6-2C	0.37	7	1875.1	104.818	17.891	0.14	0.000075	0.009	0.000083	0.000056	0.000001
PE-6ABC	FE-5/6-2C	0.37	10	1788.9	59.886	29.878	0.14	0.000078	0.009	0.000145	0.000096	0.000001

Tube	Plate	Run No.	Differential Pressure Mean	SD Mean (psi)	RSD	No. Obs.	Cal. Press. (%)	Random	System.	Discharge Coefficient C_d	Random	System.
PE-6ABC	FE-5/6-6C	19	0.410	0.00077	0.0011	168	0.936	0.00331	0.00360	0.61211	0.003309	0.003794
PE-6ABC	FE-5/6-6C	22	1.010	0.00168	0.0011	111	0.383	0.00142	0.00147	0.61063	0.001436	0.001661
PE-6ABC	FE-5/6-6C	25	2.999	0.00466	0.0011	63	0.133	0.00065	0.00050	0.60827	0.000768	0.000697
PE-6ABC	FE-5/6-2C	7	10.012	0.01495	0.0011	158	0.043	0.00047	0.00016	0.60062	0.000495	0.000373
PE-6ABC	FE-5/6-2C	10	28.000	0.02180	0.0011	93	0.019	0.00024	0.00007	0.59979	0.000358	0.000281

- ** -

Tube	Plate	Beta	Run No.	Mass (lb)	Divert Time (sec)	Mass Flow Rate (lb/s)	S_I (lb)	S_I/M_w	S_t (sec)	S_t/Time	Mass Flow Rate Uncert. in C_d Random	Mass Flow Rate Uncert. in C_d System
PE-2ABC	FE-1/2-1B	0.24	35	316.50	501.087	0.6316	0.03	0.000095	0.009	0.000017	0.000024	0.000001
PE-2ABC	FE-1/2-1B	0.24	38	384.21	351.210	1.0940	0.03	0.000078	0.009	0.000025	0.000024	0.000001
PE-2ABC	FE-1/2-1B	0.24	50	341.68	173.485	1.9696	0.03	0.000088	0.009	0.000050	0.000038	0.000001
PE-2ABC	FE-1/2-1B	0.24	53	368.09	113.284	3.2496	0.03	0.000082	0.009	0.000077	0.000053	0.000001
PE-2ABC	FE-1/2-2B	0.36	64	383.28	85.404	4.4884	0.03	0.000078	0.009	0.000102	0.000069	0.000001

Tube	Plate	Run No.	Differential Pressure Mean	SD Mean (psi)	RSD	No. Obs.	Cal. Press. (%)	Random	System.	Discharge Coefficient C_d	Random	System.
PE-2ABC	FE-1/2-1B	35	1.012	0.00039	0.0010	152	0.382	0.00128	0.00145	0.60466	0.001286	0.001984
PE-2ABC	FE-1/2-1B	38	3.061	0.00092	0.0010	148	0.130	0.00044	0.00049	0.60231	0.000443	0.001021
PE-2ABC	FE-1/2-1B	50	9.984	0.00146	0.0010	200	0.044	0.00015	0.00016	0.60044	0.000179	0.000691
PE-2ABC	FE-1/2-1B	53	27.225	0.00490	0.0010	200	0.019	0.00008	0.00007	0.59996	0.000167	0.000600
PE-2ABC	FE-1/2-2B	64	10.022	0.00152	0.0010	151	0.043	0.00014	0.00016	0.60346	0.000239	0.000540

H. Uncertainty in the Reynolds Number

The primary results of this work are pairs of discharge coefficient and Reynolds number values. Values for each are computed from a combination of observed and calculated parameter values. The contributions of the various independent parameters and their uncertainties to discharge coefficient values have been discussed above. Those associated with the Reynolds number are discussed here if not discussed previously, specifically the kinematic viscosity of water.

The pipe Reynolds number may be written in the following form, which is derived in section III.C,

$$R_D = \frac{4}{\pi} \frac{\dot{m}}{\rho \nu D} \tag{15}$$

where D = pipe diameter,
$\dot{m}$ = mass flow rate,
ρ = density of the flowing fluid, and
ν = kinematic viscosity of the flowing fluid.

The kinematic viscosity, ν, is defined as the ratio of the absolute viscosity, μ, to the density of the flowing fluid. Computation of the density of water and its uncertainty has been discussed previously. Computation of the water's absolute viscosity and its uncertainty are discussed here.

<u>Computation of the Absolute and Kinematic Viscosity of Water</u>

Computation of the kinematic viscosity requires a method to compute the absolute viscosity and the density of water. The computation of the density of water uses the Kell [9] correlation which was discussed in section II.E.3. Computation of the absolute viscosity of water uses empirical equations developed by Kestin, Sokolov, and Wakeham [18] based on a re-evaluation of the most recent data on the subject. This re-evaluation of the data reduces the uncertainty in viscosity ratio values, i.e., viscosity at temperature, t, to that at 20 °C, to 0.1% or less for the temperature range of interest here, which is consistent with the uncertainty of the measured value of Swindells [19] at 20 °C. The combined uncertainty of the value of the ratio and the 20 °C value is approximately 0.2%.

The empirical relations are :

for the 0° to 40 °C range

$$\log \frac{\mu_t}{\mu_{20}} = \frac{20 - T}{T + 96} \{1.2364 - 1.37\text{x}10^{-3} (20 - T) + 5.7\text{x}10^{-6}(20 - T)^2\}, \tag{16}$$

for the -8° to 150 °C range

$$\log \frac{\mu_t}{\mu_{20}} = \frac{20 - T}{T + 96} \{1.2378 - 1.303\times10^{-3} (20 - T) + 3.06\times10^{-6}(20 - T)^2 + 2.55\times10^{-8} (20 - T)^3, \quad (17)$$

where the temperature, T, has units of degrees celsius, and the logarithm is to the base 10.

The Swindells 20 °C viscosity value is 1.002 centipoise.

Equation (16) is used for test run water temperatures less than 40 °C and eq (17) for higher temperatures.

Uncertainty in the Reynolds Number Value

Parameters contributing to uncertainty in Reynolds number values are mass flow rate, which was discussed previously and summarized in table 11, pipe diameter, also discussed previously, absolute viscosity, and density of water. The observed parameters, mass flow rate and diameter, are dominated by systematic effects. The uncertainty in the two computed parameters are taken as systematic. Therefore, the uncertainty in the Reynolds number is computed for all components being systematic with negligible contribution from random effects. The contributions of each are the following:

1. Mass Flow Rate - Inspection of table 11 shows the range of uncertainty in mass flow rate to be 0.02% to 0.09%.

2. Pipe Diameter - Uncertainty in the pipe diameter values ranges from 0.01 to 0.02%.

3. Water Density - Uncertainty in the density is 0.015%.

4. Water Viscosity - Uncertainty in the viscosity value is 0.2%.

Combination of the error components, which are considered to be all systematic in the propagation of error analysis, results in an upper bound for the uncertainty in Reynolds number of 0.32 percent.

III. Working Equations and Dimensional Conversion Factors

A. Introduction

The formulations derived here are those used in the various computations necessary to the various analyses used for development of results from the observed values discussed in subsequent sections of this report. These are not unique and may be found in several sources familiar to the fluid metering community [20,21]. The purpose of their placement in this document is one of completeness and contractual compliance. Previous documents describing data bases upon which basic orifice discharge coefficient values have been based have not described the complete rationale used in generation of the published results. It is our intent to do so here.

B. Derivation of the Coefficient of Discharge Relation and Associated Units Conversion Factors

Figure 19 illustrates schematically an exploded view of the arrangement of an orifice meter placed in a pipeline with differential pressure tappings located in the adjacent flanges. The parameters pertinent to this derivation are shown in the figure. For the purposes of this derivation the following assumptions are made:

1. the flowing fluid is incompressible,
2. the velocity profile is uniform (one-dimensional) with no boundary layers at the pipewall or the surface of the orifice plate,
3. the pipeline is horizontal and of uniform, circular cross-section, and
4. no energy loss occurs between the pressure taps.

The parameters used here are defined as follows:

P_1 - pressure at the upstream orifice tapping,

V_1 - velocity in the pipe upstream of the orifice plate,

A_1 - area of the meter tube through which the fluid flows,

$\dot{m}_1$ - mass flow rate through the pipe,

P_2 - pressure at the downstream orifice tapping,

V_2 - velocity of the fluid through the orifice,

A_2 - area of the orifice,

$\dot{m}_2$ - mass flow rate through the orifice, and

ρ - density of the fluid flowing in the pipeline and the orifice.

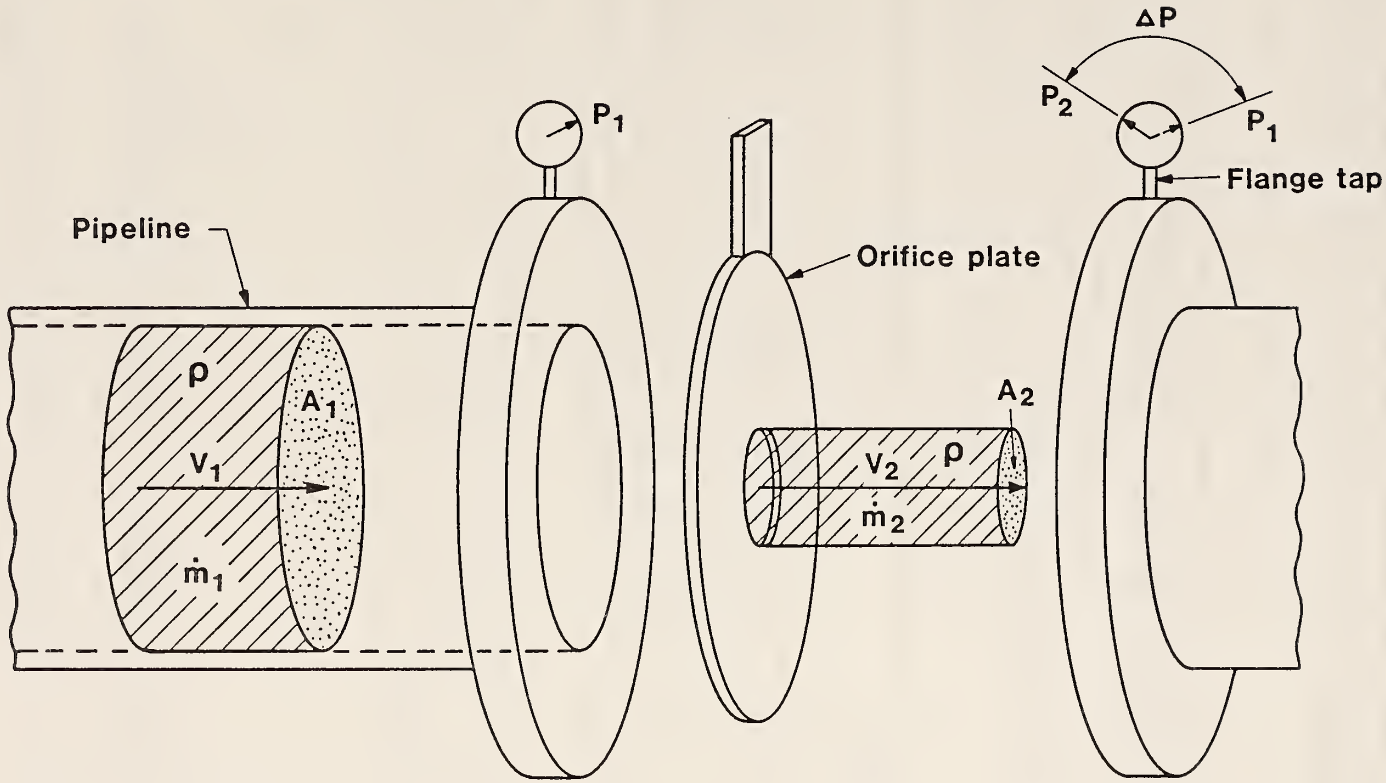


Figure 19. Orifice Meter Installation in Pipeline - Formulation of Working Equation for Coefficient of Discharge

The physical principles applicable here are expressed by the continuity equation, which is an expression of the conservation of mass flow rate through the orifice meter, and Bernoulli's equation, which is an expression of the conservation of energy applied to this case. The continuity equation is the following:

$$\dot{m}_1 = \dot{m}_2. \tag{18}$$

The mass flow rate of fluid passing through the meter tube or the orifice may be expressed as a function of the average fluid velocity, V, the area traversed, A, and the density of the fluid, ρ.

$$\dot{m} = \rho AV. \tag{19}$$

Substitution of eq (19) into eq (18) yields

$$\rho A_1 V_1 = \rho A_2 V_2. \tag{20}$$

Bernoulli's equation in SI units applied to the geometry of the orifice meter is the following:

$$\frac{P_1}{\rho} + \frac{V_1^2}{2} + gZ_1 = \frac{P_2}{\rho} + \frac{V_2^2}{2} + gZ_2, \tag{21}$$

where Z_1 and Z_2 are the elevations of the points at which the pressures are effective, i.e., the pressure tappings, and g is the local acceleration of gravity. With the assumption that the pressure tappings are at the same elevation, the form of the equation becomes the following:

$$\frac{P_1}{\rho} + \frac{V_1^2}{2} = \frac{P_2}{\rho} + \frac{V_2^2}{2}. \tag{22}$$

Rearrangement of the terms in eq (22) yields

$$\frac{P_1 - P_2}{\rho} = \frac{V_2^2 - V_1^2}{2}. \tag{23}$$

Obtaining the dependence of V_1 on V_2 from the continuity equation, eq (20), substituting and rearranging terms in eq (23) yields the following relation between the pressure difference across the orifice and the average velocity of fluid through the orifice.

$$\frac{P_1 - P_2}{\rho} = \frac{V_2^2(1 - A_2^2/A_1^2)}{2}. \tag{24}$$

Since the shape of the orifice and the meter tube is circular in cross-section, the areas will be expressed in terms of the diameters of the meter tube and the orifice. Introducing the beta ratio as

$$\beta = d/D, \tag{25}$$

where d is the orifice diameter and D is the meter tube diameter, eq (24) may be rewritten in the following form, using the beta ratio and expressing V_2 as a function of the mass flow rate through the orifice.

$$\frac{P_1 - P_2}{\rho} = \frac{(1-\beta^4)}{2} \quad (\dot{m}_2/\rho A_2 F_a)^2. \tag{26}$$

The subscript for the mass flow rate can be eliminated to reflect the conservation of mass in this system. Also the parameter F_a is introduced and is the thermal expansion factor for the orifice area. eq (26) has been rearranged in the following form to express the theoretical mass flow rate as a function of the differential pressure developed across the orifice meter, and the geometry of the meter, expressed as the ratio of diameters.

$$\dot{m}_t = \frac{\pi}{2\sqrt{2}} \; \frac{d^2 F_a}{(1-\beta^4)^{1/2}} \; (\rho \Delta P)^{1/2} \tag{27}$$

Using SI units the theoretical flow rate given by eq (27) has units of kg/s. However, most of the observational units are given in the English, customary system of units. Since mass is a derived quantity in the customary system, conversion between mass and force units must be accomplished using the defining relation between force, F, mass, M, and acceleration, a,

$$M = F/a.$$

The value of acceleration is that of the acceleration of the earth's gravity at 45° latitude and sea level, which is 9.80665 m/sec^2 or 32.1740 ft/sec^2. Therefore, one pound mass produces a force of 32.1740 $lb\text{-}ft/sec^2$. This value is the basis of a conversion factor for the differential pressure values derived from the transducer calibration. Substitution of the appropriate unit into eq (27) yields the following relation,

$$\dot{m}_t = \frac{\pi}{2\sqrt{2}} \qquad \frac{d^2\ (in^2) F_a}{(1\ -\ \beta^4)^{1/2}} \quad x$$

$$\left[\rho\ (lb/ft^3)\ x\ 32.1740\ \Delta P\ (lb\text{-}ft/sec^2\ -\ in^2)\ x\ \frac{1\ ft^2}{144\ in^2} \right]^{1/2}$$

Collection of the various numerical terms yields the final working equation for the mass flow rate in the customary units system,

$$\dot{m}_t = 0.5250202 \; \frac{d^2 F_a}{(1-\beta^4)^{1/2}} \; (\rho)^{1/2} \; (\overline{\Delta P})^{1/2} \tag{28}$$

where F_a, area thermal expansion factor for stainless steel orifice plates, is given by

$$F_a = (1+0.0000333(T_w-T_r)), \tag{29}$$

with T_w being the water temperature in degrees Celsius and T_r is the reference temperature.

Computation of the flowing water density utilized Kell's correlation as discussed previously. This correlation equation produces density values having units of kg/m^3. Conversion of these values to the customary system of units uses the following conversion factor,

$$1\ (kg/m^3) \times 2.2046226\ lb/kg \times [0.0254\ (m/in) \times 12\ (in/ft)]^3$$

$$= 62.42796 \times 10^{-3}\ lb/ft^3.$$

The bar over the ΔP term in eq (28) denotes that the average of the square roots of the differential pressure values are used during the computation of the discharge coefficient. The average of the square roots of the differential pressure values was obtained using the following summation.

$$(\overline{\Delta P})^{1/2} = \frac{\Sigma \sqrt{\Delta P_i}}{n}.$$

Equation (28) is a theoretical relationship based on the assumptions given above. The development of this equation neglects the many real effects which occur in actual orifice meter configurations, e.g., effects due to velocity profile non-uniformity, turbulence, frictional losses, orifice edge sharpness, the finite thickness of the orifice plate, pressure tap location, etc. The inability to realistically model these effects results in a significant difference between the observed mass flow rate through an orifice meter and that theoretically predicted by eq (28). Accommodation of these differences is obtained through the use of a correction factor. This may be defined as the ratio of the actual mass flow rate, $\dot{m}_a$ to the theoretical mass flow rate, $\dot{m}_t$. It is customary to denote this ratio as the coefficient of discharge, or discharge coefficient, C_d. This ratio is ubiquitous to head class flow metering devices irrespective of their shape.

$$C_d = \dot{m}_a/\dot{m}_t. \tag{30}$$

The actual mass flow rate was defined previously as

$$\dot{m}_a = \frac{M_t}{(t+\tau)}, \tag{31}$$

where M_t is the true mass of water collected in lbm,
t is the flow diversion time in s, and
τ is the diverter correction value.

Furthermore, the true mass of water collected can be expressed as

$$M_t = M_a/(1-\rho_a/\rho_w), \tag{32}$$

where M_a is the apparent mass value (gross weight - tare weight),
ρ_a is the density of air in g/cm^3, and
ρ_w is the density of water.

Equations (31) and (32) can be combined to give

$$\dot{m}_a = \frac{M_a}{(1-\rho_a/\rho_w)(t+\tau)}. \tag{33}$$

Combining eqs (28), (29), and (33), the discharge coefficient may be expressed in terms of observed parameter values and the geometrical parameters associated with the orifice meter in the following relation:

$$C_d = \frac{M_a \sqrt{1-\beta^4}}{0.5250203\ F_a d^2(1-\rho_a/\rho_w)\ (t+\tau)\ \sqrt{\rho\Delta P}}. \tag{34}$$

Equation (34) forms the basis for the computation of discharge coefficients presented in this report. Using the expression for actual mass flow rate as given in eq (33), we can write eq (34) in its conventional form,

$$C_d = \dot{m}\ (1-\beta^4)^{1/2}/[Nd^2\ F_a(\rho\Delta P)^{1/2}], \tag{35}$$

where $\dot{m} = \dot{m}_a$ = actual mass flow rate,
N = the product of units conversion factors (see eq. (28)), and
F_a = the orifice thermal expansion factor.

Equation (35) was given in this convenient form as eq (1) in section II.B.1 to perform sensitivity analyses of the orifice measurement system.

C. Derivation of the Reynolds Number Including Units Conversion Factors

The Reynolds number is a dimensionless correlating quantity used to combine the effects of density, viscosity, and velocity of a fluid. It is defined as

$$R_D = VD/\nu, \tag{36}$$

where V is the velocity of the fluid in the pipe,
D is a characteristic length, in this case pipe diameter, and
ν is the kinematic viscosity, which is the ratio of absolute viscosity, μ, to density, ρ.

Since velocity may be expressed as the ratio of volumetric flow rate to area (V=Q/A), and mass flow rate may be expressed as the product of density and volumetric flow rate ($\dot{m}=\rho Q$), the expression for Reynolds number becomes

$$R_D = \frac{4}{\pi} \frac{\dot{m}}{\rho \nu D} . \quad (37)$$

Expressing $\dot{m}$ in lb_m/sec, ρ in g/cm^3, ν in centistokes, and D in inches, which are not compatible units, a units conversion factor is needed. The units conversion factor for the Reynolds number is

$$(2.54 \text{ cm/in})^{-1} \times (453.59237 \text{ g/lb}_m) \times (0.01 \text{ (cm}^2\text{/s)/(centistokes))}^{-1}.$$

In addition, a diameter expansion factor for the meter tube may be expressed as

$$F_\ell = (1 + 0.000103(T_w-20)), \quad (38)$$

where T_w is the temperature in degrees Celsius and the linear, thermal expansion coefficient for carbon steel at 20 °C [13] is used. Multiplying eq (37) by the units conversion factor above and $4/\pi$ and introducing the expansion factor of eq (39) yields the non-dimensional Reynolds number equation used to compute pipe Reynolds numbers,

$$R_D = 22737.47 \frac{\dot{m}}{\rho \nu D F_\ell} . \quad (39)$$

D. Calculation of Differential Pressure Values: Compensation for Drift in the Zero Differential Pressure Response Values

Although the stability of the differential pressure transducer was good, small drifts were observed in the response of the transducers. A method of drift compensation was used to reduce these effects. Two observations of zero impressed differential pressure on the transducers were added to the test run observation procedures to provide the means for drift compensation. These were designated as no-flow and transducer zero observations. Both were applied to each transducer's observed value in its conversion to pressure units. The no-flow zero value was taken with the transducers responding to the differential pressure across the orifice meter with no flow through it and with the line pressure set to 41 psig. This observation was the first taken at the beginning of a set of test run groups for an orifice plate/meter tube combination. Typically a set of test run groups were taken for the full flow rate range for the meter tested for one mounting of the orifice plate with several groups comprising a set. It was applied as a drift correction for all subsequent differential pressure observations taken on that orifice meter configuration. The rationale for this observation was to develop a means of compensation for drifts in the differential pressure measurement system not directly associated with the transducers alone.

The transducer zero observations were taken before each test run group, where a test run group was generally a group of three successive observations. These observations were taken with each transducer's test and reference port connected together via the crossover valve of the five-valve manifold. These observations were taken with the line pressure set to 41 psig and each port's blocking valves closed. These observations were taken to compensate for drift in transducer response characteristics alone. The following discussion gives the mathematical relations used in converting differential pressure response observations for each type of transducer to pressure unit values.

<u>Differential Pressure Calculation for the Quartz Oscillator Type Transducers</u>

As discussed in part D of section II, the response equation used for the quartz oscillator type transducers is the following

$$P = Y_0 + Y_1 + Y_2 \qquad (40)$$

where $x = 1 - T_o/T$. The T term is the oscillator period at the differential pressure of interest and T_o at zero differential pressure. The calibration coefficients, Y_0, Y_1, and Y_2, are those appropriate for pressure units of psi and oscillator period of microseconds. As discussed above T_o was found to exhibit small changes between transducer calibration and subsequent use, therefore, it was necessary to adjust eq (40) appropriately.

One approach to compensating for drift effects is to assume that the ratio of oscillation periods in x are invariant. Investigation of this adjustment to the model indicated that it was not particularly effective. A second approach is the assumption that a shift in the zero differential pressure period, T_o, represents a translation and, thus, an equal shift in the period, T, at non-zero differential pressures as shown in the following relations.

$$T_o' = T_o + dT_o, \quad T' = T + dT_o \qquad (41)$$

These may be rearranged as

$$T_o = T_o' - dT_o, \quad T = T' - dT_o \ . \qquad (42)$$

Taking the ratio, T_o/T, from eq (42)

$$\frac{T_o}{T} = \frac{T_o' - dT_o}{T' - dT_o} = \frac{T_o}{T' - dT_o} \qquad (43)$$

This expression is used to compute the ratio of the drift or translation in the period value of the transducer. To perform the calculation requires the additional observation of the transducer's zero differential pressure response in its translated state. This cannot be achieved ideally, but is approximated by the zero differential pressure observations taken before each group of test runs. The dT_o values used in computing the effective response variable of the quartz oscillator type transducers, x', are the differences between the observed zero differential pressure values taken before each test run series and those observed during the most recent calibration.

This algorithm was tested thoroughly prior to the formation of the final orifice discharge coefficient data base and was found to provide a significant reduction in the effects of transducer drift which affects the low differential pressure values to the greatest degree. The compensated response equation has the same form as eq (40), but uses the effective response variable,

$$\Delta P = Y_0 + Y_1 x' + Y_2 x'^2, \qquad (44)$$

where $x' = 1 - \frac{T_o}{T' - dT_o}$

T_o = zero diff. press. response at the time of calibration,

T_o' = zero diff. press. response for the test group, and

$dT_o = T_o' - T_o$

T' = observed response for the orifice meter diff. press., assumed to be translated.

Differential Pressure Calculation for the Quartz Bourdon Tube Transducer

As discussed in part D of section II, a linear response model was used for the quartz bourdon tube type transducer, expressed algebraically as

$$\Delta P = C_1 + C_2 V, \qquad (45)$$

where V is the analog response voltage observed for differential pressure, ΔP, and C_1 and C_2 are the two calibration coefficients. Since the transducer's response is linear, drifts in the zero voltage may be compensated by using the difference $V - V_o$ to replace the voltage variable in the linear term of eq (45). V_o is taken as the zero differential pressure voltage observed at the time of the most recent calibration. Subsequent drifts in the response voltage at zero or near zero differential pressure are used for compensation.

No Flow Corrections

To compensate for small drifts in the differential pressure measurement observations caused by changes in the piping configuration around the orifice meter as plates were changed, an observation of differential pressure at zero flow through the meter and normal operating pressure was taken. These no-flow zero values were made for all transducers and were subsequently subtracted from each observation. Denoting these ΔP_{oi}, the compensated values, $\Delta P_i'$ used in computation of the mean differential pressure values were of the following form,

$$\Delta P_i' = \Delta P_i - \Delta P_{oi}, \tag{46}$$

where ΔP_i is the observed value.

E. Screening of the Differential Pressure Observations

As is the case with any large data base of experimental values, a small incidence of individual observations not consistent with the body of the observations is expected. A means to detect and reject these was used in computing the mean differential pressure values for each test run of the data base. Since the observed differential pressures are considered to be derived from stable flow conditions through the orifice meter, variations in observed values from a single transducer are assumed to be generated by a random process. Therefore, certain characteristics of the population of observed values may be made and its members tested for conformity with those characteristics. Additionally, the experimental conditions were such that the differential pressure values observed should not be negative. Screening of the differential pressure observations was based on these assumptions.

Data Acquisition Filter

To deal with difficulties encountered with the interfacing procedures between the differential pressure instruments and the data acquisition computer in the initial phase of this project, two methods of differential pressure observation testing and screening were employed. The objective of both was the elimination of spurious observations. The first filter was placed in the data acquisition system software used in generating the data base, and was based on the assumption that no valid differential pressure observation would be negative. In operation the observed differential pressure values for each transducer were compared with the zero differential pressure response observed during that day's calibration procedures. If an observation was less than that observed at zero differential pressure, the observed value was replaced with zero. This filter operated following each test run before storage of the data on magnetic media. It was initially installed to reject values which were incorrectly transferred between the instrumentation and microprocessor interfaces. By the time of collection of the final data base in 1985, the source of these incorrect transfers was substantially removed. However, this filter identified 34 test runs not identified by the operator as having operational errors. These test runs are identified in table 31. The number of rejected observations for each transducer and the total number of observations are given. With the exception of one test run this filter rejected only observations of the Ruska (quartz bourdon tube) differential pressure transducer.

Outlier Testing and Rejection

The second screening procedure inspected each of the three arrays of differential pressure observations for entries which were not characteristic of the body of the observations. This procedure was based on the following assumptions:

1. flow through the orifice meter was under steady state conditions or closely so, and

2. fluctuations in the flow rate, and therefore the differential pressure, were only the result of the turbulent nature of the flow in the meter.

Under these assumptions the population of differential pressure observations taken over the period of a test run may be considered to be a subset of a normally distributed population. Observations not belonging to the population subset may be detected by computing the deviation of an observation from an appropriate estimate of the subset mean and testing this against an estimated width, i.e., the standard deviation. To perform such a test a method for estimating the mean and standard deviation was devised. Since the total population must be assumed to contain a number of outlying members, the computation method for the mean and standard estimates must exclude these.

The method used to compute an estimate of the mean and standard deviation of the population used the middle two quartiles of the array of differential pressure observations after sorting them in ascending order based on their magnitude. The steps in the procedure performed independently on each differential pressure array were the following:

1. Convert the observed instrument indications to pressure units using the appropriate transducer calibration coefficients and zero offset observations.

Table 31. Data Acquisition Filter Rejections

Run No.	Date	Meter Tube	Orifice Plate	Number Obs.	---- 1st Filter ---- Ruska	Upper	Lower
1	07/29/85	PE-1ABC	FE-1/2-6A	198	1	0	0
10	07/24/85	PE-3ABC	FE-3/4-4B	200	1	0	0
16	07/29/85	PE-4ABC	FE-3/4-5A	200	3	0	0
17	07/29/85	PE-4ABC	FE-3/4-5A	80	6	0	0
18	07/29/85	PE-4ABC	FE-3/4-5A	81	1	0	0
20	07/29/85	PE-4ABC	FE-3/4-5A	164	5	0	0
23	07/29/85	PE-4ABC	FE-3/4-5A	142	10	0	0
6	10/11/85	PE-5ABC	FE-5/6-1B	200	4	0	0
8	10/11/85	PE-5ABC	FE-5/6-1B	155	4	0	0
12	10/11/85	PE-5ABC	FE-5/6-5B	200	1	0	0
20	07/01/85	PE-6ABC	FE-5/6-1C	180	1	0	0
22	06/26/85	PE-6ABC	FE-5/6-5C	191	2	0	0
23	06/26/85	PE-6ABC	FE-5/6-5C	191	7	0	0
6	06/25/85	PE-6ABC	FE-5/6-6C	119	2	0	0
10	06/25/85	PE-6ABC	FE-5/6-6C	168	1	0	0
11	06/25/85	PE-6ABC	FE-5/6-6C	167	1	0	0
3	12/04/85	PE-7ABC	FE-7/8-2B	178	4	0	0
4	12/04/85	PE-7ABC	FE-7/8-2B	50	5	0	0
5	12/04/85	PE-7ABC	FE-7/8-2B	51	2	0	0
8	12/04/85	PE-7ABC	FE-7/8-2B	178	4	0	0
9	12/04/85	PE-7ABC	FE-7/8-2B	178	3	0	0
2	12/04/85	PE-7ABC	FE-7/8-4B	156	5	0	0
3	12/04/85	PE-7ABC	FE-7/8-4B	158	1	0	0
7	11/14/85	PE-0ABC	FE-9/0-1A	200	8	0	0
11	11/14/85	PE-0ABC	FE-9/0-1A	150	2	0	0
12	11/14/85	PE-0ABC	FE-9/0-1A	150	2	0	0
17	11/14/85	PE-0ABC	FE-9/0-1A	192	9	0	0
7	07/08/85	DAN-4SS	FE-5/6-2C	161	1	0	0
18	06/24/85	DAN-4SS	FE-5/6-4C	88	1	0	0
13	06/17/85	DAN-4SS	FE-5/6-6C	200	0	13	0
2	06/19/85	DAN-4SS	FE-5/6-6C	165	5	0	0
54	08/13/85	DAN-4SS	FE-5/6-6C	161	8	0	0
43	12/30/85	DAN-4SS	FE-5/6-8A	136	1	0	0
48	12/30/85	DAN-4SS	FE-5/6-8A	147	1	0	0

2. Sort the array in ascending order.

3. Count the number of initial zero values inserted by the data acquisition filter. Adjust the array size for the occurrence of these zeroes.

4. Form the test mean and standard deviation of the middle two quartiles of the adjusted array.

5. Test the minimum and maximum quartiles for values greater than 10 test standard deviations from the test mean and set to zero those which are greater.

6. Adjust the array to be continuous, i.e., non-zero values are eliminated and the size of the array is reduced accordingly.

7. Compute the mean differential pressure and its standard deviation using the method of Heidelberger and Welsh [14].

An example of the operation of the filter is given in the pressure trace of figure 20. The array of observations for the quartz oscillator-type transducer measuring the differential pressure at the upper taps of the orifice meter are shown. The observations are connected by a line sequentially to show the order of occurrence. The test mean obtained from the middle 50% of the array after sorting in ascending order is 0.3995 psi and the standard deviation is 0.0033 psi. These give upper and lower filtering limits of 0.4326 psi and 0.3664 psi respectively and are shown by the outer, short dashed boundaries. At approximately 130 seconds into the test run an observation lying outside the filters bounds occurred. This observation was rejected from the final computation of the mean and standard deviation of the array. The longer dashed boundaries are obtained using the mean and three standard deviations of the filtered array. In this case the means differ by 0.0003 psi. This difference is considerably smaller than a single standard deviation. Both the filter boundaries and the three standard deviation (as derived from the filtered array) are shown in the figure.

The basis for outlier screening is steady flow through the orifice meter. Differential pressure values considered to be outliers may have been due to actual flow fluctuations. Therefore, all transducers would exhibit similar behavior to that shown in figure 20. However, in analyzing the data base no method was used to adjust the filter for non-steady flow effects during test runs. As a result systematic effects in the results could occur. The result of the 10 standard deviation filter is reflected in the tabulation of test results by listing the average number of rejections for each test run. The user of the data base may wish to take such action as deemed appropriate for use of these results or compute differential pressure and discharge coefficient values without the use of this filter from the archival data base (see Appendix D).

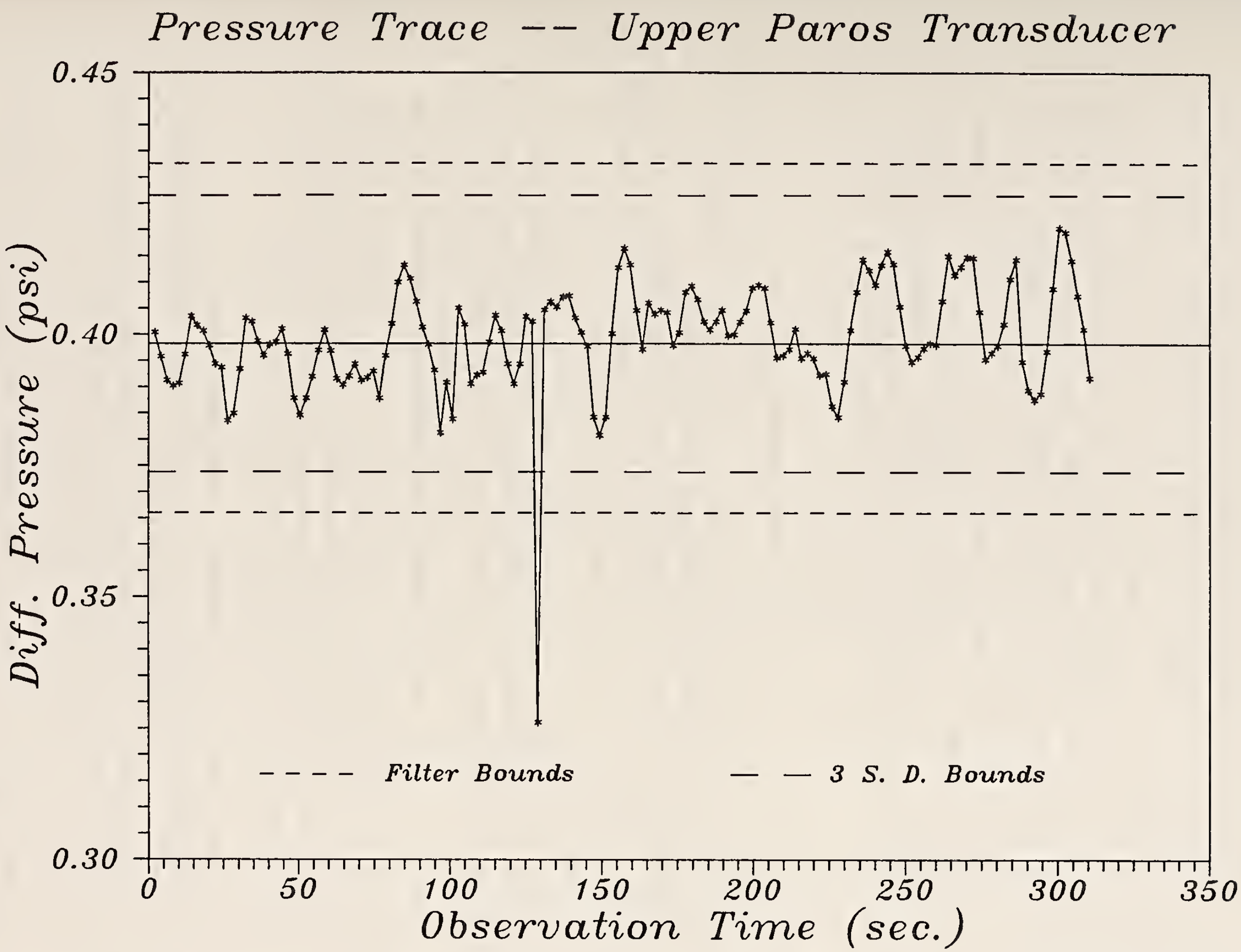


Figure 20. Pressure Observations for a Test Run Showing 10 Standard Deviation Filter Bounds and the 3 Standard Deviation Bounds Computed for the Filtered Observation Set.

IV. Data Acquisition and Control Systems

A. General Description

The data acquisition and control system used in this project consisted of an 8-bit microprocessor system interfaced to the NBS water flow- rate measurement facility. The system included 64 kilobytes of random access memory (64K RAM), dual 8-inch floppy disk drives, and a serial printer. The microprocessor communicated with external devices using a 4-port, parallel input/output (I/O) interface, an IEEE-488 interface, and an RS-232C communications interface.

The system software consisted of compiled BASIC and data base management software. A word processing software package was used for text entry, primarily operator notebook entries, and an assembly language driver was written to acquire mass value and scale status indications from the electronic scales. Compiled Basic was chosen because of the increased speed afforded both measurement and computational functions. The data base management software was a commercially available package which allowed sufficient programming capability to maintain the data base files generated by the system and to allow menu-driven operation of the complete data acquisition software system.

B. Data Acquisition and Control System Hardware

The data acquisition and control microprocessor utilizes the S-100 microcomputer bus and a Z-80A central processing unit (CPU) microprocessor. In addition to a 100,000 Day Clock used for time-of-day information stored in the data base, three other interface boards were necessary for data acquisition and flow system control.

The four-port parallel input/output interface was used for both data acquisition and measurement system control. This interface consisted of three 8-bit input ports, one input port dedicated to software status polling of the interface ports themselves, two 8-bit output ports, one magnetic relay output port, and one output port dedicated to software enabling/disabling of the other three output ports. The magnetic relay output port was used for automatic control of flow diversion. One input and output port was used for acquiring temperature information from the thermistor-based thermometer and controlling the selection of one of eight thermistor inputs to the thermometer indicator.

An IEEE-488 interface was used to interface three universal counter/timers and a digital multimeter to the data acquisition system. The IEEE-488 interface is also known as the HP-IB or GPIB interface, and is a widely available laboratory instrumentation interface. Two of the universal counter/timers were used to measure the oscillation period of the quartz oscillator-type, differential pressure transducers. Typically the oscillation period was in the 25 millisecond range, and the period was measured with a precision of 0.00001 milliseconds via the counter/timer's internal 100 MHz clock. The third counter/timer was used to measure the diverter time.

A four-port RS-232C asynchronous communications interface provided input/output functions for the microprocessor system. In addition to ports for the system console and printer, one port was used to acquire electronic scale readings from the switching and summing module/indicator unit of the electronic scales. This task was accomplished using an assembly-language driver, which read the data output by the scale indicator and stored the data in a predetermined location in the microprocessor's memory for subsequent access by the compiled BASIC data acquisition program.

C. Data Acquisition and Control System Software

The data acquisition and control system software controlled the two primary functions of the project, namely the differential pressure transducer calibration and orifice data acquisition. The diverter calibration software was an adjunct to these operations. The software system was designed to be user-friendly and to involve as little operator intervention as practicable. In fact, the only data not automatically acquired by the computer were the date, the barometric pressure, and the relative humidity. The entire system was menu-driven using data base management software as the command shell for program control and data storage functions. The use of menus was decided early in the planning of the project in order to alleviate the possibility of operator error during data acquisition.

The software system was designed to minimize operator intervention, thereby reducing the number of entry errors for the various data items which were input to the data bases. The software provided specific instructions displayed on the terminal to instruct the operator in the next step required by the current task at hand. In addition, most repetitive inputs were put into look-up tables or disk files so that the operator need only choose a menu item or input an abbreviated response associated with the desired choice. However, a more important function of the software was the use of internal diagnostic procedures which, although transparent to the operator, continuously monitored the integrity of various components of the data acquisition system.

Pressure Transducer Calibration Procedures

During differential pressure transducer calibrations, the weight stack compositions placed on the dead weight testers were stored in a file called WEIGHTS.DAT. These were used by the operating program to instruct the operator which weights were to be placed in the weight stacks for each pressure value. The mass values for the weights were stored internally in the program using DATA statements in the program (DWTCAL.COM) so that the differential pressure being applied was computed correctly. If the applied pressure was greater than 6 psid, the program warned the operator to turn off the valves to the 6 psid range Paros Scientific transducer when it was in operation. This step was removed after the 6 psid transducers were no longer used in the system.

Temperature Value Data Acquisition Procedures

Temperature measurements for both the transducer calibration and the orifice data acquisition program were read using identical software procedures. The software used a decision process to determine whether the temperature reading was steady by comparing the first and tenth readings of a 10 reading set. If these two values differed by more than 0.02 °C then another set of readings was made until this requirement was met, at which point the tenth reading was assigned to the desired temperature parameter. This process normally required about 10 seconds to complete.

IEEE-488 Interface Bus Error Detection

Bus error detection for the IEEE-488 interface was used during all bus operations. The subroutine to check for errors was provided by the manufacturer and was used to check for the following errors:

1. Set-up error
2. No listener
3. Serial poll address error
4. Service request
5. Timeout error
6. ATN true
7. IFC true
8. Reset S-100 system.

During the entire phase of orifice meter testing, no such IEEE-488 bus errors occurred.

Orifice Flow Test Data Consistency Checks and Diagnostics

More extensive built-in checks by the software system were used in the orifice data acquisition portion of the software. For example, the active scale deck selection made at the scale system multiplexer was checked to be consistent with the information entered by the operator from the console. If the software indicated that the wrong scale deck was being used, then the operator was notified via the console and could correct the error and resume data acquisition. Before the computer accepted a value from the scale, motion in the scale deck was also checked via its motion index character. Transmitted data were accepted by the computer only after the motion indicator was in the off state. In this manner, no erroneous data was sent to the system. The scale was also checked for an over-capacity reading which, if detected, caused all data acquisition operations to halt. This problem occurred only if the operator entered an incorrect flow diversion time, which caused the tank to overflow.

A file look-up table (ORIFDIAM.TXT) was used in the orifice program to find the orifice plate diameter for use in the program. In this manner the operator need only enter the plate designation to obtain a diameter. If he entered a designation not contained in the table, then the program would ask him again for the correct designation until a match was found in the table of values. This style of programming significantly reduced the occurrence of operator errors.

There were times during orifice data acquisition when data collection extended past midnight. The software would adjust the date so that the correct date was recorded in the data base files. In addition, because the clock board was used to control flow diversion timing by counting seconds since the previous midnight, a delay near midnight was forced to prevent overflowing the tank during data acquisition. This would happen because the clock would reset to zero seconds at midnight.

An important part of the diagnostics capability of the orifice data acquisition software was a data rejection routine which checked the absolute value of the measured voltage for the quartz bourdon tube type differential pressure transducer and the period for the quartz oscillator type transducers against prescribed limits defined in the program. If too many values were rejected by the routine, the operator was notified via the console, and a diagnostics program which checked the IEEE-488 bus was run. This program was called CHEKIEEE.COM, and its purpose was to record and display the values for each of the three pressure transducers for a period of 60 seconds (typically 80 to 90 measurements). The results were displayed in volts for the Ruska transducer and microseconds for the Paros Scientific transducers and could be printed out, if desired, for examination by the operator. This program was very useful in diagnostic tests of the pressure transducers. This initial filtering of differential pressure observations was directed at identification of errors caused by a data transfer/instrumentation malfunction. This filter was an aperture type which passed values lying within a specified range. The bounds for the quartz bourdon tube transducer were 0.0 to 11 volts. For the quartz oscillator type of transducer, the bounds were 25 to 29 microseconds. The normal ranges of transducer indication for the three transducers are 25.2 to 27.3 microseconds for the oscillator type transducers and 0.13 to 9.7 volts for the bourdon tube transducer. The period of oscillation for the quartz oscillator type transducers was measured with an indication sensitivity of five decimal places, e.g., 25.65432 microseconds. The analog voltage of the quartz bourdon tube transducer was digitized with a sensitivity of four decimal places, e.g., 5.1234 volts.

V. Calibration and Test Procedures

In this section a detailed description of the procedures used during calibration of the differential pressure transducers and acquisition of orifice meter test data is presented. As discussed in section II.A of this report the data collection procedures were automated to the greatest extent possible, consistent with realistic operation of the measurements systems. The initial objective of this approach was the reduction or elimination of human error in the recording of the data. As the system was planned and constructed it became clear that the procedures necessary to collect the data could be made to be very uniform in their execution. To this end a menu driven software system was developed for controlling the greatest part of the data base collection activities. This approach utilized data base management, word processing and customized software, written in both assembly language and compiled BASIC language, modules.

Each of the major tasks was controlled from a main menu of operator selectable tasks. For the production of the data base a relatively fixed sequence of operations was executed. The data base was arranged generally in data blocks which contained all of the information developed during an arbitrarily selected time period. In the case of the final pass of measurements on the nickel plated meter tubes these blocks contained the data collected during a single day. During a portion of the period of time in which the tests were run, data collection procedures ran on a 16- or 24-hour basis. Data blocks were defined to cover the time period of 1 day in all cases. Each data block was begun, usually in the morning, with a full calibration of the differential pressure transducers, followed by orifice meter testing. For the most part a single orifice meter tube was tested during one data block with several data blocks necessary to complete the data for all orifice plates to be tested for that meter tube. On several occasions the meter tubes were dismounted and mounted in the same data block, thereby causing the data block to contain data for two meter tubes.

The main menus for the various tasks performed daily were written using the data base management system's command files. The menus as they appeared for the operators on the console screen are shown in each of the following sections. The last two items listed are common to each menu. These items are necessary for the cataloging of data diskettes and give the operator information about how much storage space remains on a diskette and how to properly back up a data diskette to insure no loss of data. One of the constraints in the selection of the length of time of the data blocks was the amount of data which could be stored on a 1-megabyte floppy diskette.

A. Differential Pressure Transducer Calibration

Differential pressure transducer calibration procedures were executed from the following main menu.

API ORIFICE METERING DATA BASE PROJECT

PRESSURE TRANSDUCER CALIBRATION MENU

(Note - This program diskette MUST be in drive A:)

0 - EXIT
1 - Calibrate pressure transducers (14 points)
2 - Compute transducer coefficients and append data to the appropriate data bases
3 - Surveillance test of transducers (6 points)
4 - Data diskette status
5 - Back up a full data diskette in drive B: onto a floppy diskette in drive A:

Calibration of the differential pressure transducers using the deadweight testers was performed on a daily basis, as the first procedure of the morning. This task was accomplished using programs DWTCAL and TRANCALC. DWTCAL controlled the calibration procedure itself and formed the data base containing the observed and auxiliary parameter values. TRANCALC performed the least squares fitting procedures on the data for each transducer and produced the coefficient data base for them. The basic features of this particular portion of the software system are shown in figure 21. The floppy diskette containing these programs was placed in drive A of the computer disk drive and a data diskette containing the accumulated data was inserted in drive B.

The details of the operation of the two deadweight testers (DWT's) used as working pressure standards for differential pressure transducer calibration procedures were discussed in a previous section. The first DWT, serial number 73520, was connected to the high pressure side of the transducers, and the other DWT, serial number 73521, was connected to the low pressure side. Transducer serial number 13150, labeled #2 in the data base structures, always measured the differential pressure produced at the bottom set of taps of the orifice meter. Transducer serial number 12200, labeled #3 in the data base structures, and the quartz bourdon tube transducer serial number 30827 always measured the differential produced from the top set of pressure taps.

During transducer calibration procedures, DWT 73521 supplied the reference pressure of 41 psig to the transducers' low pressure ports and DWT 73520 applied pressures ranging from 41 to 69 psig to the transducer's high pressure port. The following gives a description of the transducer manifold operation during these calibration procedures.

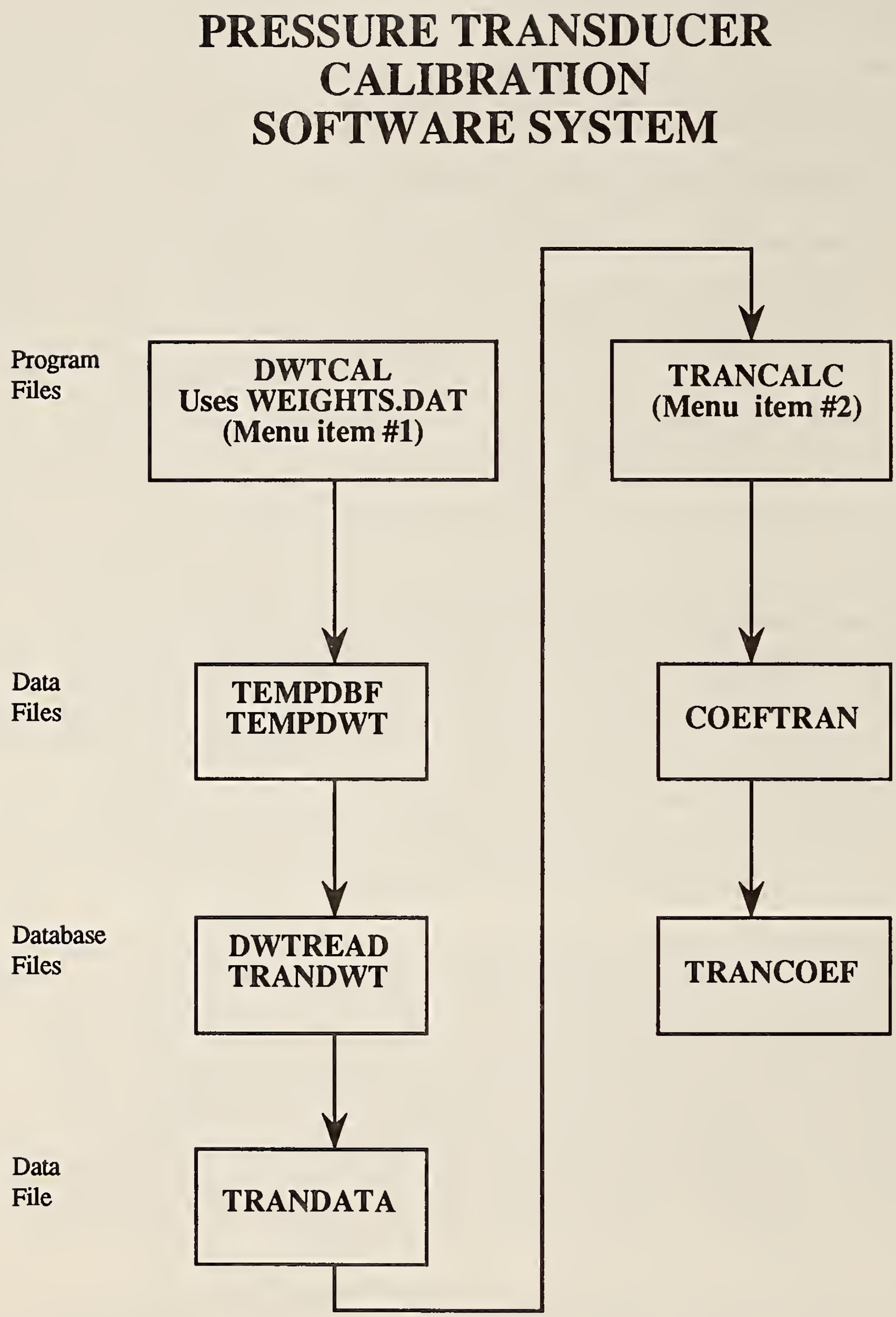


Figure 21. Differential Pressure Transducer Calibration Software

Figure 6 is a schematic diagram of the five-valve manifold associated with the Paros transducers.

Non operational transducer manifold settings and designations:

1. All valves closed except for the bypass in center.
2. Valves on the left of the bypass valve are high pressure.
3. Valves on the right of the bypass valve are low pressure.

The transducer manifold opening sequence is:

1. Open low pressure valve (right side).
2. Close bypass valve (middle valve).
3. Open high pressure valve (left side).

The transducer manifold closing sequence is:

1. Close high pressure valve (left side).
2. Open bypass valve (middle valve).
3. Close low pressure valve (right side).

The operator normally would select item #1 of the pressure transducer calibration main menu for a complete calibration procedure for the transducers. A file called WEIGHTS.DAT contained the list of weights to be placed on the deadweight tester during the calibration. This procedure was comprised of 14 differential pressure points for most of the calibrations run in 1985. Prior to that, procedures having a greater number of points were used. The use of the external data file WEIGHTS.DAT allowed the schedule of differential pressures to be changed easily without changing the operating program, DWTCAL, in any way. After manual entry of the date, barometric pressure, and relative humidity, the operator was instructed to perform the calibration using the weight designations read from WEIGHTS.DAT.

The first test point taken is observation of the transducer response values to zero differential pressure at the reference pressure, 41 psig, applied to both sides of the transducers. This was accomplished by opening only the valves on the low pressure side of the transducer manifolds at the air/oil interfaces with each bypass valve open. The remainder of the test points were taken with the bypass valves closed and both the high and low pressure valves open. The remaining test point differential pressures were obtained by adding and removing the appropriate weights to the high pressure side DWT (s/n 73520) as listed below for the 14-point calibration schedule. The weight designations, differential, and test pressures are also listed. The pressure values listed are indicative of the numerical precision used in computation and storage of these values.

14-Point Calibration Schedule

Obs.	Weight Stack Designation	Diff. Press.	Test Press.
1	66- 77- 88-	0.00137	41.00646
2	66- 77- 88-10W-11W-12W-13W-	0.36207	41.36715
3	66- 77- 88-10W- 9- 10- 12-	8.18395	49.18904
4	66- 77- 88-10W- 7-	10.18463	51.18971
5	66- 77- 88-10W- 7- 9- 12-	16.18635	57.19143
6	66- 77- 88-10W- 7- 9- 10- 12-	18.18685	59.19194
7	66- 77- 88-10W- 7- 8-	20.18704	61.19213
8	66- 77- 88-10W- 7- 8- 9- 10- 12-	28.18927	69.19436
9	66- 77- 88-10W- 7- 8- 9- 10-	27.18903	68.19412
10	66- 77- 88-10W- 7- 8- 10- 12-	23.18779	64.19287
11	66- 77- 88-10W- 7- 10- 12-	13.18537	54.19046
12	66- 77- 88-10W- 10- 12-	3.18247	44.18756
13	66- 77- 88-10W- 12-	1.18196	42.18705
14	66- 77- 88-	0.00137	41.00646

The pressures listed above are representative values. These did change slightly from day to day as atmospheric conditions changed. Before the data were taken at each pressure the oil levels in each leg of the transducer valve manifolds were balanced using the traveling telemicroscope.

The calibration procedure was quite straightforward. The operator was instructed by messages displayed on the the computer's console to place each series of weight stacks on the deadweight testers to generate a known differential pressure relative to the reference pressure of 41 psig. The computer then acquired 25 readings from all of the pressure transducers. These individual readings were stored in a file called TEMPDBF.DAT for later inspection of any suspect data. The average transducer indication along with temperature, weight stack designation, and other information were saved in a file called TEMPDWT.DAT. Upon completion of the calibration procedure, the ASCII data file TEMPDBF.DAT was appended to data base file DWTREAD.DBF and the file TEMPDWT.DAT was appended to TRANDWT.DBF as shown in figure 21. At this point it was possible to mark data for deletion that were obviously incorrect in the data base file TRANDWT.DBF so that they would not be used in the subsequent fitting procedures. It should be stressed, however, that these deleted data were not lost, but merely marked for deletion. After deleting any suspect data a new data file called TRANDATA.DAT was created for use in the least square fitting procedures, and then the software system returned to the main menu.

The transducer calibration coefficients were computed using menu item #2. The program TRANCALC computed a linear least squares fit of the data for the Ruska transducer and a second order least squares fit for the two Paros Scientific transducers. These calibration coefficients were stored in the data file COEFTRAN.DAT and were appended to the data base file TRANCOEF.DBF upon completion of the program. The software system then returned to the main menu.

The choice of item #3 on the main menu allowed a six-point surveillance test of the pressure transducers. This test was designed as a check of the transducer performance between calibrations. This test compared predicted results to measured results for the current calibration coefficient values and presented these data in tabular form on the console for inspection. If a problem was detected, the full calibration was rerun (item #1 on the main menu). The test side DWT weight stack composition for these tests is shown below with the computed differential pressure value and typical results for the transducers.

Six-Point Surveillance Test

Obs.	Weight Stack Designation	Diff. Press. (psid)	Paros 13150 (psid)	Paros 12200 (psid)	Ruska 30827 (psid)
1	66-77-88-	0.0014	0.0093	0.0080	0.0098
2	66-77-88-10W-11W-12W-13W-	0.3621	0.3686	0.3612	0.3701
3	66-77-88-10W-12-	1.1820	1.1880	1.1867	1.1892
4	66-77-88-10W-10-12-	3.1824	3.2102	3.1914	3.1897
5	66-77-88-10W- 7-	10.1847	10.1901	10.1886	10.1914
6	66-77-88-10W-7-8-9-10-12-	28.1896	28.1964	28.1953	28.1970

This surveillance testing proved quite useful in determining the presence of any strange behavior in the transducers. However, it should be stressed that any problems detected in the transducers were corrected immediately, and then the transducers were re-calibrated before orifice data collection procedures were resumed.

B. Meter Tube Installation

All orifice meters tested were always installed with the Sprenkle flow conditioner upstream, meter sections A, B, and C, respectively, from upstream to downstream, with the orifice plate mounted between the orifice meter flanges of sections B and C. These were located near the control console and pressure transducer rack near the downstream end of the facility test sections. This arrangement gave the longest possible upstream lengths of straight pipe between the upstream end of the flow conditioner and the pump manifold. In the case of the 4-inch test section of the water flow measurement facility, a 4-inch in-line filter was also permanently placed in the flow line immediately downstream of the pump manifold. This filter was of the re-entrant type with a stainless mesh filter element having a mesh spacing of 150 micrometers (0.006 inches) had the effect of preconditioning the velocity profile of the water flow as it left the pump manifold. A bleed valve was attached to the Sprenkle flow conditioner to release entrapped air. This valve was generally open except when taking a no flow differential pressure measurement. Each upper tap of the orifice meter was fitted with a small manifold, which consisted of a short length of 1/4-inch pipe connected to a tee with a valve connected to the opposite side of the tee. The orifice meter was mounted such that this connection piping in the orifice taps was in the vertical plane. The valve was placed above the tap hole and providing the means of bleeding air which may have accumulated in either of the upper tap holes. The transducer connections were arranged such that the lower orifice meter taps were connected to the lower transducer (S/N 12200) and the upper taps led to the two upper transducers (S/N 13150 and S/N 30827). Ball valves were located in the lines leading to the transducers to allow these lines to be isolated in the filled condition during changing of the orifice plates or meters, and during changes in the flow rate during data collection procedures. This was a very effective means of protecting the transducers from differential pressure extremes, and allowed the transducer manifold and associated tubing to be water filled at all times. By using these valves the need to bleed air from the transducer manifold and tubing was much reduced.

Once all the connections were made, an orifice plate was selected and installed in the meter run. The orifice plate was installed with the sharp edge of the orifice facing upstream. Before an orifice plate was installed it was washed in acetone and dryed with a soft cotton cloth. Any discolorations were removed in this manner. After installing the plate, the gap between the locating pins on both the east and west sides of the meter were checked with a feeler gauge. These values were recorded in the notebook file maintained by the operating program, ORIFICE. Generally, the acceptance limit for this separation was 0.0015 inches (37 micrometers). Once the meter was installed, the power to the flow system control bench was turned on. The pumps were turned on with extreme care in order to avoid bending the orifice plate by keeping the backpressure less than 41 psig and the differential pressure below the maximum value noted for each plate.

C. Orifice Meter Data Acquisition Procedures

The main menu used to control data acquisition and storage functions for orifice testing procedures is shown below.

API ORIFICE METERING DATA BASE PROJECT

ORIFICE DATA MENU

(Note - This program diskette MUST be in drive A:)

0 - EXIT
1 - Copy transducer coefficient file
    from drive B: to A:
2 - Test orifice plates and append
    orifice data to data bases
3 - Data diskette status
4 - Back up a full data diskette in drive B:
    onto a floppy diskette in drive A:

Figure 22 shows a block diagram illustrating the organization of the software system used to acquire the flow measurement system data during orifice discharge coefficient measurement operations. Following the calibration of the differential pressure transducers, it was necessary to transfer the calibration coefficient data file COEFTRAN.DAT to the orifice data acquisition program diskette. This task was accomplished using item #1 in the main menu, which copied the file from the data diskette in disk drive B to the program diskette in drive A and was necessary to prevent any ambiguity between the files on either diskette.

Data acquisition during orifice meter testing was accomplished using three programs, ORIFTEST, ORIFICE2, and ORIFICE3. Using the Microsoft Basic "CHAIN" statement, these three programs were chained together due to memory limitations of the computer system. The "%INCLUDE" compiler directive was used with the file ODEF.BAS in order to declare common variables, functions, and subroutines used by each of the programs. Data acquisition was started by choosing item #2 in the main menu. This choice loaded and ran the first of the three chained programs. It should be stressed that the loading of these programs from the systems disk was transparent to the operator, whose menu selections controlled operations at any time.

ORIFTEST is an initialization program. Its tasks were to initialize variables, place the number zero in two data files, NUMBFILE.DAT and ZEROFILE.DAT, which will be discussed in the following paragraphs, and to read the transducer calibration coefficients from the file COEFTRAN.DAT. The operator was also required to enter the date and to answer whether or not the Ruska pressure transducer was in operation. Finally, the operator's notebook file, COMMENT.DOC, was opened for subsequent input.

The data acquisition software next chained to the program ORIFICE2. This program first recalled the previous meter tube, plate, and run number information from the file ORIFSTAT.DOC. After the operator entered the run number for the next run, he could change the meter tube and/or plate combination. A table of orifice plate diameters (ORIFDIAM.TXT) was searched for the plate diameter. If not found, the program asked for the corrected orifice plate designation and checked the table again.

At this point the response of the differential pressure transducers and the electronic scales were checked against the appropriate check standards. The deadweight testers were used to generate a known differential pressure, in this case approximately 5.18 psid. This pressure was applied to the transducers through the manifold in the same way that the transducers were calibrated. The oil/air menisci were adjusted by the operator to equal heights, and the microcomputer read the transducer response values after being given the command to do so by the operator. Twenty-five consecutive, sequential observations were made of the three transducer indications. These values were stored in a disk file. Next a scale check was performed using a set of calibrated weights. The following is a list of the detailed procedures displayed on the console and followed by the operator to perform these tasks:

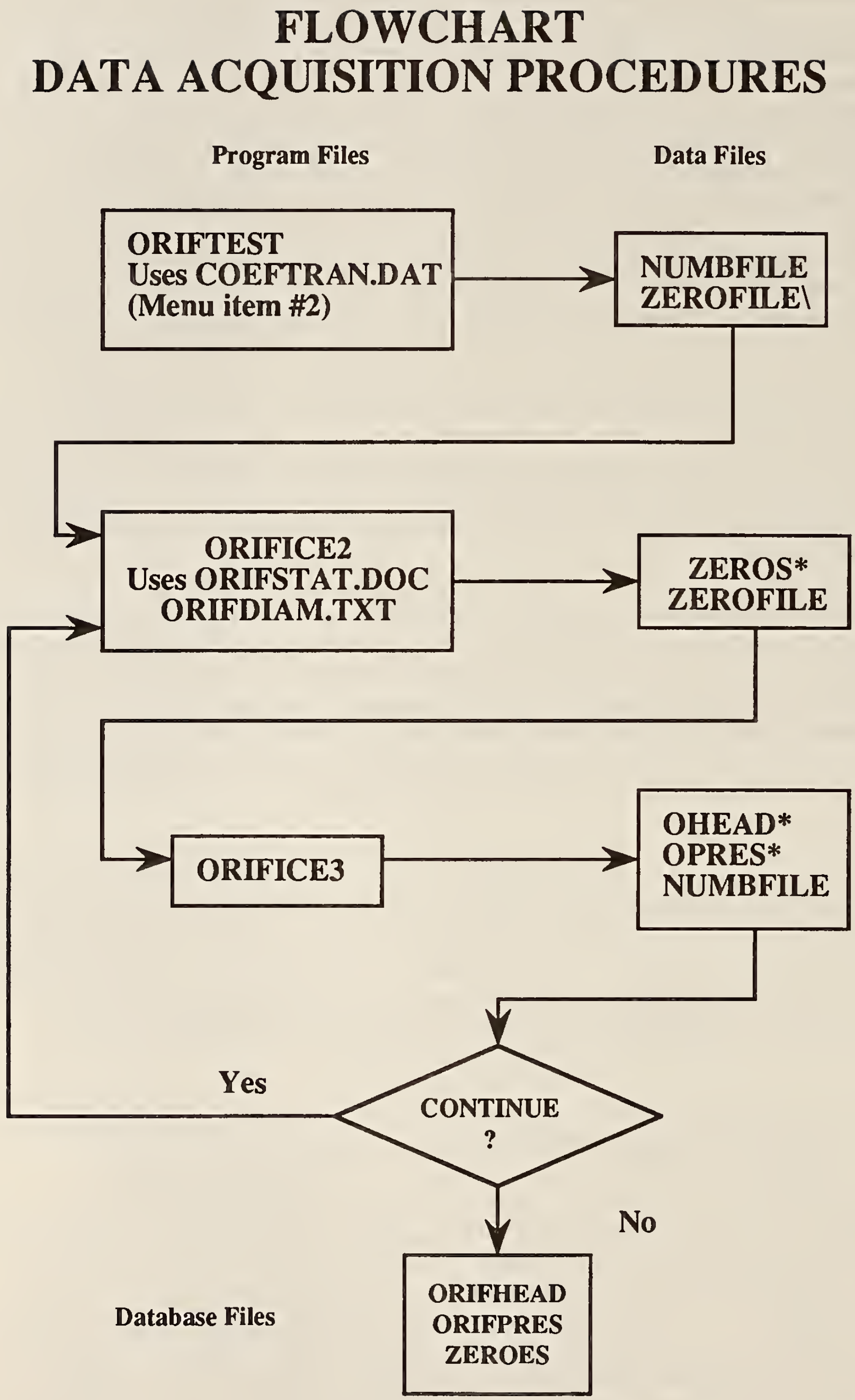


Figure 22. Orifice Meter Data Acquisition Software

1. Starting with all manifold valves closed, open the air pressure supply from the cylinder to the deadweight testers.

2. Place weights #10W and #9 on the high pressure side of the deadweight tester.

3. Close the drain valve to the tank of the scale to be checked.

4. Open inlet valves on both deadweight testers to "HIGH RANGE". This will levitate the ball and weight stack of each deadweight tester.

5. Open outlet valves of the DWT's to "ON".

6. Open transducer manifold valves of the air-oil interfaces as the console screen instruction directs.

7. Load the specified check weights onto the scale. Gross weight will be read upon a "RETURN" from the console. Remove the weights from the scale deck.

8. The tare weight will be read on a "RETURN" from the console.

9. Gently spin the weight stacks of the deadweight testers. Balance the air/oil menisci using the telemicroscope.

10. When the values stabilize on the differential pressure transducer indicators, initiate reading of the transducer values with a "RETURN" from the console.

11. Close the transducer manifold valves. The transducers should indicate approximately 5.18 psid and the scale should indicate within one count of the specified weight. If this doesn't occur, redo Transducer/Scale check from the console.

An observation of the transducer response was next performed with zero flow through the orifice meter. The following procedure was used to accomplish this task:

1. With the transducer manifold valves closed, open the upper and lower transducer line valves at the meter.

2. Relieve any back pressure on the orifice plate by opening the bypass valves and close the downstream outlet valve on the meter run.

3. Adjust the bypass valves to set the backpressure to 41 psig.

4. Close all bleed valves, including the valve on the Sprenkle flow conditioner.

5. Open the transducer manifold valves at the water-oil interfaces and balance the menisci.

6. Close the upstream inlet valve supplying the meter run. The computer will read the transducer values (20 consecutive values are read and stored). The values should be near the following. This message is displaced on the system console.

   Upper Paros 25.215 Lower Paros 25.597
   Ruska .002

7. Close the transducer manifold valves.

8. Open the upstream inlet valve, open the downstream outlet valve, and open the bleed valve on the Sprenkle flow conditioner. If the transducer values are not as indicated above, perform the zero flow measurement procedures again.

Finally, the program instructed the operator to perform a zero differential pressure measurement at a reference pressure of 41 psig. This measurement was made with each transducer's crossover opened and the two shutoff valves closed. The sequence of valve manipulations was the following. The high side shutoff valve was closed, and the crossover was opened. Finally the low side shutoff valve was closed. The sequence insured that the static pressures at the transducers were near 41 psig for this observation. All of the individual readings of "no flow" zeroes and deadweight tester zeroes were saved in files designated as ZEROS*.DAT, where the * indicates ascending numbers from one up to the number of times this measurement was performed in a single day. This index was saved in the file ZEROFILE.DAT to aid in the appending of this data to the data base file ZEROES.DBF.

ORIFICE3 was the final of the three chained programs and acquired the orifice discharge coefficient data over the flow rate range. Each orifice plate was tested at differential pressures of 0.4, 1.0, 3.0, 10.0, and 28 psid (or the maximum allowed for the plate under test, whichever was lower) at a base pressure of 41 psig. (These pressures were selected to approximately equal incremental changes in the Reynolds number over the flow rate range.) The operator was first instructed to adjust the flow rate for the desired differential pressure and do a manual filling of the weigh tank in order to determine a nominal value for the diversion time. After entering this time from the console, the operator entered the number of test runs the system was to execute at this particular flow rate setting (normally three runs were chosen), values for the barometric pressure, the relative humidity, and any pertinent comments he might have about the current test. The software system then controlled the data acquisition procedures until the selected number of runs were complete.

The system closed the weigh tank drain valve and measured the tare weight. The operator was given another opportunity to adjust the flow rate, then the system read the system time-of-day clock and diverted the flow into the weigh tank for approximately the prescribed amount of time. During the time of the flow diversion, the data acquisition system read the values from each of the pressure transducer indicators sequentially. This reading loop was terminated with a reading of the time-of-day clock to check if the diversion time interval had been exceeded. If not, the transducer reading loop was executed again. This loop was executed until the diversion time interval was completed. All of the individual values of the differential pressure indications were stored for the entire run. The maximum number of transducer readings which could be stored was 200. This number of observations was selected based on the size of the data space available, and on the minimum time interval between readings. For the majority of the data base the approximately 1-second reading interval was used. The transducer indicator reading loop was executed in somewhat less than one second. For diversion times below 150 seconds this loop was executed as quickly as possible. Above 150 seconds a variable delay loop was inserted into this observation loop to keep the maximum number of transducer readings near or below the limit of 200. In this way the differential pressure observations were evenly distributed over the diversion time of the run.

The system measured the flow loop, weigh tank and air temperatures as well as the gross weight of the tank and diversion time after the diverter valve switched the flow back to the reservoir. The weigh tank was drained and this process continued until the desired number of observation runs were complete. After the final flow diversion, the data was computed and the results along with average values were displayed on the console screen and output to the printer. Data files OHEAD*.DAT and OPRES*.DAT were used to store the raw data. Again the * indicates ascending numbers from one up to the number of times the measurement was performed in 1 day. The final number was saved in the file NUMBFILE.DAT to aid in the appending of the orifice data to the data base files ORIFHEAD.DBF and ORIFPRES.DBF.

At this point the software system chained back to ORIFICE2 in order to measure the transducer zero values against the deadweight tester. The system continued in a cyclic manner between ORIFICE2 and ORIFICE3 until either the data acquisition for the day was completed or all flow rates for an orifice plate were completed. Then the operator was instructed to perform, at his option, a final transducer and scale check as well as a final "no flow" pressure measurement as described above before the system stopped. Finally, the data were appended to the appropriate data base files as described above.

After the data base files had been appended, the software system called the word processor to append the file COMMENT.DOC to a list of notes kept during the course of the project called NOTEBOOK.DOC. This file contained not only comments from the operator as described above, but also such data as the operator(s) initials, date, time, plate and meter tube designations, scale check value, and transducer check values. This notebook was an extremely useful tool for the operators as well as for the managers of this program.

<u>Selection of Flow Rate Values for Each Orifice Plate</u>

The selection of the sequence of differential pressure values for a set of observations for each orifice plate during a data block was done using table 32 prepared by the NBS Statistical Engineering Division. It was used to minimize or eliminate the possibility that systematic errors would not be introduced into the data base through the use of a fixed sequence of differential pressures run on every orifice plate. This schedule was originally developed for a set of tests involving a single meter run and two orifice plates. It was later generalized for use throughout the testing program. The schedule for the first plate of a block was selected by the operator on duty such that it was not the one selected for the previous data block. Once the beginning point in table 32 was selected, successive sequences were used for the remainder of the block. After the plate 16 schedule, succession began with plate 1.

Table 32. Schedule of Differential Pressure Values for Flow Rate Setting

Plate #1	2	3	4	5	6	7	8
10	3	1	1	3	3	10	28
.4	.4	3	28	.4	10	1	10
1	1	.4	10	28	28	3	.4
3	10	28	.4	1	1	.4	1
28	28	10	3	10	.4	28	3
Plate #9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
3	28	28	3	.4	10	28	.4
.4	1	1	28	3	28	3	10
1	.4	3	1	1	3	.4	1
10	10	.4	.4	28	1	10	28
28	3	10	10	10	.4	1	3

This schedule was modified somewhat for more efficient use of scales, i.e., all flow rates to be run on one scale were completed before selecting the next scale. Randomization of the flow rates was attempted for the majority of the data base collection within these constraints.

D. Diverter Correction Calibration

The data necessary for computation of the diverter correction values were obtained through the use of the following menu.

API ORIFICE METERING DATA BASE PROJECT

DIVERTER CORRECTION MENU

(Note - This program diskette MUST be in drive A:)

0 - EXIT
1 - Calibrate diverter
2 - Re-compute diverter correction
3 - Data diskette status
4 - Back up a full data diskette in drive B: onto a floppy diskette in drive A:

Calibration of each of the four weigh tank diverters was accomplished using the software system shown in figure 23. The program DIVERTER was run by choosing item #1 in the diverter correction main menu. The specific measurements are discussed in detail in section II.C.2 of this report. The results of the calibration were saved in a data file called DIVERT.DAT, which was appended to the data base file DIVERTER.DBF upon completion of the program. The system then returned to the main menu.

Item #2 of the main menu allowed recomputation of diverter correction values off-line so that thermistor calibrations or scale calibrations could be included in the data reduction at a later time. This feature of the system allowed the operator to continue orifice data acquisition while using another computer system to recompute data.

Flow Chart
Diverter Calibration Software

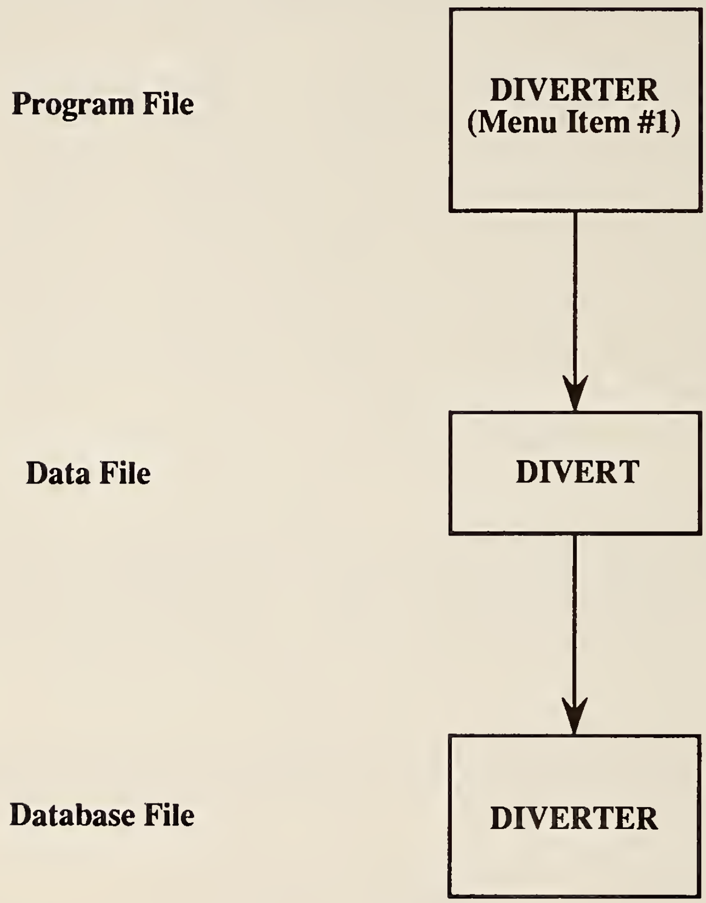


Figure 23. Weigh Tank Diverter Calibration Software

VI. Archiving of the Data Base, Data Analysis Results, and Statistical Analysis of the Results

The extent of the complete data base generated during the course of this work is quite large. It is stored in computer readable form only and available from either NBS or API. The bulk of the data base consists of the differential pressure transducer observations recorded for each test run, 40 to 200 values for each of the three transducers. The results of the analyses of the final data base are much less extensive. However, listing of all the intermediate parameter values for each test run is not possible here. To keep the size of this report within manageable proportions, the results for each valid test run are summarized in a single line of information. Plots of discharge coefficient vs. pipe Reynolds number are given for each orifice meter. A brief discussion is given of the operational events and the data collection procedures used in collection of the final data base because these affect the test runs analysis.

The final data base contains the normal operational malfunctions and blunders encountered in obtaining any experimental data base. A detailed inventory of the runs in which malfunctions occurred is included.

A. Operational History, Final Data Base Definition, and Archiving of the Data Base

A detailed operational history of this project from its inception through completion of the major period of data collection in January 1986 is given in Appendix A. A brief description of the major events shaping the structure and segmentation of the data base is given here to provide the rationale for elimination of certain blocks of test data from the analysis procedures. The complete data base generated by this project is quite large and is clearly segmented into two parts. The segment of the data base which will be referenced here consists of test runs taken on June 17, 1985 and thereafter.

On June 17, 1985 the initial observation runs were taken on the four-inch stainless steel, meter tube which served as a check standard in generating the final data base. Stainless steel was chosen as the meter tube material to ensure that surface roughness effects induced by corrosion of the meter tube's interior surfaces would be absent and have no effect on the performance of the 4-inch orifice plates tested with the tube. In this way the performance of the total measurement system could be quantified over the generation time period using statistical methods. As mentioned above, an extensive experimental program was necessary to unquestionably identify and, to some extent, quantify the role that corrosion-induced surface roughness may play on orifice meter discharge coefficient values when determined using water as the test fluid.

The test run data taken before June 17, 1985 were contaminated by modification of the surface roughness of the meter tubes over time. This modification was shown by experimental work to be caused by the continual increase in the roughness of the surface induced by corrosion of the mild steel. Previously published work [22] investigating the effects of surface roughness on orifice meter performance was performed on meter tubes generally smoother (30 to 60 microinches rms surface roughness), with one exception, than those used in this work. The previous tests were done in natural gas (no corrosion-induced roughness changes) and concluded that smooth or honed pipe could be used in making orifice meters with no adverse effect on discharge coefficient values. The magnitude of the effects observed at NBS was unexpected, and was clearly shown to be induced by surface corrosion near the end of the time period of the project. The investigation to demonstrate and quantify these effects, and then, to explore corrosion inhibition methods to control them, is discussed in detail in Appendix A. This investigation ended in mid-June 1985.

The investigations performed between January and June 1985 clearly demonstrated the effect of increased meter tube surface roughness on discharge coefficient values. In February a method acceptable to the API was devised to obtain a level of statistical control in the collection of the final data base through the use of a single four-inch, stainless steel meter tube, designated DAN-4SS. It was similar to the other 4-inch meter tubes, but did not conform to all geometrical specifications of the AGA Report No. 3/API 2530 standard [17]. It consisted of a single upstream section 20 feet in length with a downstream section 3 feet, 4 inches in length, and did not meet all industrial standards criteria. It only was to provide a measurement systems performance reference that would not include effects of changing surface roughness levels. Data were collected with this meter tube and one orifice plate set in the same manner as with the other meter tubes. Observation repetitions were greater to provide a reasonably large amount of data roughly scattered over the length of the data base collection period. These data formed the basis for a statistical analysis of measurement system performance which will be given later in this section.

In the late spring of 1985 NBS and the API, through its Orifice Database Steering Committee, had agreed that any data base developed using water flows must incorporate a method to eliminate meter tube surface corrosion. (It had been shown that relatively small levels of rust formed on the meter tube were measurable in the discharge coefficient value with the NBS measurement system.) Several inhibition methods were explored. Finally, it was agreed that the electroless nickel plating process would be used on one meter tube. In preparation for obtaining the data base, each of the meter tubes was refurbished to restore its interior surfaces to a level judged to be of commercial quality by the API. Because the API's Orifice Database Steering Committee had expressed some apprehension that nickel plating would adversely affect and deteriorate this level of quality, and, hence, the value of the discharge coefficients derived from them, brief tests were conducted on the first refurbished meter tube before the nickel was applied. These series, designated bare meter tube tests, were subsequently performed on all meter tubes. To distinguish the data on the bare steel meter tubes from the data on the nickel plated meter tubes, the bare or unplated tubes retained the designation FE-XABC, where X ranges from 0 to 9 indicating the meter tube size. The nickel plated meter tubes were designated PE-XABC.

On June 18, 1985, a bare meter tube test on the refurbished FE-6ABC meter tube assembly with the largest beta ratio orifice plate (approx. 0.75) was run. This test run series consisted of 21 test runs completed in approximately 4 hours. The meter tube was removed from the water flow rate measurement facility, dried, and shipped to be plated with approximately 0.001 inch thickness of nickel using the electroless process. Inspection of the tube upon removal showed little visible rust on the tube surfaces. Upon the return of this meter tube a full set of test runs was completed involving each of the eight orifice plates tested for this tube. No corrosion was observed visually in the meter tube. The consistency of test result replication between the bare and plated meter tube was within the bounds expected from the propagation of errors analysis, and, most importantly, did not show large between-day differences. With these results in hand it was decided to nickel plate the remainder of the meter tubes using the electroless nickel process. Subsequently, each of the meter tubes used in generating the final data base was tested before electroless nickel plating with the largest beta ratio orifice plate and the 0.37 beta ratio plate. Because the largest beta ratio plate (beta = 0.75) is the most sensitive to surface roughness effects, the smaller beta ratio plate was added to give a basis for drift effects, should a significant difference develop between the plated and unplated results for the large beta ratio plate.

<u>Archival Data Base Segments</u>

The complete data base is archived in two segments. The segment of interest for correlation equation development, such as in the currently used Buckingham [17] and Stolz [23] equations, would appear to be that segment not unduly influenced by corrosion induced surface roughness effects. This is defined as the final data base developed on the plated meter tubes. The remainder of the data base taken before June 17, 1985 is of limited practical utility, although it may have academic interest to future workers in the flow measurement field. The archiving of the complete data base in computer readable form is described in Appendix D of this report. Only the final data base will be discussed henceforth.

<u>Criteria For Marking Test Runs for Deletion</u>

In archiving the data base all of the complete test runs recorded on magnetic diskettes are included, i.e., those marked for deletion and those not. This archival method was required by the API. Test runs marked for deletion were excluded from the analysis. The criteria used in marking runs for deletion are discussed below.

Marking test runs for deletion was based on the following criteria.

1. Deletion based on facility malfunctions as observed and indicated by the operators in the hand written notebook, the data acquisition computer notebook, or the preliminary results sheets, or operator mistakes in entering the necessary data into the computer during data collection procedures. Typical examples are:

   (a) air bubbles observed when bleeding orifice meter taps,

   (b) improper positioning of transducer manifold valves,

   (c) not opening the main shutoff valves to the transducers before beginning a test run group.

   (d) keyboard entry errors of the operators. In several cases the simplest method of recovery without restarting the program was repetition of a test run series allowing a complete data acquisition cycle and start a new test run group. This second group would be the actual test runs with the initial group marked as deleted. This method was much more time efficient than restarting the data acquisition procedures as was done for each newly installed orifice plate. Typical keyboard entry errors were incorrect entry of the diversion time or system number.

2. Improper setting of the pumping or flow control systems leading to poor reproducibility in the test run observations, e.g., pressure pulsations attributable to using pumps at orifice meter flow rates well below the stable operating capacity of the pump.

3. Runs never recorded on the magnetic storage diskettes due to data acquisition computer malfunction, e.g., operating program errors before test run data were written to disk files, or operators inadvertently skipping a number in the run number sequence.

Operator entry of specific descriptions of malfunctions into the computerized and handwritten notes did not always occur. Deletion of specific test runs or test run groups was made on the preliminary results sheets printed by the data acquisition computer. In most cases the test runs or groups of test runs so marked were repeated before the orifice plate was removed from the meter tube in order to complete a full set of flow rate settings on each plate installation. Operator indicated deletions are the basis for the subsequent marking of a significant number of test runs for deletion and fall into the first deletion criteria.

Deletion based on the second criterion is applied to blocks of test run data on specific orifice plates. These blocks generally include all test runs made on a particular day on a plate. This criterion is used to describe a difficulty observed at the lowest flow rates and Reynolds number which occurred with the small beta ratio orifice plates of the smaller diameter meter tubes.

Abnormal Behavior at Low Reynolds Numbers

As mentioned in the introduction to this report this project was one of three which ran concurrently and covered overlapping or adjacent Reynolds number ranges. The API program manager, Mr. W. A. Fling, noted a discrepancy between the results obtained in this project and those obtained from the low Reynolds number project being conducted in a high viscosity oil at Colorado Engineering Experiment Station, Inc. (CEESI) [24] on the same meter tube/orifice plate combinations. As a result a collaborative investigation of the effects seen in the water flow measurement facility was undertaken. The following is taken from the report of that work, and is given here to describe the investigation, its results, and its impact upon the data base.

The test results of the low and intermediate Reynolds number projects using the same meter runs and orifice plates have shown good correlation for all meter tubes and plates tested with the exception of the 2-inch meter tube with the small beta ratio orifice plates (0.1, 0.2, and 0.375 beta ratios). For these plates the discharge coefficient values obtained in the low Reynolds number project uniformly decreased with increasing Reynolds number. The discharge coefficient values obtained at NBS using water as the fluid exhibited an increase in discharge coefficient from very low values (approx. 0.5) observed at lower differential pressures to values similar in magnitude to those predicted by either the Stolz or Buckingham correlation. The objective of the investigation was to determine whether the differential pressure instrumentation of the two laboratories had systematic effects differing by a sufficiently large amount to explain this discrepancy and behavior.

Approach

The approach taken was to use CEESI's differential pressure instrumentation in conjunction with those used at NBS-Gaithersburg to investigate the behavior of the low beta ratio plates in the water flow facility. The only changes in the NBS instrumentation or flow facility made were to provide a means to connect the CEESI instruments to the data acquisition system. Also, CEESI brought a set (3) of diaphragm-type, differential pressure transducers of different range and the deadweight tester used by them. The deadweight tester was connected to the transducer manifold of the NBS differential pressure transducer manifold to perform joint tests of the 2-inch meter run, PE-2, using primarily the 0.1 beta ratio plate. The three diaphragm-type transducers were connected in parallel to the bottom taps of the orifice meter. These were then connected in parallel with the lower Paros transducer used at NBS. Initial tests were run with the 750 inch-of-water, diaphragm-type transducer monitored by an independent data acquisition system. These initial tests were run at 10 and 27 psid differential pressure and the pressure values obtained by both sets of instruments agreed with only minimal differences (less than 0.1% at these two pressures).

The remainder of the data was collected in a similar manner with the exception that the analog signal from the diaphragm-type transducer in use was fed to the NBS data acquisition system through the voltmeter normally used by the Ruska transducer. This arrangement allowed the diaphragm-type transducer response to be stored in the identical manner as that used for the Ruska transducer. Also this allowed computation of discharge coefficient values derived from the average differential pressures observed by the diaphragm-type transducers for immediate comparison of discharge coefficient values obtained by the two types of instruments.

<u>Observations</u> <u>and</u> <u>Results</u>

In general the differential pressure values obtained from both types of transducers showed good agreement and the calculated discharge coefficients were similar with less than 2 parts in 600 difference between them. The decrease in discharge coefficient values with decreasing Reynolds number was observed to be reproducible with both sets of instruments. After observing the characteristics of all the data collected, it was decided that the 1000-gpm pump may be the source of spurious differential pressure signals or that pulsations were caused by throttling of the pumps for the very small flow rates involved (approx. 1 to 10 gpm). As a final test another source of water was substituted. The municipal water supply was connected as a source to the 2-inch meter run via a flexible hose and tests were run through the differential pressure range obtainable with this source of supply. The discharge coefficient values observed in this way showed a marked difference to those observed with the normal pumping system. These discharge coefficient values were in the 0.61 to 0.62 region and were consistent with the higher differential pressure points observed in water flows and with all the data obtained with the high viscosity fluid at CEESI.

Following these tests a smaller turbine pump (approx. 100-gpm capacity) was installed in the water flow facilities' reservoir. This installation was completed on August 23, 1985. Test run series were repeated using this pump on the smaller beta ratio orifice meters which had shown a characteristic down turn in the discharge coefficient. This behavior is illustrated in the graph shown in figure 24 for the 2-inch meter tube, PE-2ABC, with the FE-1/2-7B orifice plate (beta ratio of 0.1210, orifice diameter approximately 0.25 inches) installed. The orifice discharge coefficient is plotted as a function of the pipe Reynolds number. The observations were taken on 4 days in August 1985. The initial two day's data were taken on August 6 and 12, and the results show good reproducibility at the higher differential pressure values of 10 and 28 psid. However, as the differential pressure and Reynolds number decrease, the discharge coefficient values decrease as well until at the lowest differential pressure, approximately 0.4 psid, the discharge coefficients have decreased substantially. This characteristic, rapid decrease in the discharge coefficient value with decreasing Reynolds number was observed in several, but not all, of the small meter tubes with the smallest beta ratio plates for test run results taken

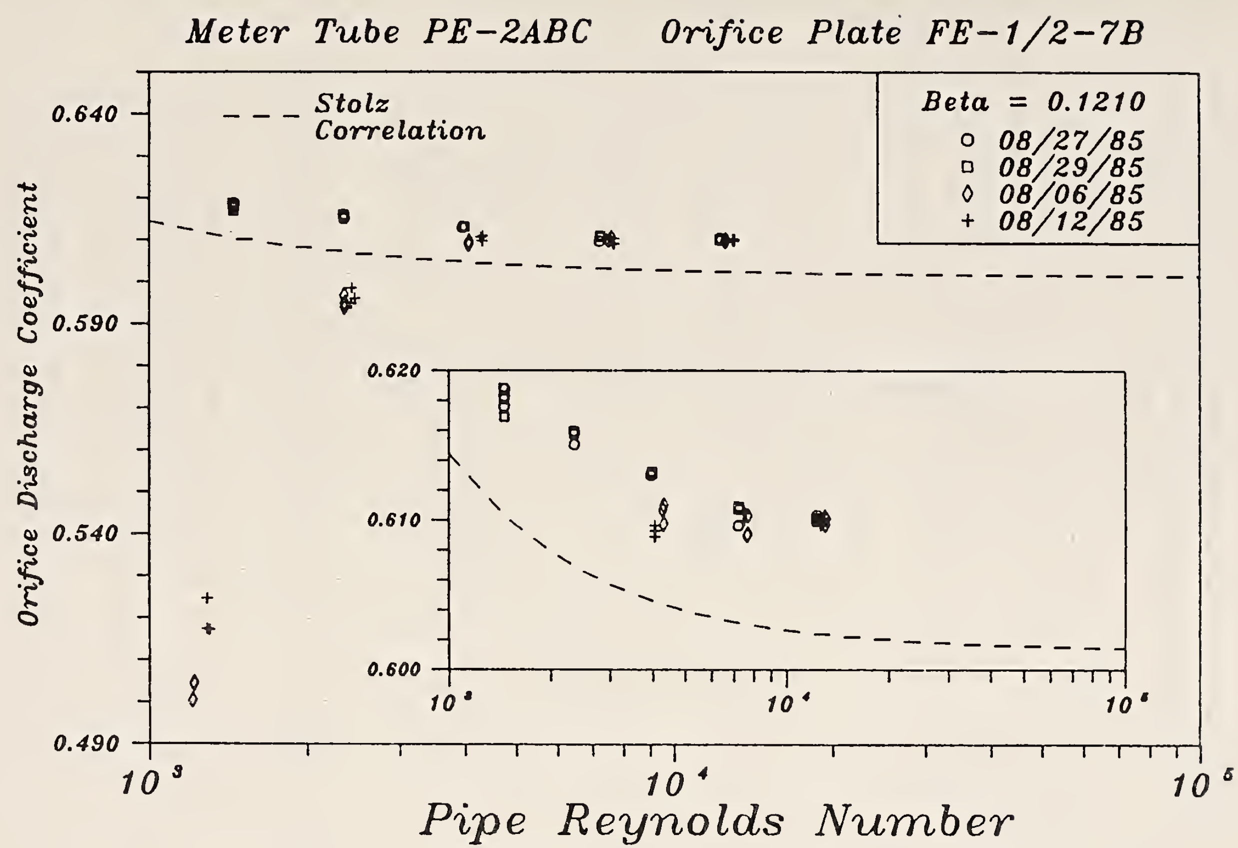


Figure 24. Effects of Pumping System on Orifice Discharge Coefficient

before August 23, 1985. The Stolz correlation is shown as the dashed line. Reruns of meter tube/orifice plate combinations exhibiting this behavior were rerun after installation of the smaller, 100-gpm pump and showed increasing discharge coefficient values with decreasing Reynolds number and agreed well with the high differential pressure results obtained previously in the low Reynolds number project.

Several groups of test runs were affected by the selection of a pump of too high a capacity, these were marked for deletion in the final data base and were rerun with the smaller pump. Shown in the inset of figure 24 is an expanded plot of the higher Reynolds number points. The discharge coefficients at approximately 2,200 Reynolds number are clearly affected. Values around Reynolds numbers of 4,000 and 8,000 are in two groups and are near the pipe Reynolds value for which these effects appear to cease. The high Reynolds number values taken at 27 psid appear to be consistent with the results taken with the higher capacity pump. Certainly a pumping system dependence is evident.

It was expected that use of the 100-gpm pump would eliminate these effects, and did so for many meter tests taken in the lowest flow rate range. However, similar behavior to that shown in figure 24 was observed at the lowest flow rates. As was the case previously at low flow rate settings, this condition was observed intermittently. Substitution of the municipal water supply, as had been done in the diagnostic testing described above, for the 100-gpm pump mitigated these effects. However, large variations in results continued to appear intermittently. These were attributed to uncontrollable pressure fluctuations in the municipal water supply. To some extent these were avoided by taking the test run observations after normal working hours. Due to the press of the operating schedule however, this could not always be done, and a portion of the results for test runs taken at these low flow rates show a degree of scatter either greater than or near that predicted by the propagation of errors analysis.

<u>Collection of Additional Data on Selected Orifice Meter Configurations</u>

Data collection procedures for the bulk of the data base were completed on January 6, 1986. However, upon further analysis of the data base certain of the orifice plate/meter tube combinations were rerun. The primary reason to rerun selected meters was significant scatter in the discharge coefficient relative to the remainder of the data base. As noted above this variation exceeded that expected from the propagation of errors analysis and was not consistent with the variation in the spread of results obtained at similar flow rates meter configurations. Most of those orifice meters rerun had been either wholly or partially run using either the municipal water supply or the low flow rate end of the 100-gpm pump's range.

For certain of the orifice meters chosen for additional test runs, the discharge coefficient values exhibited characteristics similar to those discussed above and shown in the inset of figure 24, but to a lesser degree. Generally the scatter in these discharge coefficient values was near the level expected from the propagation of errors analysis, although a significant number of them were greater than this level. To check the possibility that this scatter could be due, in some degree, to an oversize pump or to pressure fluctuations in the municipal water supply, a smaller turbine pump (maximum capacity of 20 gpm developed at a pressure of 95 psig) was installed in the flow facility's reservoir in a manner similar to that used with the 100-gpm turbine pump installed in August 1985, and additional test runs were taken.

The meter tube/orifice plate combinations involved in this rerun schedule are tabulated in table 33. These orifice meters were rerun in January and February of 1987 after installation of the 20-gpm pump. Additionally, test runs were taken on two 4-inch orifice plates installed in the stainless steel meter tube, DAN-4SS. These were to function as the statistical control plates for the 1-month rerun period. These were the FE-5/6-7C (beta ratio = 0.1) and the FE-5/6-4C (beta ratio of 0.56) plates, and were selected to span the flow rate range.

Table 33. Meter Tubes/Orifice Plates Rerun in 1987

Meter Tubes	Orifice Plates	Nom. Beta Ratio	Meter Tubes	Orifice Plates	Nom. Beta Ratio
PE-1ABC	FE-1/2-5A	0.67	PE-5ABC	FE-5/6-7B	0.10
	FE-1/2-6A	0.75		FE-5/6-2C	0.38
PE-3ABC	FE-3/4-7B	0.10	PE-6ABC	FE-5/6-8A	0.06
	FE-5/6-2C	0.38			
PE-4ABC	FE-3/4-7A	0.10	PE-8ABC	FE-7/8-7A	0.10
	FE-3/4-8A	0.08			

The 20-gpm pump was was assumed to be correctly sized to remove effects causing down turns in the results as shown in figure 24, and would provide a stable operating pressure at the smallest flow rate settings.

The data collection schedule was planned, for statistical control purposes, for the initial and final test series to be taken on both these plates in the stainless steel meter tube. However, due to difficulties discussed more fully below, this objective could not be fully realized.

The FE-5/6-4C orifice plate mounted in the DAN-4SS meter tube was run on the initial day of the data collection period, January 5, 1987. The FE-5/6-7C plate was tested the following day. Although the results of the test runs taken on FE-5/6-7C were consistent with those taken in 1985, results obtained at the lowest flow rate range were erratic. Diagnostic tests indicated the possibility of resonance between the control valve controller and the pneumatic pressure regulator controlling it in the lowest flow rate range. To eliminate potential fluctuations, the pneumatic valve controller was disabled. Tests in this range of flow rate were controlled with manual valve positioning for the remainder of the test runs, i.e., all of the lowest flow rates up to a maximum of approximately 1.1 pounds/second (7.9 gallons/minute). Additionally, operating procedures were modified to improve reproducibility of the measurement system in the low flow rate range. These were:

(1) the time period before beginning a test run group was increased to allow the system to stabilize to a greater degree than had been done previously, and

(2) water and air were allowed to escape through a small gap created between the orifice plate and the meter flanges. The flange bolts were loosened to produce this gap which allowed much larger water velocities in the meter tube, thereby sweeping any collected air from the region of the orifice plate. This procedure was completed by re-sealing the orifice flange with the securing bolts/nuts.

(3) replication of test point groups at low flow rate settings for which both the 20- and 100-gpm pumps were used.

Replication consistency of the discharge coefficient/Reynolds number data pairs for most of the orifice meter configurations tested during this period were considerably improved relative to the 1985 period.

A point of primary concern in performing this set of tests was demonstration of the level of consistency in replication of the discharge coefficient/Reynolds number values obtained between observation days and between the two smallest pumps used at the low flow rates. After modifying data acquisition procedures as described above, the day-to-day variation in the observations was consistent with that of 1985 at the higher flow rates. Frequent crossover checks between the two smallest pumps were made and showed very good reproducibility. Table 34 gives an example of result replication for a pump crossover.

Table 34. Pump Crossover Between the 100- and the 20-gpm Pumps in the 1987 Data Collection Period

DATA TAKEN ON 01/08/87 AT 10:41:41 -- COMPUTED ON 01-09-87 @ 14:55:48
METER TUBE -- PE-5ABC WITH PLATE FE-5/6-7B

RUN NO.	COLLECT MASS (lbm)	DIVERT TIME (sec)	OBS.MASS FLOWRATE (lb/sec)	DIFF. PRESSURE UPPER mean	DIFF. PRESSURE LOWER mean	DISCHARGE COEFF. UPPER	DISCHARGE COEFF. LOWER	REYN. NO.
43	181.75	165.550	1.098	10.0085	10.0100	0.59965	0.59961	6436
44	181.53	165.048	1.100	10.0447	10.0417	0.59966	0.59975	6452
45	181.61	165.007	1.101	10.0605	10.0603	0.59958	0.59958	6461
					MEAN VALUES	0.59963	0.59965	6450

Table 34. Pump Crossover Between the 100- and the 20-gpm Pumps in the 1987 Data Collection Period -- Continued

RUN NO.	COLLECT MASS (lbm)	DIVERT TIME (sec)	OBS. MASS FLOWRATE (lbm/sec)	DIFF. PRESSURE UPPER mean	DIFF. PRESSURE LOWER mean	DISCHARGE COEFF. UPPER	DISCHARGE COEFF. LOWER	REYN. NO.
46	181.85	164.958	1.102	10.0917	10.0909	0.59968	0.59970	6560
47	181.87	164.725	1.104	10.1217	10.1211	0.59970	0.59972	6560
48	182.29	164.893	1.106	10.1494	10.1488	0.59963	0.59965	6565
					MEAN VALUES	0.59967	0.59969	6562

<u>General Operating Schedules</u>

For a considerable time period through the summer and early fall of 1985 the testing program ran 24 hours a day for 5 days a week. This schedule was only interrupted for equipment failures, or when no meter tubes were in the NBS-Gaithersburg flow laboratory for testing. This situation occurred occasionally due to the requirements of the schedule for tube plating and the need to maintain a compatible test run schedule with the other data base projects which were being conducted at that time also. For many of the meter tubes the initial data collection pass took 1 to 2 weeks with several orifice plate test run series being completed in 1 day. A test run series consists of all test runs covering the full differential pressure range (0.4 to 28 psid) made on a single orifice plate for one installation in the appropriate meter tube. To avoid damage to the small beta ratio orifice plates of the 4- and 6-inch meter tubes and to maintain systematic errors below the 0.1% level the highest differential pressure setting was decreased. These upper differential pressure limits were computed using the method of Gorter [25]. This method allows computation of the differential pressure at which elastic deformation of the plate would cause a systematic offset in the discharge coefficient of 0.1% or less.

All test series were replicated at least once. Some were repeated for selected meter tubes and plates where results showed unexpected characteristics. The previous test run data was marked for deletion as described above. As test run data was collected, discharge coefficient and pipe Reynolds number values were printed, and the operators maintained plots of the preliminary results. In many cases values for test run groups or individual test runs which were inconsistent with previously collected data were rerun before ending the test series.

B. Inventory of the Final Database

The final data base consists of three sections:

1. The data collected on the bare metal or steel meter tubes before plating, the bare tube section,

2. The data collected on the nickel plated meter tubes, the plated tube section, and

3. The data collected on the stainless steel check standard meter tube, the stainless steel meter tube section.

The data base collected on the stainless steel meter tube provides the means of assessing the long term performance of the measurement systems used in developing the final data base. This section consists of the repetitive test runs taken on the 4-inch orifice plates used with the stainless steel meter tube designated, DAN-4SS. Groups of test runs were made on several days on each of the orifice plates tested in the meter tube. Typically the meter tube would be mounted in the flow facility's 4-inch test section and a full set of test runs would be taken on several or all of the plates.

The identification code is based upon a combination of the meter tube and orifice plate designations, the date of the test run and the run number assigned to the test run. Except for a few cases, the run numbers for each meter tube/orifice plate combination were consecutive. In some cases run number sequence was broken, i.e., the first test run of a repetition was not consecutive with that of the last test run of the preceding test run series. In a few cases the numbering sequences are partially or wholly repeated. Gaps in the test run numbering sequence are designated as run numbers skipped.

The inventory of the final data base is given in tables 35 (bare meter tube tests), 36 (plated meter tube tests), and 37 (stainless steel meter tube tests). It contains a listing of all the test runs recorded arranged by meter tube and orifice plate. Each page of the inventory table has a listing of the test run blocks analyzed and those marked for deletion. The causes for deletion are given in the comments column. Several causes were recurrent throughout the testing. These have been assigned a character code which is given in the comments column. These codes are listed below. Otherwise, specific causes are cited for the deletion.

Deletion Comment Codes

- Keyboard entry error. Improper responses were given by the operator to the data acquisition microprocessor

+ - Run numbering skip.

% - Delete due to improper pump selection or improper operation of flow control valves.

* - Operator Indicated Deletion, no specific notation as to cause

! - Run Number block used for bare meter tube test runs

$ - Flow conditions not sufficiently equilibrated. This condition observed in the 1987 data only.

Table 35. Archival Database Inventory, Bare Meter Tube Tests Run Immediately Before Plating

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs	Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
								Deleted Runs or Groups of Runs							Comments
09/30/85	FE-0ABC	FE-9/0-2A	1	18	6	18		09/30/85	FE-0ABC	FE-9/0-6A	10	10	1	1	Lost flow fac.
09/30/85	FE-0ABC	FE-9/0-6A	1	19	6	18	36								air pressure
07/15/85	FE-1ABC	FE-1/2-2A	1	18	6	18		07/15/85	FE-1ABC	FE-1/2-6A	1	1	1	1	#
07/15/85	FE-1ABC	FE-1/2-6A	2	22	8	17	35	07/15/85	FE-1ABC	FE-1/2-6A	12	12	1	1	Trans. manifold
07/17/85	FE-2ABC	FE-1/2-2B	1	22	8	20									valves closed
07/17/85	FE-2ABC	FE-1/2-6B	1	15	5	15	35	07/15/85	FE-1ABC	FE-1/2-6A	14	16	1	3	Water splashing
07/03/85	FE-3ABC	FE-3/4-2B	1	22	7	21									over tank edge
07/03/85	FE-3ABC	FE-3/4-6B	1	18	6	18	39								
07/16/85	FE-4ABC	FE-3/4-2A	1	16	5	14		07/17/85	FE-2ABC	FE-1/2-2B	8	8	1	1	*
07/16/85	FE-4ABC	FE-3/4-6A	1	18	6	18	32	07/17/85	FE-2ABC	FE-1/2-2B	14	14	1	1	Timer malfunction
09/17/85	FE-5ABC	FE-5/6-2B	1	18	6	18		07/03/85	FE-3ABC	FE-3/4-2B	18	18	1	1	Transducer valves
09/17/85	FE-5ABC	FE-5/6-6B	1	21	7	21	39								closed
06/18/85	FE-6ABC	FE-5/6-6C	1	21	7	21	21	07/16/85	FE-4ABC	FE-3/4-2A	5	6	1	2	*
08/23/85	FE-7ABC	FE-7/8-2B	1	19	6	18		07/16/85	FE-4ABC	FE-3/4-2A	17	19	1	3	Diverter
08/23/85	FE-7ABC	FE-7/8-6B	1	18	6	18	36								malfunction
07/18/85	FE-8ABC	FE-7/8-2A	1	15	5	15		08/23/85	FE-7ABC	FE-7/8-2B	3	3	1	1	Poor flow control
07/18/85	FE-8ABC	FE-7/8-6A	1	21	7	21	36	07/12/85	FE-9ABC	FE-9/0-6B	6	6	1	1	*
07/12/85	FE-9ABC	FE-9/0-2B	1	21	7	21		07/12/85	FE-9ABC	FE-9/0-6B	8	8	1	1	*
07/12/85	FE-9ABC	FE-9/0-6B	1	23	7	20	41	07/12/85	FE-9ABC	FE-9/0-6B	20	20	1	1	Top tap bleed
					Total Test Runs		350								

Table 36. Archival Database Inventory, Test Runs Performed on Orifice Meter Tube Assembly PE-1ABC

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs	Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
								Deleted Runs or Groups of Runs							
09/03/85	PE-1ABC	FE-1/2-1A	32	46	5	15		07/30/85	PE-1ABC	FE-1/2-1A	1	15	5	15	%
09/04/85	PE-1ABC	FE-1/2-1A	47	61	5	15	30	08/07/85	PE-1ABC	FE-1/2-1A	16	30	5	15	%
09/03/85	PE-1ABC	FE-1/2-2A	58	72	5	15		09/03/85	PE-1ABC	FE-1/2-1A	31	31	1	1	Unbal. meniscus
09/04/85	PE-1ABC	FE-1/2-2A	73	87	5	15	30	07/30/85	PE-1ABC	FE-1/2-2A	1	21	6	18	%
07/30/85	PE-1ABC	FE-1/2-3A	1	18	6	18		07/31/85	PE-1ABC	FE-1/2-2A	22	30	3	9	%
08/07/85	PE-1ABC	FE-1/2-3A	19	33	5	15		08/08/85	PE-1ABC	FE-1/2-2A	31	45	5	15	%
08/08/85	PE-1ABC	FE-1/2-3A	34	42	3	9	42	08/08/85	PE-1ABC	FE-1/2-2A	46	57	4	12	%
07/30/85	PE-1ABC	FE-1/2-4A	1	21	7	21		07/30/85	PE-1ABC	FE-1/2-2A	10	12	1	3	air in trans. lines
08/07/85	PE-1ABC	FE-1/2-4A	22	36	5	15	36								
07/30/85	PE-1ABC	FE-1/2-5A	1	18	6	18		08/07/85	PE-1ABC	FE-1/2-5A	19	19	1	1	#
08/07/85	PE-1ABC	FE-1/2-5A	20	37	6	18		02/03/87	PE-1ABC	FE-1/2-5A	83	85	1	3	*
01/07/86	PE-1ABC	FE-1/2-5A	38	61	8	24		02/03/87	PE-1ABC	FE-1/2-5A	92	92	1	1	*
02/02/87	PE-1ABC	FE-1/2-5A	62	82	7	21		02/05/87	PE-1ABC	FE-1/2-5A	108	110	1	3	*
02/03/87	PE-1ABC	FE-1/2-5A	86	107	7	21		02/02/87	PE-1ABC	FE-1/2-6A	49	49	1	1	*
02/05/87	PE-1ABC	FE-1/2-5A	111	140	10	30	132	02/03/87	PE-1ABC	FE-1/2-6A	54	54	1	1	*
07/29/85	PE-1ABC	FE-1/2-6A	1	15	5	15		02/03/87	PE-1ABC	FE-1/2-6A	66	66	1	1	*
08/07/85	PE-1ABC	FE-1/2-6A	16	30	5	15		02/04/87	PE-1ABC	FE-1/2-6A	75	75	1	1	*
01/07/86	PE-1ABC	FE-1/2-6A	31	45	5	15		07/31/85	PE-1ABC	FE-1/2-7A	1	15	5	15	%
02/02/87	PE-1ABC	FE-1/2-6A	46	52	2	6		08/08/85	PE-1ABC	FE-1/2-7A	16	30	5	15	%
02/03/87	PE-1ABC	FE-1/2-6A	53	69	5	15									
02/04/87	PE-1ABC	FE-1/2-6A	70	91	7	21	87								
09/03/85	PE-1ABC	FE-1/2-7A	31	45	5	15									
09/04/85	PE-1ABC	FE-1/2-7A	46	60	5	15	30								
					Total Test Runs		387								

Table 36. Archival Database Inventory, Test Runs Performed on Orifice Meter Tube Assembly PE-2ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs	Deleted Runs or Groups of Runs: Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
08/27/85	PE-2ABC	FE-1/2-1B	32	55	8	24		08/05/85	PE-2ABC	FE-1/2-1B	1	15	5	15	%
08/28/85	PE-2ABC	FE-1/2-1B	56	70	5	15	39	08/12/85	PE-2ABC	FE-1/2-1B	16	16	1	1	+
08/27/85	PE-2ABC	FE-1/2-2B	43	60	6	18		08/12/85	PE-2ABC	FE-1/2-1B	17	31	5	15	%
08/28/85	PE-2ABC	FE-1/2-2B	61	75	5	15	33	08/05/85	PE-2ABC	FE-1/2-1B	3	3	1	1	unbal. meniscus
08/06/85	PE-2ABC	FE-1/2-3B	1	21	7	21		08/06/85	PE-2ABC	FE-1/2-2B	1	18	6	18	%
08/12/85	PE-2ABC	FE-1/2-3B	22	39	6	18		08/09/85	PE-2ABC	FE-1/2-2B	19	33	5	15	%
08/28/85	PE-2ABC	FE-1/2-3B	40	45	2	6	45	08/12/85	PE-2ABC	FE-1/2-2B	34	42	3	9	%
08/06/85	PE-2ABC	FE-1/2-4B	1	18	6	18		08/06/85	PE-2ABC	FE-1/2-7B	3	3	1	1	Transducers
08/09/85	PE-2ABC	FE-1/2-4B	19	36	6	18	36								valved off
08/05/85	PE-2ABC	FE-1/2-5B	1	18	6	18									prematurely
08/09/85	PE-2ABC	FE-1/2-5B	19	36	6	18	36	08/06/85	PE-2ABC	FE-1/2-7B	1	4	1	3	%
08/05/85	PE-2ABC	FE-1/2-6B	1	18	6	18		08/06/85	PE-2ABC	FE-1/2-7B	5	16	4	12	%
08/09/85	PE-2ABC	FE-1/2-6B	19	36	6	18	36	08/12/85	PE-2ABC	FE-1/2-7B	17	31	5	15	%
08/27/85	PE-2ABC	FE-1/2-7B	70	84	5	15		08/14/85	PE-2ABC	FE-1/2-7B	32	72	1	41	Facility tests
08/29/85	PE-2ABC	FE-1/2-7B	85	99	5	15	30								
				Total Test Runs			255								

Table 36. Archival Database Inventory, Test Runs Performed on Orifice Meter Tube Assembly PE-3ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs
09/11/85	PE-3ABC	FE-3/4-1B	31	45	5	15	
09/13/85	PE-3ABC	FE-3/4-1B	46	60	5	15	30
07/24/85	PE-3ABC	FE-3/4-2B	1	15	5	15	
07/25/85	PE-3ABC	FE-3/4-2B	16	18	1	3	
08/02/85	PE-3ABC	FE-3/4-2B	19	36	6	18	
09/11/85	PE-3ABC	FE-3/4-2B	37	45	3	9	
09/13/85	PE-3ABC	FE-3/4-2B	46	57	4	12	57
07/24/85	PE-3ABC	FE-3/4-3B	1	15	5	15	
08/02/85	PE-3ABC	FE-3/4-3B	16	33	6	18	33
07/24/85	PE-3ABC	FE-3/4-4B	1	24	8	24	
08/02/85	PE-3ABC	FE-3/4-4B	25	39	5	15	39
07/25/85	PE-3ABC	FE-3/4-5B	1	18	6	18	
08/02/85	PE-3ABC	FE-3/4-5B	19	33	5	15	33
07/24/85	PE-3ABC	FE-3/4-6B	1	21	6	18	
08/01/85	PE-3ABC	FE-3/4-6B	22	39	6	18	36
01/21/87	PE-3ABC	FE-3/4-7B	76	93	6	18	
01/22/87	PE-3ABC	FE-3/4-7B	94	112	6	18	36
09/10/85	PE-3ABC	FE-3/4-8B	34	60	9	26	
09/11/85	PE-3ABC	FE-3/4-8B	61	72	4	12	
09/13/85	PE-3ABC	FE-3/4-8B	61	64	2	4	42
					Total Test Runs		306

Deleted Runs or Groups of Runs

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
07/25/85	PE-3ABC	FE-3/4-1B	1	15	5	15	%
07/25/85	PE-3ABC	FE-3/4-1B	16	16	1	1	#
08/01/85	PE-3ABC	FE-3/4-1B	16	30	5	14	%
08/02/85	PE-3ABC	FE-3/4-4B	40	41	1	2	#
07/24/85	PE-3ABC	FE-3/4-6B	13	15	1	3	*
07/25/85	PE-3ABC	FE-3/4-7B	1	15	5	15	%
08/02/85	PE-3ABC	FE-3/4-7B	16	36	7	21	%
09/10/85	PE-3ABC	FE-3/4-7B	37	60	9	24	%
09/11/85	PE-3ABC	FE-3/4-7B	61	75	5	15	%
01/22/87	PE-3ABC	FE-3/4-7B	106	106	1	1	*
07/25/85	PE-3ABC	FE-3/4-8B	1	15	5	15	%
08/05/85	PE-3ABC	FE-3/4-8B	16	33	6	18	%
09/10/85	PE-3ABC	FE-3/4-8B	49	49	1	1	Tap bleed valves open for a portion of the run

Table 36. Archival Database Inventory, Test Runs Performed on Orifice Meter Tube Assembly PE-4ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs
09/06/85	PE-4ABC	FE-3/4-1A	16	30	5	15	
09/09/85	PE-4ABC	FE-3/4-1A	31	45	5	15	30
09/05/85	PE-4ABC	FE-3/4-2A	21	33	5	13	
09/09/85	PE-4ABC	FE-3/4-2A	34	42	3	9	22
07/26/85	PE-4ABC	FE-3/4-3A	4	21	6	18	
09/05/85	PE-4ABC	FE-3/4-3A	22	39	6	18	36
07/26/85	PE-4ABC	FE-3/4-4A	1	18	6	18	
09/05/85	PE-4ABC	FE-3/4-4A	20	34	5	15	33
07/26/85	PE-4ABC	FE-3/4-5A	4	6	1	3	
07/29/85	PE-4ABC	FE-3/4-5A	8	25	6	18	
09/05/85	PE-4ABC	FE-3/4-5A	26	40	5	15	36
07/25/85	PE-4ABC	FE-3/4-6A	1	21	5	15	
09/05/85	PE-4ABC	FE-3/4-6A	22	36	5	15	30
01/23/87	PE-4ABC	FE-3/4-7A	67	84	6	18	
01/27/87	PE-4ABC	FE-3/4-7A	92	103	4	12	
01/30/87	PE-4ABC	FE-3/4-7A	104	109	2	6	36
01/28/87	PE-4ABC	FE-3/4-8A	78	95	5	15	
01/29/87	PE-4ABC	FE-3/4-8A	96	116	6	18	
01/30/87	PE-4ABC	FE-3/4-8A	117	122	2	6	39
				Total Test Runs			262

Deleted Runs or Groups of Runs

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
07/26/85	PE-4ABC	FE-3/4-1A	1	15	5	15	%
07/26/85	PE-4ABC	FE-3/4-2A	1	18	6	18	%
09/05/85	PE-4ABC	FE-3/4-2A	19	20	1	2	#
07/26/85	PE-4ABC	FE-3/4-3A	1	3	1	3	Wrong weigh sys. selected
09/05/85	PE-4ABC	FE-3/4-4A	19	19	1	1	+
07/26/85	PE-4ABC	FE-3/4-5A	1	3	1	3	Air bubble in trans. lines
07/26/85	PE-4ABC	FE-3/4-5A	7	7	1	1	+
07/25/85	PE-4ABC	FE-3/4-6A	13	18	1	6	Diverter malfunction
07/26/85	PE-4ABC	FE-3/4-7A	1	15	5	15	%
09/06/85	PE-4ABC	FE-3/4-7A	16	30	5	15	%
09/09/85	PE-4ABC	FE-3/4-7A	31	31	1	1	*
09/09/85	PE-4ABC	FE-3/4-7A	32	45	5	14	%
09/16/85	PE-4ABC	FE-3/4-7A	46	57	4	12	%
09/17/85	PE-4ABC	FE-3/4-7A	58	66	3	9	%
01/27/87	PE-4ABC	FE-3/4-7A	85	91	3	7	*
07/29/85	PE-4ABC	FE-3/4-8A	1	15	5	15	%
09/06/85	PE-4ABC	FE-3/4-8A	16	30	5	15	%
09/09/85	PE-4ABC	FE-3/4-8A	31	46	6	16	%
09/16/85	PE-4ABC	FE-3/4-8A	47	53	1	7	*
09/16/85	PE-4ABC	FE-3/4-8A	54	65	4	12	%
09/17/85	PE-4ABC	FE-3/4-8A	66	66	1	1	*
09/17/85	PE-4ABC	FE-3/4-8A	67	77	4	11	%
01/28/87	PE-4ABC	FE-3/4-8A	87	89	1	3	trans. conn. lines switched for diagnostic tests
01/29/87	PE-4ABC	FE-3/4-8A	111	113	1	3	*

Table 36. Archival Database Inventory, Test Runs Performed on Orifice Meter Tube Assembly PE-5ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs	Deleted Runs or Groups of Runs: Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
10/11/85	PE-5ABC	FE-5/6-1B	1	18	6	18		10/09/85	PE-5ABC	FE-5/6-2B	1	18	6	18	!
10/15/85	PE-5ABC	FE-5/6-1B	19	42	8	24	42	10/10/85	PE-5ABC	FE-5/6-3B	19	21	1	3	trans. bleed
10/09/85	PE-5ABC	FE-5/6-2B	19	36	6	18									valves open
10/15/85	PE-5ABC	FE-5/6-2B	37	54	6	18	36	10/16/85	PE-5ABC	FE-5/6-4B	25	27	1	3	*
01/07/87	PE-5ABC	FE-5/6-2C	1	21	7	21		10/17/85	PE-5ABC	FE-5/6-5B	28	28	1	1	wrong weigh
01/09/87	PE-5ABC	FE-5/6-2C	22	42	7	21	42								sys. selected
10/10/85	PE-5ABC	FE-5/6-3B	1	18	6	18		10/10/85	PE-5ABC	FE-5/6-6B	1	21	7	21	!
10/16/85	PE-5ABC	FE-5/6-3B	22	36	5	15	33	10/10/85	PE-5ABC	FE-5/6-6B	38	40	1	3	+
10/10/85	PE-5ABC	FE-5/6-4B	1	18	6	18		11/19/85	PE-5ABC	FE-5/6-6B	62	63	1	2	*
10/16/85	PE-5ABC	FE-5/6-4B	19	36	6	15		10/11/85	PE-5ABC	FE-5/6-7B	1	21	6	18	%
11/19/85	PE-5ABC	FE-5/6-4B	37	45	3	9	42	10/17/85	PE-5ABC	FE-5/6-7B	22	39	6	18	%
10/11/85	PE-5ABC	FE-5/6-5B	1	18	6	18		10/11/85	PE-5ABC	FE-5/6-7B	4	6	1	3	incorrect DP
10/17/85	PE-5ABC	FE-5/6-5B	19	34	5	15									setting
11/20/85	PE-5ABC	FE-5/6-5B	35	46	4	12	45	01/08/87	PE-5ABC	FE-5/6-7B	43	63	7	21	$
10/10/85	PE-5ABC	FE-5/6-6B	22	37	6	16		01/12/87	PE-5ABC	FE-5/6-7B	69	85	6	17	$
10/16/85	PE-5ABC	FE-5/6-6B	41	58	6	18		02/06/87	PE-5ABC	FE-3/4-7B	86	88	1	3	air in trans.
11/19/85	PE-5ABC	FE-5/6-6B	59	78	6	18	52								lines
01/08/87	PE-5ABC	FE-5/6-7B	40	42	1	3		10/15/85	PE-5ABC	FE-5/6-8B	4	6	1	3	trans. not
01/12/87	PE-5ABC	FE-5/6-7B	64	68	1	5									valved on
02/06/87	PE-5ABC	FE-5/6-7B	89	100	4	12		10/16/85	PE-5ABC	FE-5/6-8B	16	16	1	1	air in trans.
02/09/87	PE-5ABC	FE-5/6-7B	101	112	4	12	32								lines
10/15/85	PE-5ABC	FE-5/6-8B	1	15	4	12									
10/16/85	PE-5ABC	FE-5/6-8B	17	27	4	11	23								
						Total Test Runs	347								

Table 36. Archival Database Inventory, Test Runs Performed on Orifice Meter Tube Assembly PE-6ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs
06/26/85	PE-6ABC	FE-5/6-1C	1	18	6	18	
07/01/85	PE-6ABC	FE-5/6-1C	19	33	5	15	33
09/18/85	PE-6ABC	FE-5/6-2C	37	68	8	24	
09/20/85	PE-6ABC	FE-5/6-2C	70	87	6	18	
01/13/87	PE-6ABC	FE-1/2-2C	1	24	7	21	
01/15/87	PE-6ABC	FE-1/2-2C	28	51	8	24	87
06/26/85	PE-6ABC	FE-5/6-3C	1	27	9	27	
11/22/85	PE-6ABC	FE-5/6-3C	37	51	5	15	42
06/27/85	PE-6ABC	FE-5/6-4C	1	18	6	18	
07/01/85	PE-6ABC	FE-5/6-4C	34	51	6	18	
09/18/85	PE-6ABC	FE-5/6-4C	52	66	5	15	
09/20/85	PE-6ABC	FE-5/6-4C	67	85	6	19	70
06/26/85	PE-6ABC	FE-5/6-5C	1	36	12	36	36
06/25/85	PE-6ABC	FE-5/6-6C	1	18	6	18	
06/26/85	PE-6ABC	FE-5/6-6C	19	37	7	18	
06/27/85	PE-6ABC	FE-5/6-6C	38	55	6	18	54
09/18/85	PE-6ABC	FE-5/6-7C	1	9	3	9	
09/19/85	PE-6ABC	FE-5/6-7C	14	26	5	13	
09/19/85	PE-6ABC	FE-5/6-7C	27	35	3	9	
09/20/85	PE-6ABC	FE-5/6-7C	36	44	3	9	40
01/15/87	PE-6ABC	FE-5/6-8A	62	73	4	12	
01/16/87	PE-6ABC	FE-5/6-8A	74	82	3	9	21
				Total Test Runs			383

Deleted Runs or Groups of Runs

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
06/26/85	PE-6ABC	FE-5/6-2C	1	18	6	18	%
06/27/85	PE-6ABC	FE-5/6-2C	19	36	6	18	%
09/18/85	PE-6ABC	FE-5/6-2C	43	45	1	3	Trans. bleed valves open
09/18/85	PE-6ABC	FE-5/6-2C	55	57	1	3	Incorrect weigh system selected
09/18/85	PE-6ABC	FE-5/6-2C	61	62	1	2	Bleed valves closed too soon
09/18/85	PE-6ABC	FE-5/6-2C	69	69	1	1	Mun. water too low pressure
01/13/87	PE-6ABC	FE-5/6-2C	4	6	1	3	*
01/13/87	PE-6ABC	FE-5/6-2C	25	27	1	3	*
06/26/85	PE-6ABC	FE-5/6-3C	28	36	1	9	+
06/27/85	PE-6ABC	FE-5/6-4C	19	33	1	15	+
06/26/85	PE-6ABC	FE-5/6-6C	27	27	1	1	Transducer line valves closed
06/27/85	PE-6ABC	FE-5/6-7C	1	15	5	15	%
07/02/85	PE-6ABC	FE-5/6-7C	16	36	7	21	%
09/18/85	PE-6ABC	FE-5/6-7C	10	13	1	4	#
09/19/85	PE-6ABC	FE-5/6-8A	7	7	1	1	*
09/19/85	PE-6ABC	FE-5/6-8A	1	18	7	17	%
09/20/85	PE-6ABC	FE-5/6-8A	19	24	2	6	%
09/27/85	PE-6ABC	FE-5/6-8A	25	36	4	12	%
09/30/85	PE-6ABC	FE-5/6-8A	37	49	5	13	%
01/14/87	PE-6ABC	FE-5/6-8A	50	55	2	6	bleed valves leaking
01/14/87	PE-6ABC	FE-5/6-8A	56	61	2	6	diag. test runs
01/16/87	PE-6ABC	FE-5/6-8A	83	88	2	6	diag. test runs

Table 36. Archival Database Inventory -- Test Runs Performed on Orifice Meter Tube Assembly PE-7ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs	Deleted Runs or Groups of Runs: Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
12/05/85	PE-7ABC	FE-7/8-1C	1	18	6	18		12/06/85	PE-7ABC	FE-7/8-1C	29	29	1	1	*
12/06/85	PE-7ABC	FE-7/8-1C	19	31	4	12	30								
12/04/85	PE-7ABC	FE-7/8-2B	1	15	5	15									
12/05/85	PE-7ABC	FE-7/8-2B	16	30	5	15									
12/06/85	PE-7ABC	FE-7/8-2B	31	36	2	6	36								
12/04/85	PE-7ABC	FE-7/8-3C	1	18	6	18									
12/06/85	PE-7ABC	FE-7/8-3C	19	36	6	18	36								
12/04/85	PE-7ABC	FE-7/8-4B	1	18	6	18									
12/05/85	PE-7ABC	FE-7/8-4B	19	33	5	15	33								
12/04/85	PE-7ABC	FE-7/8-5B	1	18	6	18									
12/05/85	PE-7ABC	FE-7/8-5B	19	33	5	15	33								
12/05/85	PE-7ABC	FE-7/8-6B	1	18	6	18									
12/06/85	PE-7ABC	FE-7/8-6B	19	36	6	18	36								
12/05/85	PE-7ABC	FE-7/8-8B	1	12	4	12									
12/06/85	PE-7ABC	FE-7/8-8B	13	24	4	12	24								
				Total Test Runs			228								

Table 36. Archival Database Inventory -- Test Runs Performed on Orifice Meter Tube Assembly PE-8ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs
08/19/85	PE-8ABC	FE-7/8-2A	1	15	5	15	
08/29/85	PE-8ABC	FE-7/8-2A	16	30	5	15	30
08/26/85	PE-8ABC	FE-7/8-3A	1	18	6	18	
08/29/85	PE-8ABC	FE-7/8-3A	19	33	5	15	33
08/26/85	PE-8ABC	FE-7/8-4A	1	18	6	18	
08/29/85	PE-8ABC	FE-7/8-4A	19	36	6	18	
08/30/85	PE-8ABC	FE-7/8-4A	37	51	5	15	51
08/26/85	PE-8ABC	FE-7/8-5C	1	21	7	21	
08/29/85	PE-8ABC	FE-7/8-5C	22	36	5	15	36
08/16/85	PE-8ABC	FE-7/8-6A	1	18	6	18	
08/19/85	PE-8ABC	FE-7/8-6A	19	33	5	15	33
01/20/87	PE-8ABC	FE-7/8-7A	31	42	4	12	
01/21/87	PE-8ABC	FE-7/8-7A	43	54	4	12	24
08/26/85	PE-8ABC	FE-7/8-8A	1	18	6	18	
08/30/85	PE-8ABC	FE-7/8-8A	22	55	10	30	48
						Total Test Runs	255

Deleted Runs or Groups of Runs

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
08/26/85	PE-8ABC	FE-7/8-7A	1	12	4	12	%
08/30/85	PE-8ABC	FE-7/8-7A	13	30	6	18	%
08/26/85	PE-8ABC	FE-7/8-8A	19	21	1	3	Air in trans. lines
08/30/85	PE-8ABC	FE-7/8-8A	31	31	1	1	*
08/30/85	PE-8ABC	FE-7/8-8A	41	43	1	3	*

Table 36. Archival Database Inventory -- Test Runs Performed on Orifice Meter Tube Assembly PE-9ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs
11/06/85	PE-9ABC	FE-9/0-1B	1	15	5	15	
11/12/85	PE-9ABC	FE-9/0-1B	16	34	6	18	
11/13/85	PE-9ABC	FE-9/0-1B	35	43	3	9	42
11/07/85	PE-9ABC	FE-9/0-2B	22	39	6	18	
11/08/85	PE-9ABC	FE-9/0-2B	40	57	6	18	36
11/07/85	PE-9ABC	FE-9/0-3B	1	18	6	18	
11/12/85	PE-9ABC	FE-9/0-3B	19	37	7	18	36
11/06/85	PE-9ABC	FE-9/0-4B	1	18	6	18	
11/12/85	PE-9ABC	FE-9/0-4B	19	39	6	18	36
11/07/85	PE-9ABC	FE-9/0-5B	1	18	6	18	
11/12/85	PE-9ABC	FE-9/0-5B	19	33	5	15	33
11/07/85	PE-9ABC	FE-9/0-6B	24	41	6	18	
11/08/85	PE-9ABC	FE-9/0-6B	44	61	6	18	36
11/07/85	PE-9ABC	FE-9/0-7B	1	13	4	12	
11/12/85	PE-9ABC	FE-9/0-7B	13	33	7	21	33
				Total Test Runs			252

Deleted Runs or Groups of Runs

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
11/12/85	PE-9ABC	FE-9/0-1B	31	31	1	1	*
11/07/85	PE-9ABC	FE-9/0-2B	1	21	1	21	!
11/12/85	PE-9ABC	FE-9/0-3B	33	33	1	1	Weigh tank drain valve partially open
11/12/85	PE-9ABC	FE-9/0-4B	28	30	1	3	Incorrect weigh system selected
11/07/85	PE-9ABC	FE-9/0-6B	1	23	1	23	!
11/08/85	PE-9ABC	FE-9/0-6B	42	43	1	2	#
11/07/85	PE-9ABC	FE-9/0-7B	10	10	1	1	Air in the transducer lines

Table 36. Archival Database Inventory -- Test Runs Performed on Orifice Meter Tube Assembly PE-0ABC -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs	Deleted Runs or Groups of Runs: Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
11/14/85	PE-0ABC	FE-9/0-1A	1	24	8	24		11/14/85	PE-0ABC	FE-9/0-2A	4	6	1	3	Flow unstable
11/18/85	PE-0ABC	FE-9/0-1A	25	39	5	15	39	11/14/85	PE-0ABC	FE-9/0-2A	10	12	1	3	Air in
11/14/85	PE-0ABC	FE-9/0-2A	1	27	6	18									transducer lines
11/19/85	PE-0ABC	FE-9/0-2A	29	42	5	14	32	11/14/85	PE-0ABC	FE-9/0-2A	22	24	1	3	Computer
11/14/85	PE-0ABC	FE-9/0-3A	1	18	6	18									malfunction
11/15/85	PE-0ABC	FE-9/0-3A	19	33	5	15		11/14/85	PE-0ABC	FE-9/0-2A	28	28	1	1	#
11/19/85	PE-0ABC	FE-9/0-3A	34	42	3	9	42	11/18/85	PE-0ABC	FE-9/0-4A	19	21	1	3	Upstream valve
11/14/85	PE-0ABC	FE-9/0-4A	1	18	6	18									not fully open
11/18/85	PE-0ABC	FE-9/0-4A	22	30	3	9		11/14/85	PE-0ABC	FE-9/0-6A	19	33	5	15	Upstream valve
11/19/85	PE-0ABC	FE-9/0-4A	31	48	6	18									not fully open
11/20/85	PE-0ABC	FE-9/0-4A	49	69	7	21	66	11/21/85	PE-0ABC	FE-9/0-7A	40	43	1	4	Upstream valve
11/15/85	PE-0ABC	FE-9/0-5A	1	18	6	18									not fully open
11/19/85	PE-0ABC	FE-9/0-5A	19	33	5	15									
11/21/85	PE-0ABC	FE-9/0-5A	34	63	10	30	63								
11/14/85	PE-0ABC	FE-9/0-6A	1	18	6	18									
11/15/85	PE-0ABC	FE-9/0-6A	34	48	5	15	33								
11/15/85	PE-0ABC	FE-9/0-7A	1	18	6	18									
11/18/85	PE-0ABC	FE-9/0-7A	19	39	7	21									
11/21/85	PE-0ABC	FE-9/0-7A	44	52	3	9	48								
						Total Test Runs	323								

Table 37. Archival Database Inventory -- Test Runs Performed on Orifice Meter Tube Assembly DAN-4SS

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs	Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	
07/08/85	DAN-4SS	FE-5/6-1C	1	19	6	17		06/24/85	DAN-4SS	FE-5/6-4C	4	21	6	18	
07/09/85	DAN-4SS	FE-5/6-1C	23	44	6	18		07/05/85	DAN-4SS	FE-5/6-4C	22	39	6	18	
08/01/85	DAN-4SS	FE-5/6-1C	45	59	5	15		07/08/85	DAN-4SS	FE-5/6-4C	40	45	2	6	
08/14/85	DAN-4SS	FE-5/6-1C	60	74	5	15		07/31/85	DAN-4SS	FE-5/6-4C	1	18	6	18	
09/25/85	DAN-4SS	FE-5/6-1C	76	93	6	18		08/14/85	DAN-4SS	FE-5/6-4C	19	33	5	15	
09/26/85	DAN-4SS	FE-5/6-1C	94	112	6	18		09/24/85	DAN-4SS	FE-5/6-4C	34	48	5	15	
10/22/85	DAN-4SS	FE-5/6-1C	116	130	4	12		10/24/85	DAN-4SS	FE-5/6-4C	49	63	5	15	
11/06/85	DAN-4SS	FE-5/6-1C	131	139	3	9		12/10/85	DAN-4SS	FE-5/6-4C	64	78	5	15	
12/10/85	DAN-4SS	FE-5/6-1C	140	157	6	18	140	01/05/87	DAN-4SS	FE-5/6-4C	79	99	6	18	
								02/10/87	DAN-4SS	FE-5/6-4C	100	108	3	9	
07/08/85	DAN-4SS	FE-5/6-2C	1	18	5	15		02/11/87	DAN-4SS	FE-5/6-4C	109	118	3	9	156
07/09/85	DAN-4SS	FE-5/6-2C	19	36	6	18									
07/31/85	DAN-4SS	FE-5/6-2C	1	18	6	18		06/17/85	DAN-4SS	FE-5/6-5C	1	18	6	18	
08/13/85	DAN-4SS	FE-5/6-2C	19	33	5	15		06/20/85	DAN-4SS	FE-5/6-5C	1	18	6	18	
09/24/85	DAN-4SS	FE-5/6-2C	34	48	5	15		07/31/85	DAN-4SS	FE-5/6-5C	1	18	6	18	
10/24/85	DAN-4SS	FE-5/6-2C	50	63	5	14		08/13/85	DAN-4SS	FE-5/6-5C	19	33	5	15	
12/09/85	DAN-4SS	FE-5/6-2C	64	81	6	18	113	09/24/85	DAN-4SS	FE-5/6-5C	34	48	5	15	
								10/24/85	DAN-4SS	FE-5/6-5C	49	63	5	15	
06/24/85	DAN-4SS	FE-5/6-3C	1	18	6	18		12/10/85	DAN-4SS	FE-5/6-5C	65	79	5	15	114
07/05/85	DAN-4SS	FE-5/6-3C	19	36	6	18									
08/01/85	DAN-4SS	FE-5/6-3C	37	51	5	15									
08/13/85	DAN-4SS	FE-5/6-3C	53	74	6	18									
09/24/85	DAN-4SS	FE-5/6-3C	75	92	6	18									
10/23/85	DAN-4SS	FE-5/6-3C	93	107	5	15									
12/10/85	DAN-4SS	FE-5/6-3C	108	122	5	15	117								

Table 37. Archival Database Inventory, Test Runs Performed on Orifice Meter Tube Assembly DAN-4SS -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Total Runs
06/17/85	DAN-4SS	FE-5/6-6C	4	21	4	11	
06/19/85	DAN-4SS	FE-5/6-6C	1	18	5	18	
06/20/85	DAN-4SS	FE-5/6-6C	19	24	2	6	
07/31/85	DAN-4SS	FE-5/6-6C	25	39	5	15	
08/13/85	DAN-4SS	FE-5/6-6C	40	58	6	18	
09/24/85	DAN-4SS	FE-5/6-6C	59	76	6	18	
10/23/85	DAN-4SS	FE-5/6-6C	77	94	6	18	
12/09/85	DAN-4SS	FE-5/6-6C	98	112	5	15	119
07/09/85	DAN-4SS	FE-5/6-7C	1	15	5	15	
08/01/85	DAN-4SS	FE-5/6-7C	1	15	5	15	
09/25/85	DAN-4SS	FE-5/6-7C	16	36	7	21	
09/26/85	DAN-4SS	FE-5/6-7C	37	48	4	12	
09/26/85	DAN-4SS	FE-5/6-7C	49	54	2	6	
10/22/85	DAN-4SS	FE-5/6-7C	55	69	5	15	
11/06/85	DAN-4SS	FE-5/6-7C	70	72	1	3	
12/09/85	DAN-4SS	FE-5/6-7C	75	95	6	18	
02/10/87	DAN-4SS	FE-5/6-7C	121	129	3	9	
02/11/87	DAN-4SS	FE-5/6-7C	130	138	3	9	123

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	
09/25/85	DAN-4SS	FE-5/6-8A	1	12	4	12	
09/26/85	DAN-4SS	FE-5/6-8A	13	24	4	12	
12/10/85	DAN-4SS	FE-5/6-8A	25	36	4	12	
12/30/85	DAN-4SS	FE-5/6-8A	37	48	4	12	48
11/13/85	DAN-4SS	FE-5/6-8B	1	12	4	12	12
				Total Test Runs			942

Table 37. Archival Database Inventory, Test Runs Performed on Orifice Meter Tube Assembly DAN-4SS -- Continued

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
		Deleted Runs or Groups of Runs					
07/08/85	DAN-4SS	FE-5/6-1C	3	3	1	1	Timer/Counter failure
07/08/85	DAN-4SS	FE-5/6-1C	11	11	1	1	Computer Error
07/09/85	DAN-4SS	FE-5/6-1C	20	22	1	3	#
07/09/85	DAN-4SS	FE-5/6-1C	29	31	1	3	*
07/09/85	DAN-4SS	FE-5/6-1C	38	38	1	1	*
08/14/85	DAN-4SS	FE-5/6-1C	75	75	1	1	+
09/26/85	DAN-4SS	FE-5/6-1C	109	109	1	1	Wrong weigh system transducers - Not deleted
10/22/85	DAN-4SS	FE-5/6-1C	113	115	1	3	Air in transducer lines
10/22/85	DAN-4SS	FE-5/6-1C	119	121	1	3	Wrong pump used
07/08/85	DAN-4SS	FE-5/6-2C	14	16	1	3	?
09/24/84	DAN-4SS	FE-5/6-2C	49	49	1	1	+
08/01/85	DAN-4SS	FE-5/6-3C	52	52	1	1	Wrong weigh system
08/13/85	DAN-4SS	FE-5/6-3C	65	68	1	4	*
06/24/85	DAN-4SS	FE-5/6-4C	1	3	1	3	Computer error
01/05/87	DAN-4SS	FE-5/6-4C	88	90	1	3	Incorrect flow rate setting
02/11/87	DAN-4SS	FE-5/6-4C	117	117	1	1	*
10/24/85	DAN-4SS	FE-5/6-5C	64	64	1	1	#

Date	Tube	Plate	First Run	Last Run	No. Grps.	No. Runs	Comments
		Deleted Runs or Groups of Runs					
06/17/85	DAN-4SS	FE-5/6-6C	1	3	1	3	Air in transducer lines
06/17/85	DAN-4SS	FE-5/6-6C	6	11	2	6	Data recording error
06/17/85	DAN-4SS	FE-5/6-6C	15	15	1	1	Data recording error
06/20/85	DAN-4SS	FE-5/6-6C	19	24	2	6	Rev. top and bottom
08/13/85	DAN-4SS	FE-5/6-6C	43	43	1	1	Unbal. meniscuses
10/23/85	DAN-4SS	FE-5/6-6C	95	97	1	3	Computer error
11/06/85	DAN-4SS	FE-5/6-7C	73	74	1	2	#
12/09/85	DAN-4SS	FE-5/6-7C	78	80	1	3	Diverter valve malfunction
01/06/87	DAN-4SS	FE-5/6-7C	96	119	8	24	$
02/10/87	DAN-4SS	FE-5/6-7C	120	120	1	1	Transducers valved off

C. Presentation of the Data Analysis Results

The results of the test run data analysis are presented in tabular and graphical form. Tabulation for each test run is limited to a single line where the information on that line is sufficient for computation of the discharge coefficients and Reynolds numbers for the test run. The precision used in listing each parameter value is determined from considerations of the propagation of errors into discharge coefficient or Reynolds number values, from the estimated uncertainties of the observed parameters and from the total number of characters available for printing the tables. The intent is to allow calculation of discharge coefficient and Reynolds number values via auxiliary parameter values, e.g., water density and viscosity may be determined from the flowing fluid temperature and the appropriate correlations or tables referenced in other sections of this report. This approach allows for checking of the values listed, while still maintaining the size of the tables within manageable proportions. Those interested in a greater level of analytical detail may consult the archival data base.

The three data table sets are ordered by meter tube and orifice plate. Tables 38-47 list the nickel plated meter tube results with each orifice plate's results contained in a subsection. The tables are ordered according to the meter designation, beginning with the 2-inch meter tube, PE-1ABC, and ending with the second 10-inch meter tube, PE-0ABC. Table 48 tabulates the results of the initial tests run on the unplated meter tubes which were restricted to two orifice plates. Table 49 tabulates the results for the check standard, stainless steel meter tube, DAN-4SS. Within each section of these tables the results for each orifice plate are given by plate designation in ascending order. The measured diameter values for the meter tube and orifice plate and the resulting beta ratio are listed in the heading for each page of the table. The contents of the table's columns are the following:

Run No.	- Test run number
Date Code	- Code designating the observation date. Code definitions are given on the last line of each table page.
Div. Time	- Diverter time (adjusted for the diverter correction)
Flow Temp.	- Temperature of the flowing fluid (degrees C)
Flow Rate	- Observed mass flow rate (includes buoyancy corrections, scale calibration, etc.)
Number Obs.	- Total number of observed differential pressure observations
Number Rej.	- Average number of differential pressure observations rejected by the 10 standard deviation filter for all transducers. These were not included in determination of the mean differential pressure.

Differential Pressure	
Mean	- Mean of the designated transducer observation set (in units of psi)
SD	- Standard deviation of the mean value of the observation set corrected for autocorrelation effects (in units of psi)
Discharge Coefficients	
CD	- Discharge coefficient values
Rand.	- Random uncertainty in the CD value taken from the propagation of errors analysis. This is the three standard deviation value.
Syst.	- Systematic uncertainty in the CD value taken from the propagation of errors analysis
Reynolds Number	- Pipe Reynolds number

The total uncertainty in the discharge coefficient values is the sum of the random and systematic components listed. The random components are three standard deviation values representing the 99% confidence level estimate derived from the propagation of errors analysis discussed previously. Refer to the statistical analysis for final uncertainty estimates.

The results of the analysis are also plotted for each orifice plate. Only the discharge coefficients obtained from the upper pressure taps with the quartz oscillator-type transducer are plotted. The plots are placed after the table section for each meter tube and are ordered sequentially by beta ratio. In each of the plots is shown two curves which are derived from the correlation equations [17,23] currently used for estimation of discharge coefficient values in the orifice metering community. Both representations are based on the test results of Beitler [1] and are a good indication of the behavior of the previous body of knowledge in this field of flow measurement. As such these are given for the purposes of comparing the results of this work with that produced previously.

Table 38A. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-1A Diameter 0.5000 Inches, Beta Ratio = 0.24135

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
32 #	109.13	32.06	3.2991	147	6	27.966	0.0019	27.962	0.0022	27.960	0.0035	0.6017	0.0002	0.0006	0.6018	0.0002	0.0006	0.6018	0.0002	0.0006	47420
33 #	110.19	32.05	3.3013	150	1	27.995	0.0080	27.989	0.0084	27.982	0.0085	0.6018	0.0002	0.0006	0.6019	0.0002	0.0006	0.6020	0.0002	0.0006	47441
34 #	110.09	32.05	3.2975	148	1	27.945	0.0034	27.942	0.0043	27.938	0.0030	0.6017	0.0002	0.0006	0.6017	0.0002	0.0006	0.6018	0.0002	0.0006	47387
35 #	169.87	31.42	1.9761	200	1	10.008	0.0016	10.008	0.0018	10.007	0.0016	0.6025	0.0002	0.0007	0.6025	0.0002	0.0007	0.6025	0.0002	0.0007	28028
36 #	190.61	31.42	1.9763	189	0	10.012	0.0018	10.011	0.0017	10.010	0.0021	0.6024	0.0002	0.0007	0.6024	0.0002	0.0007	0.6025	0.0002	0.0007	28030
37 #	189.84	31.41	1.9803	192	0	10.053	0.0019	10.053	0.0018	10.052	0.0019	0.6024	0.0002	0.0007	0.6024	0.0002	0.0007	0.6024	0.0002	0.0007	28081
38 #	351.62	31.36	1.0861	147	0	3.0111	0.0008	3.0104	0.0010	3.0111	0.0009	0.6037	0.0004	0.0010	0.6038	0.0004	0.0010	0.6037	0.0004	0.0010	15385
39 #	351.35	31.36	1.0845	147	0	3.0028	0.0006	3.0012	0.0006	3.0016	0.0005	0.6037	0.0004	0.0010	0.6038	0.0004	0.0010	0.6038	0.0004	0.0010	15362
40 #	351.66	31.35	1.0780	147	2	2.9643	0.0025	2.9631	0.0030	2.9638	0.0032	0.6039	0.0004	0.0010	0.6040	0.0005	0.0010	0.6039	0.0005	0.0010	15267
41 #	526.27	31.22	0.4012	145	0	0.4065	0.0001	0.4056	0.0001	0.4060	0.0001	0.6070	0.0026	0.0041	0.6076	0.0027	0.0042	0.6073	0.0026	0.0042	5667
42 #	526.37	31.21	0.4006	145	2	0.4053	0.0001	0.4042	0.0001	0.4048	0.0001	0.6069	0.0026	0.0041	0.6077	0.0027	0.0042	0.6073	0.0026	0.0042	5657
43 #	526.21	31.21	0.4006	145	1	0.4053	0.0001	0.4041	0.0001	0.4048	0.0001	0.6069	0.0026	0.0041	0.6078	0.0027	0.0042	0.6073	0.0026	0.0042	5657
44 #	499.86	31.29	0.6358	153	4	1.0258	0.0004	1.0246	0.0004	1.0254	0.0003	0.6055	0.0010	0.0020	0.6058	0.0011	0.0020	0.6056	0.0010	0.0020	8993
45 #	501.12	31.29	0.6361	151	3	1.0274	0.0003	1.0261	0.0002	1.0269	0.0002	0.6053	0.0010	0.0020	0.6057	0.0011	0.0020	0.6055	0.0010	0.0020	8997
46 #	502.32	31.30	0.6363	151	3	1.0279	0.0003	1.0263	0.0003	1.0273	0.0003	0.6054	0.0010	0.0020	0.6058	0.0011	0.0020	0.6055	0.0010	0.0020	9002
47 $	351.60	31.07	1.0627	148	0	2.8828	0.0263	2.8845	0.0246	2.8860	0.0247	0.6039	0.0028	0.0011	0.6037	0.0026	0.0011	0.6035	0.0026	0.0011	14962
48 $	352.16	31.06	1.0988	148	1	3.0808	0.0016	3.0787	0.0017	3.0796	0.0016	0.6038	0.0004	0.0010	0.6040	0.0004	0.0010	0.6039	0.0004	0.0010	15467
49 $	351.16	31.06	1.0823	151	17	2.9941	0.0018	2.9926	0.0016	2.9934	0.0015	0.6033	0.0004	0.0010	0.6034	0.0004	0.0010	0.6033	0.0004	0.0010	15235
50 $	320.75	31.01	0.6312	159	1	1.0092	0.0004	1.0091	0.0003	1.0091	0.0003	0.6060	0.0010	0.0020	0.6061	0.0010	0.0020	0.6061	0.0010	0.0020	8876
51 $	320.85	31.02	0.6299	159	3	1.0060	0.0001	1.0059	0.0001	1.0058	0.0002	0.6057	0.0010	0.0020	0.6057	0.0010	0.0020	0.6058	0.0010	0.0020	8859
52 $	320.57	31.01	0.6276	159	2	0.9987	0.0001	0.9987	0.0001	0.9988	0.0001	0.6057	0.0010	0.0020	0.6057	0.0010	0.0020	0.6057	0.0010	0.0020	8825
53 $	60.077	31.77	3.2970	83	0	27.923	0.0035	27.926	0.0036	27.923	0.0046	0.6018	0.0003	0.0006	0.6018	0.0003	0.0006	0.6018	0.0003	0.0006	47105
54 $	59.326	31.76	3.2958	82	0	27.915	0.0061	27.916	0.0057	27.913	0.0056	0.6017	0.0003	0.0006	0.6017	0.0003	0.0006	0.6017	0.0003	0.0006	47078
55 $	59.264	31.75	3.2967	82	1	27.919	0.0037	27.919	0.0037	27.908	0.0040	0.6018	0.0003	0.0006	0.6018	0.0003	0.0006	0.6019	0.0003	0.0006	47081
56 $	903.54	30.98	0.3999	140	1	0.4010	0.0002	0.4033	0.0002	0.4020	0.0002	0.6090	0.0024	0.0042	0.6073	0.0024	0.0042	0.6083	0.0024	0.0042	5620
57 $	903.30	30.97	0.3988	140	2	0.4009	0.0001	0.4025	0.0001	0.4014	0.0001	0.6075	0.0024	0.0042	0.6063	0.0023	0.0042	0.6071	0.0024	0.0042	5603
58 $	903.39	30.93	0.3989	140	1	0.4011	0.0001	0.4024	0.0001	0.4014	0.0001	0.6075	0.0024	0.0042	0.6065	0.0024	0.0042	0.6072	0.0024	0.0042	5600
59 $	149.39	31.12	1.9748	185	5	9.995	0.0023	9.996	0.0025	9.994	0.0023	0.6024	0.0002	0.0007	0.6024	0.0002	0.0007	0.6025	0.0002	0.0007	27834
60 $	150.66	31.12	1.9712	187	2	9.958	0.0011	9.960	0.0012	9.956	0.0020	0.6024	0.0002	0.0007	0.6024	0.0002	0.0007	0.6025	0.0002	0.0007	27783
61 $	150.04	31.12	1.9778	186	2	10.024	0.0021	10.025	0.0021	10.022	0.0032	0.6025	0.0002	0.0007	0.6025	0.0002	0.0007	0.6025	0.0002	0.0007	27876

[Test Run Date Codes # - 09/03/85 $ - 09/04/85]

Table 38B. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-2A Diameter 0.7502 Inches, Beta Ratio = 0.36212

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
58 #	251.29	31.41	1.4409	156	0	1.0205	0.0002	1.0194	0.0002	1.0201	0.0002	0.6069	0.0010	0.0018	0.6072	0.0011	0.0018	0.6070	0.0010	0.0018	20432
59 #	251.49	31.42	1.4430	156	1	1.0235	0.0003	1.0222	0.0003	1.0227	0.0002	0.6068	0.0010	0.0018	0.6072	0.0011	0.0018	0.6071	0.0010	0.0018	20466
60 #	250.67	31.40	1.4405	157	0	1.0200	0.0004	1.0185	0.0003	1.0191	0.0003	0.6068	0.0010	0.0018	0.6073	0.0011	0.0018	0.6071	0.0011	0.0018	20422
61 #	269.59	31.37	0.9143	167	2	0.4091	0.0002	0.4078	0.0002	0.4083	0.0001	0.6082	0.0026	0.0040	0.6092	0.0027	0.0040	0.6088	0.0026	0.0040	12954
62 #	270.99	31.38	0.9148	168	0	0.4096	0.0001	0.4080	0.0001	0.4086	0.0001	0.6082	0.0026	0.0040	0.6094	0.0027	0.0040	0.6089	0.0026	0.0040	12964
63 #	271.12	31.37	0.9146	168	0	0.4095	0.0001	0.4079	0.0001	0.4084	0.0001	0.6081	0.0026	0.0040	0.6093	0.0027	0.0040	0.6089	0.0026	0.0040	12958
64 #	84.427	31.50	4.4970	114	0	10.029	0.0028	10.027	0.0025	10.026	0.0013	0.6042	0.0002	0.0005	0.6042	0.0002	0.0005	0.6043	0.0002	0.0005	63889
65 #	84.133	31.49	4.4955	116	0	10.020	0.0026	10.018	0.0029	10.020	0.0021	0.6042	0.0002	0.0005	0.6043	0.0002	0.0005	0.6042	0.0002	0.0005	63854
66 #	84.849	31.48	4.4931	117	2	10.010	0.0020	10.008	0.0020	10.008	0.0013	0.6042	0.0002	0.0005	0.6043	0.0002	0.0005	0.6043	0.0002	0.0005	63807
67 #	145.34	31.42	2.4690	180	0	3.0378	0.0006	3.0095	0.0004	3.0108	0.0005	0.6027	0.0004	0.0009	0.6055	0.0004	0.0009	0.6054	0.0004	0.0009	35018
68 #	145.31	31.44	2.4623	180	0	3.0170	0.0006	2.9927	0.0005	2.9937	0.0007	0.6031	0.0004	0.0009	0.6056	0.0004	0.0009	0.6055	0.0004	0.0009	34938
69 #	145.01	31.44	2.4604	180	0	2.9911	0.0004	2.9881	0.0005	2.9891	0.0006	0.6053	0.0004	0.0009	0.6056	0.0004	0.0009	0.6055	0.0004	0.0009	34911
70 #	249.72	31.72	6.6868	155	0	22.234	0.0035	22.233	0.0033	22.230	0.0036	0.6034	0.0001	0.0005	0.6034	0.0001	0.0005	0.6034	0.0001	0.0005	95436
71 #	249.98	31.71	6.6665	155	13	22.115	0.0031	22.112	0.0027	22.110	0.0025	0.6032	0.0001	0.0005	0.6032	0.0001	0.0005	0.6032	0.0001	0.0005	95127
72 #	250.10	31.72	6.6706	155	0	22.127	0.0027	22.123	0.0029	22.122	0.0035	0.6034	0.0001	0.0005	0.6034	0.0001	0.0005	0.6034	0.0001	0.0005	95205
73 $	85.282	31.13	4.4941	118	2	10.009	0.0019	10.009	0.0020	10.008	0.0012	0.6043	0.0002	0.0005	0.6043	0.0002	0.0005	0.6044	0.0002	0.0005	63355
74 $	85.520	31.14	4.4932	118	0	10.009	0.0015	10.009	0.0016	10.006	0.0024	0.6042	0.0002	0.0005	0.6042	0.0002	0.0005	0.6043	0.0002	0.0005	63355
75 $	85.422	31.11	4.4938	118	0	10.012	0.0014	10.012	0.0014	10.011	0.0014	0.6042	0.0002	0.0005	0.6042	0.0002	0.0005	0.6042	0.0002	0.0005	63324
76 $	220.48	31.03	0.9092	182	0	0.4329	0.0005	0.4033	0.0003	0.4032	0.0003	0.5879	0.0022	0.0036	0.6091	0.0024	0.0040	0.6092	0.0024	0.0040	12790
77 $	220.42	31.03	0.9080	182	0	0.4351	0.0005	0.4026	0.0003	0.4026	0.0003	0.5856	0.0022	0.0036	0.6088	0.0024	0.0040	0.6088	0.0024	0.0040	12774
78 $	220.42	31.02	0.9079	182	0	0.4335	0.0005	0.4027	0.0002	0.4028	0.0002	0.5867	0.0022	0.0036	0.6087	0.0024	0.0040	0.6087	0.0024	0.0040	12769
79 $	120.36	31.03	2.4677	160	10	3.0341	0.0012	3.0069	0.0010	3.0068	0.0010	0.6027	0.0004	0.0009	0.6054	0.0004	0.0009	0.6055	0.0004	0.0009	34715
80 $	120.58	31.05	2.4655	166	0	3.0024	0.0007	3.0002	0.0007	3.0013	0.0006	0.6053	0.0004	0.0009	0.6056	0.0004	0.0009	0.6055	0.0004	0.0009	34699
81 $	120.09	31.06	2.4666	165	0	3.0048	0.0013	3.0029	0.0013	3.0041	0.0014	0.6054	0.0004	0.0009	0.6056	0.0004	0.0009	0.6054	0.0004	0.0009	34721
82 $	139.87	31.05	1.4388	192	0	1.0170	0.0006	1.0160	0.0006	1.0170	0.0007	0.6070	0.0010	0.0018	0.6073	0.0010	0.0018	0.6070	0.0010	0.0018	20249
83 $	140.26	31.06	1.4454	187	0	1.0259	0.0002	1.0250	0.0002	1.0257	0.0002	0.6071	0.0010	0.0018	0.6074	0.0009	0.0018	0.6072	0.0010	0.0018	20346
84 $	140.35	31.05	1.4381	193	0	1.0157	0.0002	1.0148	0.0002	1.0155	0.0003	0.6071	0.0010	0.0018	0.6073	0.0010	0.0018	0.6071	0.0010	0.0018	20239
85 $	249.69	31.14	7.4537	155	0	27.642	0.0497	27.639	0.0546	27.626	0.0515	0.6032	0.0006	0.0004	0.6032	0.0006	0.0004	0.6033	0.0006	0.0004	105099
86 $	251.36	31.17	7.4820	156	0	27.849	0.0129	27.847	0.0140	27.835	0.0143	0.6032	0.0002	0.0004	0.6032	0.0002	0.0004	0.6033	0.0002	0.0004	105565
87 $	251.38	31.22	7.4877	156	1	27.890	0.0124	27.886	0.0127	27.876	0.0097	0.6032	0.0002	0.0004	0.6032	0.0002	0.0004	0.6034	0.0001	0.0004	105756

[Test Run Date Codes # - 09/03/85 $ - 09/04/85]

Table 38C. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-3A Diameter 0.9996 Inches, Beta Ratio = 0.48250

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid): Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients: Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	144.91	37.74	2.6119	180	1	1.0153	0.0022	1.0149	0.0027	1.0144	0.0026	0.6099	0.0013	0.0018	0.6100	0.0014	0.0018	0.6102	0.0013	0.0018	42062
2 #	145.00	37.75	2.6086	180	1	1.0130	0.0029	1.0113	0.0034	1.0112	0.0032	0.6098	0.0014	0.0018	0.6104	0.0015	0.0018	0.6104	0.0014	0.0018	42017
3 #	144.28	37.75	2.6154	179	0	1.0168	0.0022	1.0167	0.0026	1.0166	0.0026	0.6103	0.0013	0.0018	0.6103	0.0013	0.0018	0.6103	0.0013	0.0018	42126
4 #	82.393	37.83	4.4769	126	0	2.9942	0.0064	2.9946	0.0092	2.9923	0.0094	0.6088	0.0008	0.0008	0.6087	0.0010	0.0008	0.6089	0.0010	0.0008	72221
5 #	82.343	37.84	4.4847	126	0	3.0055	0.0048	3.0048	0.0088	3.0013	0.0087	0.6087	0.0007	0.0008	0.6087	0.0010	0.0008	0.6091	0.0010	0.0008	72361
6 #	82.145	37.85	4.4912	125	0	3.0153	0.0074	3.0140	0.0074	3.0116	0.0077	0.6086	0.0009	0.0008	0.6087	0.0009	0.0008	0.6089	0.0009	0.0008	72479
7 #	230.19	37.74	1.6469	190	0	0.4023	0.0009	0.4017	0.0009	0.4011	0.0008	0.6109	0.0029	0.0040	0.6114	0.0028	0.0040	0.6118	0.0026	0.0040	26521
8 #	230.35	37.75	1.6090	190	0	0.3828	0.0008	0.3833	0.0007	0.3828	0.0007	0.6119	0.0031	0.0042	0.6115	0.0029	0.0042	0.6119	0.0027	0.0042	25916
9 #	229.99	37.75	1.6126	190	1	0.3843	0.0007	0.3848	0.0008	0.3843	0.0008	0.6121	0.0030	0.0042	0.6116	0.0029	0.0041	0.6120	0.0027	0.0041	25974
10 #	350.39	37.94	4.5083	152	0	3.0413	0.0049	3.0401	0.0055	3.0382	0.0057	0.6083	0.0006	0.0008	0.6084	0.0007	0.0008	0.6086	0.0007	0.0008	72882
11 #	350.92	37.95	4.4931	153	0	3.0191	0.0040	3.0194	0.0044	3.0175	0.0047	0.6085	0.0006	0.0008	0.6084	0.0006	0.0008	0.6086	0.0006	0.0008	72650
12 #	350.94	37.97	4.4953	150	0	3.0233	0.0067	3.0206	0.0068	3.0191	0.0064	0.6083	0.0008	0.0008	0.6086	0.0008	0.0008	0.6087	0.0007	0.0008	72714
13 #	131.39	38.08	13.601	200	0	27.898	0.0095	27.892	0.0116	27.868	0.0113	0.6059	0.0002	0.0004	0.6060	0.0002	0.0004	0.6063	0.0002	0.0004	220477
14 #	130.98	38.09	13.602	200	0	27.900	0.0129	27.893	0.0134	27.868	0.0143	0.6059	0.0002	0.0004	0.6060	0.0002	0.0004	0.6063	0.0002	0.0004	220521
15 #	131.52	38.11	13.593	200	0	27.864	0.0139	27.858	0.0157	27.830	0.0163	0.6059	0.0002	0.0004	0.6060	0.0002	0.0004	0.6063	0.0002	0.0004	220463
16 #	225.29	38.14	8.1760	186	0	10.051	0.0154	10.051	0.0142	10.040	0.0144	0.6068	0.0005	0.0005	0.6068	0.0005	0.0005	0.6072	0.0005	0.0005	132684
17 #	224.20	38.16	8.1787	185	0	10.066	0.0151	10.060	0.0197	10.048	0.0215	0.6066	0.0005	0.0005	0.6068	0.0006	0.0005	0.6071	0.0007	0.0005	132779
18 #	225.35	38.18	8.1820	186	0	10.065	0.0140	10.067	0.0175	10.053	0.0174	0.6069	0.0004	0.0005	0.6068	0.0005	0.0005	0.6072	0.0005	0.0005	132884
19 $	144.94	36.20	2.6290	180	0	1.0270	0.0024	1.0287	0.0027	1.0265	0.0028	0.6103	0.0013	0.0018	0.6098	0.0013	0.0018	0.6104	0.0013	0.0018	41084
20 $	145.49	36.21	2.6263	181	0	1.0252	0.0024	1.0253	0.0030	1.0244	0.0030	0.6102	0.0013	0.0018	0.6101	0.0014	0.0018	0.6104	0.0014	0.0018	41050
21 $	145.45	36.23	2.6298	180	0	1.0288	0.0022	1.0282	0.0021	1.0274	0.0019	0.6099	0.0013	0.0018	0.6101	0.0012	0.0018	0.6103	0.0012	0.0018	41121
22 $	230.20	36.19	1.6730	190	0	0.4147	0.0008	0.4145	0.0009	0.4141	0.0008	0.6112	0.0027	0.0039	0.6113	0.0026	0.0039	0.6116	0.0027	0.0039	26139
23 $	230.13	36.21	1.6675	190	0	0.4118	0.0010	0.4115	0.0010	0.4110	0.0008	0.6113	0.0028	0.0039	0.6115	0.0026	0.0039	0.6119	0.0027	0.0039	26064
24 $	230.37	36.22	1.6643	190	0	0.4102	0.0010	0.4101	0.0009	0.4095	0.0008	0.6113	0.0028	0.0039	0.6114	0.0026	0.0039	0.6118	0.0027	0.0039	26019
25 $	81.578	36.34	4.4771	126	0	2.9945	0.0078	2.9933	0.0101	2.9907	0.0091	0.6086	0.0009	0.0008	0.6087	0.0011	0.0008	0.6090	0.0010	0.0008	70158
26 $	82.325	36.36	4.4544	127	0	2.9653	0.0070	2.9616	0.0079	2.9601	0.0083	0.6085	0.0008	0.0008	0.6089	0.0009	0.0008	0.6090	0.0010	0.0008	69830
27 $	82.176	36.38	4.2975	127	0	2.7594	0.0059	2.7588	0.0064	2.7566	0.0061	0.6086	0.0008	0.0009	0.6087	0.0008	0.0009	0.6089	0.0008	0.0009	67397
28 $	130.15	36.46	13.597	200	0	27.862	0.0113	27.863	0.0151	27.826	0.0151	0.6059	0.0002	0.0004	0.6059	0.0002	0.0004	0.6063	0.0002	0.0004	213568
29 $	134.92	36.48	13.596	200	0	27.855	0.0098	27.857	0.0124	27.825	0.0117	0.6060	0.0002	0.0004	0.6060	0.0002	0.0004	0.6064	0.0002	0.0004	213648
30 $	131.47	36.49	13.595	200	0	27.853	0.0087	27.851	0.0126	27.821	0.0139	0.6060	0.0002	0.0004	0.6060	0.0002	0.0004	0.6063	0.0002	0.0004	213664

[Test Run Date Codes # - 07/30/85 $ - 08/07/85]

Table 38C. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-3A Diameter 0.9996 Inches, Beta Ratio = 0.48250

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	225.38	36.50	8.1662	186	0	10.022	0.0201	10.023	0.0228	10.007	0.0243	0.6068	0.0006	0.0005	0.6068	0.0007	0.0005	0.6073	0.0008	0.0005	128371
32	#	225.28	36.51	8.1680	186	0	10.036	0.0122	10.026	0.0148	10.010	0.0146	0.6065	0.0004	0.0005	0.6068	0.0005	0.0005	0.6073	0.0005	0.0005	128424
33	#	225.44	36.53	8.1835	186	0	10.067	0.0141	10.067	0.0161	10.052	0.0163	0.6068	0.0005	0.0005	0.6068	0.0005	0.0005	0.6072	0.0005	0.0005	128718
34	$	144.92	37.48	2.5827	180	0	0.9932	0.0022	0.9919	0.0032	0.9926	0.0028	0.6098	0.0013	0.0018	0.6101	0.0015	0.0018	0.6099	0.0013	0.0018	41383
35	$	145.79	37.49	2.5758	181	0	0.9874	0.0019	0.9865	0.0021	0.9870	0.0020	0.6099	0.0012	0.0018	0.6102	0.0013	0.0018	0.6100	0.0012	0.0018	41280
36	$	144.96	37.50	2.5832	180	0	0.9924	0.0025	0.9918	0.0034	0.9926	0.0033	0.6101	0.0013	0.0018	0.6103	0.0015	0.0018	0.6101	0.0014	0.0018	41407
37	$	230.15	37.46	1.6738	190	0	0.4157	0.0008	0.4148	0.0009	0.4150	0.0009	0.6108	0.0026	0.0039	0.6115	0.0027	0.0039	0.6113	0.0025	0.0039	26809
38	$	230.30	37.47	1.6618	190	0	0.4097	0.0009	0.4088	0.0007	0.4091	0.0007	0.6108	0.0026	0.0039	0.6115	0.0027	0.0039	0.6113	0.0025	0.0039	26622
39	$	231.21	37.49	1.6513	191	0	0.4040	0.0012	0.4034	0.0011	0.4038	0.0012	0.6113	0.0027	0.0040	0.6117	0.0028	0.0040	0.6114	0.0026	0.0040	26464
40	$	81.861	37.63	4.4718	123	0	2.9880	0.0074	2.9873	0.0082	2.9864	0.0078	0.6087	0.0009	0.0008	0.6088	0.0009	0.0008	0.6088	0.0009	0.0008	71860
41	$	82.624	37.64	4.4666	128	0	2.9855	0.0082	2.9825	0.0095	2.9799	0.0091	0.6082	0.0009	0.0008	0.6085	0.0011	0.0008	0.6088	0.0010	0.0008	71791
42	$	81.967	37.65	4.4698	127	0	2.9845	0.0062	2.9851	0.0088	2.9833	0.0086	0.6088	0.0008	0.0008	0.6087	0.0010	0.0008	0.6089	0.0010	0.0008	71856

[Test Run Date Codes # - 08/07/85 $ - 08/08/85]

Table 38D. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-4A Diameter 1.1244 Inches, Beta Ratio = 0.54274

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	161.78	37.25	2.1310	200	0	0.4046	0.0008	0.4039	0.0012	0.4031	0.0011	0.6121	0.0029	0.0039	0.6126	0.0028	0.0040	0.6133	0.0026	0.0040	33993
2	#	161.64	37.26	2.1232	200	0	0.4017	0.0009	0.4008	0.0012	0.4000	0.0011	0.6121	0.0029	0.0040	0.6128	0.0029	0.0040	0.6134	0.0027	0.0040	33875
3	#	162.20	37.28	2.0310	200	0	0.3672	0.0009	0.3666	0.0009	0.3658	0.0009	0.6124	0.0032	0.0043	0.6128	0.0031	0.0043	0.6135	0.0029	0.0043	32417
4	#	109.86	37.37	3.3604	161	0	1.0080	0.0031	1.0062	0.0028	1.0061	0.0025	0.6116	0.0015	0.0018	0.6121	0.0014	0.0018	0.6121	0.0013	0.0018	53729
5	#	110.16	37.38	3.3615	167	0	1.0082	0.0029	1.0072	0.0032	1.0070	0.0031	0.6117	0.0014	0.0018	0.6120	0.0015	0.0018	0.6121	0.0014	0.0018	53757
6	#	110.06	37.40	3.3669	169	0	1.0122	0.0028	1.0102	0.0034	1.0100	0.0034	0.6115	0.0014	0.0018	0.6121	0.0015	0.0018	0.6121	0.0014	0.0018	53864
7	#	64.716	37.47	5.8286	99	0	3.0463	0.0078	3.0455	0.0079	3.0424	0.0087	0.6102	0.0009	0.0008	0.6103	0.0009	0.0008	0.6106	0.0010	0.0008	93374
8	#	65.382	37.48	5.7980	100	4	3.0112	0.0034	3.0122	0.0041	3.0093	0.0024	0.6105	0.0006	0.0008	0.6104	0.0006	0.0008	0.6107	0.0005	0.0008	92901
9	#	65.319	37.48	5.8285	100	0	3.0487	0.0091	3.0457	0.0078	3.0435	0.0083	0.6099	0.0010	0.0008	0.6102	0.0009	0.0008	0.6105	0.0009	0.0008	93390
10	#	299.64	37.51	5.7572	150	0	2.9769	0.0123	2.9769	0.0100	2.9750	0.0096	0.6097	0.0013	0.0008	0.6097	0.0011	0.0008	0.6099	0.0010	0.0008	92301
11	#	300.28	37.52	5.8572	149	0	3.0807	0.0053	3.0791	0.0053	3.0754	0.0053	0.6098	0.0007	0.0008	0.6099	0.0006	0.0008	0.6103	0.0006	0.0008	93923
12	#	301.04	37.55	5.8258	150	0	3.0497	0.0074	3.0465	0.0063	3.0439	0.0064	0.6096	0.0008	0.0008	0.6099	0.0007	0.0008	0.6101	0.0007	0.0008	93474
13	#	161.71	37.59	10.475	200	0	9.899	0.0109	9.898	0.0129	9.891	0.0131	0.6084	0.0004	0.0005	0.6084	0.0004	0.0005	0.6086	0.0004	0.0005	168206
14	#	161.43	37.61	10.478	200	0	9.907	0.0140	9.904	0.0179	9.897	0.0168	0.6082	0.0005	0.0005	0.6083	0.0006	0.0005	0.6086	0.0005	0.0005	168306
15	#	161.63	37.62	10.515	200	0	9.972	0.0164	9.974	0.0222	9.966	0.0203	0.6084	0.0005	0.0005	0.6084	0.0007	0.0005	0.6086	0.0006	0.0005	168940
16	#	104.96	37.68	17.556	161	0	27.892	0.0130	27.891	0.0121	27.868	0.0112	0.6074	0.0002	0.0004	0.6074	0.0002	0.0004	0.6077	0.0002	0.0004	282395
17	#	105.52	37.70	17.569	159	0	27.921	0.0101	27.923	0.0112	27.907	0.0128	0.6075	0.0002	0.0004	0.6075	0.0002	0.0004	0.6077	0.0002	0.0004	282702
18	#	104.68	37.72	17.561	155	0	27.911	0.0141	27.905	0.0156	27.885	0.0151	0.6074	0.0002	0.0004	0.6074	0.0002	0.0004	0.6077	0.0002	0.0004	282690
19	#	162.08	37.59	2.1306	200	0	0.4052	0.0009	0.4064	0.0011	0.4044	0.0011	0.6116	0.0029	0.0039	0.6107	0.0028	0.0039	0.6122	0.0026	0.0039	34211
20	#	161.50	37.61	1.9699	200	2	0.3454	0.0007	0.3468	0.0008	0.3450	0.0009	0.6125	0.0034	0.0046	0.6112	0.0032	0.0045	0.6128	0.0030	0.0045	31643
21	#	161.79	37.63	2.2046	200	0	0.4326	0.0009	0.4336	0.0009	0.4320	0.0009	0.6125	0.0027	0.0037	0.6118	0.0026	0.0037	0.6129	0.0024	0.0037	35427
22	$	64.950	36.61	5.7991	100	0	3.0208	0.0089	3.0165	0.0093	3.0127	0.0091	0.6096	0.0010	0.0008	0.6100	0.0010	0.0008	0.6104	0.0010	0.0008	91357
23	$	64.620	36.62	5.7911	96	0	3.0115	0.0084	3.0078	0.0107	3.0035	0.0100	0.6097	0.0010	0.0008	0.6100	0.0012	0.0008	0.6105	0.0011	0.0008	91249
24	$	64.828	36.63	5.7989	100	0	3.0126	0.0051	3.0144	0.0082	3.0084	0.0089	0.6104	0.0007	0.0008	0.6102	0.0009	0.0008	0.6108	0.0010	0.0008	91390
25	$	162.12	36.57	2.1398	200	0	0.4067	0.0007	0.4063	0.0007	0.4062	0.0006	0.6131	0.0028	0.0039	0.6133	0.0026	0.0039	0.6134	0.0027	0.0039	33683
26	$	161.87	36.57	2.1314	200	0	0.4034	0.0008	0.4027	0.0009	0.4028	0.0009	0.6131	0.0028	0.0040	0.6136	0.0027	0.0040	0.6136	0.0028	0.0040	33551
27	$	161.78	36.58	2.1444	200	0	0.4082	0.0010	0.4075	0.0009	0.4078	0.0010	0.6132	0.0028	0.0039	0.6137	0.0026	0.0039	0.6135	0.0027	0.0039	33762
28	$	109.18	36.64	3.3849	168	0	1.0230	0.0024	1.0213	0.0026	1.0203	0.0026	0.6114	0.0013	0.0018	0.6119	0.0013	0.0018	0.6122	0.0013	0.0018	53356
29	$	109.81	36.65	3.4156	169	0	1.0413	0.0035	1.0404	0.0040	1.0393	0.0039	0.6115	0.0015	0.0017	0.6118	0.0016	0.0017	0.6121	0.0016	0.0017	53850
30	$	110.33	36.67	3.4240	170	0	1.0469	0.0025	1.0451	0.0024	1.0436	0.0027	0.6114	0.0013	0.0017	0.6119	0.0012	0.0017	0.6124	0.0013	0.0017	54004

[Test Run Date Codes # - 07/30/85 $ - 08/07/85]

Table 38D. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-4A Diameter 1.1244 Inches, Beta Ratio = 0.54274

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	104.39	36.77	17.573	161	4	27.955	0.0198	27.949	0.0172	27.899	0.0139	0.6072	0.0003	0.0004	0.6073	0.0003	0.0004	0.6079	0.0002	0.0004	277714
32 #	105.03	36.77	17.568	157	0	27.952	0.0134	27.947	0.0126	27.889	0.0135	0.6071	0.0002	0.0004	0.6072	0.0002	0.0004	0.6078	0.0002	0.0004	277633
33 #	105.04	36.78	17.583	162	0	27.993	0.0143	27.986	0.0170	27.937	0.0151	0.6072	0.0002	0.0004	0.6072	0.0002	0.0004	0.6078	0.0002	0.0004	277919
34 #	162.16	36.80	10.497	200	0	9.943	0.0123	9.944	0.0146	9.925	0.0147	0.6082	0.0004	0.0005	0.6082	0.0005	0.0005	0.6088	0.0005	0.0005	165984
35 #	161.87	36.81	10.480	200	0	9.911	0.0180	9.911	0.0246	9.893	0.0244	0.6082	0.0006	0.0005	0.6082	0.0008	0.0005	0.6088	0.0008	0.0005	165746
36 #	161.70	36.83	10.556	200	0	10.052	0.0132	10.053	0.0181	10.033	0.0172	0.6083	0.0004	0.0005	0.6082	0.0006	0.0005	0.6088	0.0005	0.0005	167008

[Test Run Date Codes # - 08/07/85]

Table 38E. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-5A Diameter 1.3750 Inches, Beta Ratio = 0.66371

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	109.77	38.76	3.4013	168	0	0.4004	0.0017	0.3972	0.0012	0.3983	0.0009	0.6173	0.0038	0.0040	0.6197	0.0040	0.0041	0.6187	0.0036	0.0041	55858
2 #	110.51	38.77	3.3943	169	0	0.3979	0.0016	0.3962	0.0008	0.3964	0.0008	0.6180	0.0038	0.0040	0.6191	0.0040	0.0041	0.6189	0.0036	0.0041	55753
3 #	110.48	38.78	3.3966	169	0	0.3997	0.0015	0.3958	0.0012	0.3967	0.0012	0.6169	0.0037	0.0040	0.6198	0.0041	0.0041	0.6191	0.0037	0.0041	55802
4 #	70.067	38.84	5.5200	107	2	1.0581	0.0021	1.0565	0.0014	1.0549	0.0008	0.6161	0.0015	0.0017	0.6166	0.0015	0.0017	0.6170	0.0014	0.0017	90790
5 #	70.011	38.85	5.5340	107	0	1.0646	0.0036	1.0629	0.0032	1.0610	0.0029	0.6158	0.0017	0.0017	0.6163	0.0017	0.0017	0.6168	0.0016	0.0017	91038
6 #	70.308	38.86	5.5372	107	0	1.0635	0.0021	1.0642	0.0029	1.0629	0.0030	0.6165	0.0015	0.0017	0.6162	0.0017	0.0017	0.6166	0.0016	0.0017	91108
7 #	299.64	38.91	5.5429	149	0	1.0678	0.0023	1.0675	0.0025	1.0659	0.0025	0.6159	0.0015	0.0017	0.6159	0.0016	0.0017	0.6164	0.0015	0.0017	91289
8 #	301.67	38.92	5.5408	150	0	1.0658	0.0021	1.0669	0.0016	1.0651	0.0015	0.6162	0.0015	0.0017	0.6159	0.0015	0.0017	0.6164	0.0014	0.0017	91271
9 #	301.67	38.93	5.5545	150	0	1.0725	0.0023	1.0718	0.0022	1.0703	0.0024	0.6158	0.0015	0.0017	0.6160	0.0016	0.0017	0.6164	0.0015	0.0017	91515
10 #	190.40	38.98	9.3714	191	0	3.0784	0.0042	3.0750	0.0056	3.0686	0.0061	0.6132	0.0006	0.0008	0.6136	0.0008	0.0008	0.6142	0.0008	0.0008	154548
11 #	190.42	38.99	9.3863	190	0	3.0871	0.0055	3.0829	0.0062	3.0780	0.0057	0.6134	0.0007	0.0008	0.6138	0.0008	0.0008	0.6143	0.0007	0.0008	154823
12 #	191.21	39.01	9.3791	193	0	3.0768	0.0051	3.0780	0.0067	3.0719	0.0068	0.6139	0.0007	0.0008	0.6138	0.0008	0.0008	0.6144	0.0008	0.0008	154763
13 #	109.72	39.08	16.692	165	0	9.819	0.0231	9.823	0.0235	9.806	0.0237	0.6116	0.0008	0.0005	0.6115	0.0008	0.0005	0.6120	0.0008	0.0005	275801
14 #	109.88	39.09	16.838	168	0	9.989	0.0113	9.987	0.0125	9.963	0.0128	0.6117	0.0004	0.0005	0.6117	0.0004	0.0005	0.6124	0.0004	0.0005	278258
15 #	110.46	39.09	16.843	169	0	9.991	0.0124	9.993	0.0130	9.972	0.0129	0.6118	0.0004	0.0005	0.6117	0.0005	0.0005	0.6124	0.0004	0.0005	278352
16 #	65.445	39.15	28.172	100	0	28.076	0.0105	28.064	0.0107	27.995	0.0093	0.6104	0.0003	0.0004	0.6106	0.0003	0.0004	0.6113	0.0003	0.0004	466095
17 #	65.331	39.15	28.169	100	1	28.053	0.0118	28.056	0.0091	27.984	0.0108	0.6106	0.0003	0.0004	0.6106	0.0003	0.0004	0.6114	0.0003	0.0004	466057
18 #	65.425	39.15	28.189	99	0	28.092	0.0116	28.088	0.0115	28.026	0.0109	0.6106	0.0003	0.0004	0.6107	0.0003	0.0004	0.6114	0.0003	0.0004	466386
20 $	69.876	35.86	5.4278	108	0	1.0245	0.0033	1.0227	0.0036	1.0169	0.0033	0.6154	0.0015	0.0018	0.6160	0.0015	0.0018	0.6177	0.0015	0.0018	84255
21 $	69.832	35.88	5.4243	108	0	1.0232	0.0036	1.0223	0.0045	1.0157	0.0045	0.6154	0.0015	0.0018	0.6157	0.0017	0.0018	0.6177	0.0018	0.0018	84234
22 $	70.561	35.90	5.4282	109	0	1.0225	0.0033	1.0229	0.0052	1.0171	0.0043	0.6161	0.0015	0.0018	0.6159	0.0019	0.0018	0.6177	0.0017	0.0018	84328
23 $	110.12	35.89	3.4601	171	0	0.4120	0.0011	0.4131	0.0015	0.4104	0.0013	0.6187	0.0028	0.0039	0.6178	0.0028	0.0039	0.6198	0.0028	0.0039	53743
24 $	109.42	35.91	3.4576	170	0	0.4124	0.0012	0.4124	0.0013	0.4098	0.0011	0.6179	0.0028	0.0039	0.6179	0.0027	0.0039	0.6199	0.0028	0.0039	53725
25 $	110.31	35.92	3.4406	166	1	0.4081	0.0008	0.4080	0.0011	0.4058	0.0012	0.6181	0.0028	0.0040	0.6181	0.0027	0.0040	0.6198	0.0028	0.0040	53471
26 $	65.447	36.04	28.142	101	0	27.971	0.0077	27.978	0.0085	27.854	0.0073	0.6106	0.0003	0.0004	0.6106	0.0003	0.0004	0.6119	0.0003	0.0004	438395
27 $	65.691	36.05	28.152	99	0	27.990	0.0104	27.990	0.0109	27.874	0.0100	0.6107	0.0003	0.0004	0.6107	0.0003	0.0004	0.6119	0.0003	0.0004	438648
28 $	65.486	36.06	28.135	101	0	27.968	0.0084	27.963	0.0116	27.836	0.0142	0.6105	0.0003	0.0004	0.6106	0.0003	0.0004	0.6120	0.0003	0.0004	438471
29 $	109.98	36.07	16.864	170	0	10.013	0.0119	10.014	0.0128	9.968	0.0136	0.6116	0.0004	0.0005	0.6116	0.0004	0.0005	0.6130	0.0005	0.0005	262870
30 $	110.09	36.09	16.875	170	0	10.026	0.0166	10.023	0.0197	9.979	0.0177	0.6116	0.0005	0.0005	0.6117	0.0006	0.0005	0.6130	0.0006	0.0005	263136
31 $	110.04	36.10	16.850	170	0	9.993	0.0145	9.994	0.0162	9.947	0.0159	0.6117	0.0005	0.0005	0.6117	0.0005	0.0005	0.6131	0.0005	0.0005	262809

[Test Run Date Codes # - 07/30/85 $ - 08/07/85]

Table 38E. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-5A Diameter 1.3750 Inches, Beta Ratio = 0.66371

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Diff. Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
32 #	190.45	36.09	9.2712	185	0	3.0085	0.0053	3.0084	0.0058	2.9930	0.0059	0.6134	0.0007	0.0008	0.6134	0.0007	0.0008	0.6150	0.0007	0.0008	144571
33 #	190.13	36.12	9.2622	192	0	3.0005	0.0073	3.0009	0.0086	2.9859	0.0091	0.6137	0.0008	0.0008	0.6136	0.0010	0.0008	0.6151	0.0010	0.0008	144516
34 #	190.35	36.13	9.2739	193	0	3.0112	0.0057	3.0095	0.0055	2.9945	0.0057	0.6133	0.0007	0.0008	0.6135	0.0007	0.0008	0.6150	0.0007	0.0008	144727
35 #	300.09	36.14	5.3641	150	0	1.0007	0.0025	1.0000	0.0030	0.9948	0.0031	0.6154	0.0014	0.0018	0.6156	0.0014	0.0018	0.6172	0.0015	0.0018	83728
36 #	300.82	36.16	5.3764	150	0	1.0043	0.0022	1.0040	0.0025	0.9987	0.0027	0.6157	0.0013	0.0018	0.6158	0.0013	0.0018	0.6174	0.0014	0.0018	83953
37 #	301.64	36.18	5.3707	150	0	1.0015	0.0023	1.0015	0.0026	0.9963	0.0025	0.6159	0.0013	0.0018	0.6159	0.0013	0.0018	0.6175	0.0013	0.0018	83897
38 $	190.05	21.92	9.2531	192	0	2.9877	0.0044	2.9739	0.0061	2.9646	0.0060	0.6134	0.0279	0.0008	0.6148	0.0007	0.0008	0.6157	0.0007	0.0008	106170
39 $	190.03	21.96	9.3150	192	0	3.0312	0.0058	3.0155	0.0062	3.0063	0.0060	0.6130	0.0275	0.0008	0.6146	0.0007	0.0008	0.6156	0.0007	0.0008	106982
40 $	186.09	21.99	9.3037	200	0	3.0214	0.0055	3.0055	0.0064	2.9962	0.0067	0.6133	0.0276	0.0008	0.6149	0.0007	0.0008	0.6158	0.0008	0.0008	106928
41 $	110.08	22.04	16.934	134	0	10.086	0.0101	10.033	0.0121	10.001	0.0116	0.6109	0.0083	0.0005	0.6125	0.0004	0.0005	0.6135	0.0004	0.0005	194853
42 $	109.93	22.08	16.933	134	0	10.081	0.0102	10.032	0.0148	9.998	0.0146	0.6111	0.0083	0.0005	0.6126	0.0005	0.0005	0.6136	0.0005	0.0005	195035
43 $	110.51	22.09	16.961	135	0	10.115	0.0116	10.065	0.0151	10.031	0.0146	0.6111	0.0082	0.0005	0.6126	0.0005	0.0005	0.6136	0.0005	0.0005	195399
44 $	65.446	22.14	28.249	80	0	27.831	0.0071	28.041	0.0095	27.949	0.0095	0.6135	0.0030	0.0004	0.6112	0.0003	0.0004	0.6122	0.0003	0.0004	325828
45 $	64.525	22.16	28.216	79	0	27.799	0.0136	27.976	0.0161	27.886	0.0210	0.6132	0.0030	0.0004	0.6112	0.0003	0.0004	0.6122	0.0003	0.0004	325608
46 $	64.561	22.18	28.156	79	0	27.713	0.0096	27.850	0.0108	27.763	0.0066	0.6128	0.0030	0.0004	0.6113	0.0003	0.0004	0.6123	0.0003	0.0004	325062
47 $	69.484	22.22	5.4755	85	7	1.0428	0.0016	1.0394	0.0016	1.0323	0.0019	0.6144	0.0802	0.0017	0.6154	0.0011	0.0017	0.6175	0.0012	0.0017	63276
48 $	69.828	22.23	5.4655	85	0	1.0354	0.0036	1.0316	0.0036	1.0254	0.0028	0.6155	0.0809	0.0017	0.6166	0.0015	0.0018	0.6184	0.0013	0.0018	63175
49 $	70.335	22.24	5.4817	86	0	1.0418	0.0024	1.0371	0.0033	1.0308	0.0032	0.6154	0.0804	0.0017	0.6168	0.0014	0.0017	0.6186	0.0014	0.0017	63377
50 $	69.485	22.27	5.4186	85	0	1.0174	0.0022	1.0130	0.0028	1.0067	0.0028	0.6155	0.0823	0.0018	0.6169	0.0013	0.0018	0.6188	0.0013	0.0018	62692
51 $	70.275	22.28	5.4197	86	0	1.0168	0.0031	1.0134	0.0043	1.0070	0.0037	0.6158	0.0824	0.0018	0.6169	0.0017	0.0018	0.6188	0.0015	0.0018	62720
52 $	70.249	22.30	5.4227	86	1	1.0187	0.0031	1.0144	0.0031	1.0086	0.0027	0.6156	0.0822	0.0018	0.6169	0.0014	0.0018	0.6187	0.0013	0.0018	62785
53 $	110.05	22.33	3.4525	135	0	0.4100	0.0008	0.4087	0.0011	0.4044	0.0010	0.6178	0.2050	0.0039	0.6188	0.0026	0.0040	0.6220	0.0026	0.0040	40002
54 $	109.53	22.36	3.4492	131	0	0.4095	0.0007	0.4079	0.0008	0.4040	0.0007	0.6176	0.2052	0.0039	0.6188	0.0026	0.0040	0.6218	0.0025	0.0040	39992
55 $	110.55	22.37	3.4354	131	0	0.4058	0.0013	0.4044	0.0016	0.4005	0.0013	0.6179	0.2072	0.0040	0.6190	0.0028	0.0040	0.6220	0.0027	0.0040	39841
56 $	70.247	22.27	5.4193	86	0	1.0168	0.0003	1.0109	0.0003	1.0087	0.0003	0.6158	0.0824	0.0018	0.6176	0.0010	0.0018	0.6183	0.0010	0.0018	62701
57 $	70.182	22.28	5.4078	86	0	1.0122	0.0003	1.0066	0.0003	1.0042	0.0003	0.6159	0.0828	0.0018	0.6176	0.0010	0.0018	0.6183	0.0010	0.0018	62582
58 $	70.242	22.29	5.4031	86	0	1.0098	0.0005	1.0044	0.0003	1.0024	0.0003	0.6161	0.0830	0.0018	0.6177	0.0010	0.0018	0.6184	0.0010	0.0018	62543
59 $	109.99	22.30	3.4627	135	0	0.4121	0.0002	0.4097	0.0001	0.4086	0.0001	0.6180	0.2040	0.0039	0.6198	0.0025	0.0040	0.6207	0.0024	0.0040	40091
60 $	109.94	22.30	3.4595	135	0	0.4112	0.0002	0.4087	0.0001	0.4078	0.0001	0.6182	0.2046	0.0039	0.6200	0.0025	0.0040	0.6208	0.0024	0.0040	40054
61 $	110.14	22.32	3.4560	130	0	0.4105	0.0001	0.4080	0.0001	0.4069	0.0001	0.6181	0.2049	0.0039	0.6200	0.0025	0.0040	0.6208	0.0025	0.0040	40033

[Test Run Date Codes # - 08/07/85 $ - 01/07/86]

Table 38E. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-5A Diameter 1.3750 Inches, Beta Ratio = 0.66371

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid): Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients: Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
62 #	110.86	21.41	3.4522	100	0	0.0000	0.0000	0.4049	0.0002	0.4055	0.0001	0.0000	0.0000	0.0000	0.6216	0.0030	0.0040	0.6211	0.0027	0.0040	39130
63 #	109.53	21.41	3.4469	99	0	0.0000	0.0000	0.4035	0.0001	0.4038	0.0002	0.0000	0.0000	0.0000	0.6217	0.0030	0.0040	0.6214	0.0027	0.0040	39070
64 #	109.48	21.41	3.4419	99	0	0.0000	0.0000	0.4021	0.0002	0.4028	0.0002	0.0000	0.0000	0.0000	0.6219	0.0030	0.0040	0.6213	0.0027	0.0040	39013
65 #	69.969	21.43	5.5035	63	0	0.0000	0.0000	1.0370	0.0002	1.0403	0.0003	0.0000	0.0000	0.0000	0.6192	0.0012	0.0018	0.6182	0.0011	0.0018	62411
66 #	69.903	21.43	5.4894	63	0	0.0000	0.0000	1.0323	0.0003	1.0349	0.0002	0.0000	0.0000	0.0000	0.6190	0.0012	0.0018	0.6182	0.0011	0.0018	62251
67 #	69.911	21.43	5.4993	63	0	0.0000	0.0000	1.0358	0.0007	1.0388	0.0003	0.0000	0.0000	0.0000	0.6191	0.0012	0.0018	0.6182	0.0011	0.0018	62363
68 #	300.49	21.43	5.5201	149	0	0.0000	0.0000	1.0451	0.0002	1.0482	0.0002	0.0000	0.0000	0.0000	0.6187	0.0011	0.0017	0.6177	0.0010	0.0017	62599
69 #	300.75	21.43	5.5185	149	0	0.0000	0.0000	1.0441	0.0003	1.0470	0.0002	0.0000	0.0000	0.0000	0.6188	0.0012	0.0017	0.6179	0.0010	0.0017	62581
70 #	300.76	21.43	5.5236	149	0	0.0000	0.0000	1.0462	0.0002	1.0493	0.0003	0.0000	0.0000	0.0000	0.6187	0.0011	0.0017	0.6178	0.0010	0.0017	62639
71 #	190.19	21.46	9.3394	171	0	0.0000	0.0000	3.0170	0.0003	3.0279	0.0005	0.0000	0.0000	0.0000	0.6160	0.0004	0.0008	0.6149	0.0004	0.0008	105987
72 #	189.44	21.46	9.3331	170	0	0.0000	0.0000	3.0136	0.0005	3.0238	0.0004	0.0000	0.0000	0.0000	0.6160	0.0004	0.0008	0.6149	0.0004	0.0008	105916
73 #	190.16	21.46	9.3435	171	0	0.0000	0.0000	3.0203	0.0004	3.0300	0.0004	0.0000	0.0000	0.0000	0.6160	0.0004	0.0008	0.6150	0.0004	0.0008	106034
74 #	190.30	21.93	9.3799	171	2	0.0000	0.0000	3.0449	0.0064	3.0575	0.0063	0.0000	0.0000	0.0000	0.6159	0.0008	0.0008	0.6146	0.0007	0.0008	107650
75 #	190.05	21.95	9.3799	171	0	0.0000	0.0000	3.0432	0.0076	3.0539	0.0080	0.0000	0.0000	0.0000	0.6161	0.0009	0.0008	0.6150	0.0009	0.0008	107702
76 #	190.05	21.98	9.3864	171	4	0.0000	0.0000	3.0533	0.0059	3.0596	0.0063	0.0000	0.0000	0.0000	0.6155	0.0007	0.0008	0.6149	0.0007	0.0008	107853
77 #	110.51	22.09	16.991	100	1	0.0000	0.0000	10.071	0.0112	10.102	0.0078	0.0000	0.0000	0.0000	0.6135	0.0004	0.0005	0.6125	0.0003	0.0005	195746
78 #	110.62	22.11	16.965	100	0	0.0000	0.0000	10.034	0.0186	10.066	0.0210	0.0000	0.0000	0.0000	0.6137	0.0006	0.0005	0.6127	0.0007	0.0005	195541
79 #	109.96	22.14	16.997	99	0	0.0000	0.0000	10.070	0.0103	10.103	0.0072	0.0000	0.0000	0.0000	0.6137	0.0004	0.0005	0.6127	0.0003	0.0005	196051
80 #	65.332	22.15	28.277	59	1	0.0000	0.0000	28.002	0.0119	28.093	0.0169	0.0000	0.0000	0.0000	0.6123	0.0003	0.0004	0.6113	0.0003	0.0004	326230
81 #	65.237	22.17	28.301	59	0	0.0000	0.0000	28.048	0.0084	28.139	0.0094	0.0000	0.0000	0.0000	0.6123	0.0003	0.0004	0.6113	0.0003	0.0004	326667
82 #	65.318	22.18	28.308	59	1	0.0000	0.0000	28.054	0.0076	28.151	0.0105	0.0000	0.0000	0.0000	0.6124	0.0003	0.0004	0.6113	0.0003	0.0004	326815
86 $	110.73	22.58	3.4417	100	0	0.0000	0.0000	0.4029	0.0002	0.4036	0.0002	0.0000	0.0000	0.0000	0.6213	0.0028	0.0040	0.6207	0.0028	0.0040	40113
87 $	110.68	22.57	3.4385	100	0	0.0000	0.0000	0.4021	0.0002	0.4025	0.0002	0.0000	0.0000	0.0000	0.6214	0.0028	0.0040	0.6210	0.0028	0.0040	40066
88 $	110.82	22.57	3.4384	100	0	0.0000	0.0000	0.4021	0.0002	0.4026	0.0002	0.0000	0.0000	0.0000	0.6213	0.0028	0.0040	0.6209	0.0028	0.0040	40065
89 $	69.890	22.58	5.4581	63	0	0.0000	0.0000	1.0219	0.0004	1.0234	0.0004	0.0000	0.0000	0.0000	0.6187	0.0011	0.0018	0.6182	0.0011	0.0018	63614
90 $	70.897	22.58	5.4656	64	0	0.0000	0.0000	1.0246	0.0005	1.0265	0.0005	0.0000	0.0000	0.0000	0.6187	0.0011	0.0018	0.6181	0.0011	0.0018	63702
91 $	70.605	22.59	5.4485	64	0	0.0000	0.0000	1.0185	0.0003	1.0198	0.0005	0.0000	0.0000	0.0000	0.6186	0.0011	0.0018	0.6182	0.0011	0.0018	63518
93 $	300.50	22.58	5.4400	149	24	0.0000	0.0000	1.0168	0.0005	1.0181	0.0006	0.0000	0.0000	0.0000	0.6181	0.0011	0.0018	0.6178	0.0011	0.0018	63403
94 $	300.85	22.60	5.4437	149	0	0.0000	0.0000	1.0179	0.0001	1.0192	0.0001	0.0000	0.0000	0.0000	0.6182	0.0011	0.0018	0.6179	0.0011	0.0018	63477
95 $	300.79	22.60	5.4408	149	0	0.0000	0.0000	1.0169	0.0001	1.0180	0.0001	0.0000	0.0000	0.0000	0.6182	0.0011	0.0018	0.6179	0.0011	0.0018	63443

[Test Run Date Codes # - 02/02/87 $ - 02/03/87]

Table 38E. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-5A Diameter 1.3750 Inches, Beta Ratio = 0.66371

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
96 #	190.08	22.59	9.3858	171	0	0.0000	0.0000	3.0531	0.0006	3.0574	0.0006	0.0000	0.0000	0.0000	0.6155	0.0004	0.0008	0.6151	0.0004	0.0008	109418
97 #	190.01	22.59	9.3862	171	0	0.0000	0.0000	3.0527	0.0005	3.0567	0.0005	0.0000	0.0000	0.0000	0.6156	0.0004	0.0008	0.6152	0.0004	0.0008	109422
98 #	190.20	22.60	9.3926	171	0	0.0000	0.0000	3.0571	0.0004	3.0607	0.0004	0.0000	0.0000	0.0000	0.6155	0.0004	0.0008	0.6152	0.0004	0.0008	109523
99 #	190.44	22.70	9.4387	171	4	0.0000	0.0000	3.0902	0.0058	3.0943	0.0052	0.0000	0.0000	0.0000	0.6152	0.0007	0.0008	0.6148	0.0006	0.0008	110320
100 #	190.09	22.74	9.4473	171	0	0.0000	0.0000	3.0938	0.0070	3.0978	0.0075	0.0000	0.0000	0.0000	0.6154	0.0008	0.0008	0.6151	0.0008	0.0008	110525
101 #	189.85	22.77	9.4536	171	6	0.0000	0.0000	3.1010	0.0053	3.1056	0.0041	0.0000	0.0000	0.0000	0.6151	0.0006	0.0008	0.6147	0.0006	0.0008	110677
102 #	110.39	22.93	16.932	100	0	0.0000	0.0000	10.011	0.0143	10.020	0.0156	0.0000	0.0000	0.0000	0.6132	0.0005	0.0005	0.6129	0.0005	0.0005	198977
103 #	110.51	22.94	16.959	100	0	0.0000	0.0000	10.041	0.0131	10.055	0.0135	0.0000	0.0000	0.0000	0.6133	0.0004	0.0005	0.6128	0.0005	0.0005	199343
104 #	110.55	22.97	16.972	100	0	0.0000	0.0000	10.057	0.0094	10.066	0.0112	0.0000	0.0000	0.0000	0.6132	0.0003	0.0005	0.6130	0.0004	0.0005	199638
105 #	65.219	22.97	28.283	59	0	0.0000	0.0000	28.057	0.0069	28.084	0.0078	0.0000	0.0000	0.0000	0.6118	0.0003	0.0004	0.6116	0.0003	0.0004	332683
106 #	65.278	22.99	28.305	59	0	0.0000	0.0000	28.094	0.0152	28.123	0.0060	0.0000	0.0000	0.0000	0.6119	0.0003	0.0004	0.6116	0.0003	0.0004	333101
107 #	65.262	23.02	28.286	59	0	0.0000	0.0000	28.055	0.0096	28.087	0.0078	0.0000	0.0000	0.0000	0.6119	0.0003	0.0004	0.6116	0.0003	0.0004	333108
111 $	109.97	22.96	3.4228	100	0	0.0000	0.0000	0.3998	0.0001	0.3984	0.0001	0.0000	0.0000	0.0000	0.6203	0.0025	0.0040	0.6214	0.0029	0.0040	40251
112 $	110.21	22.96	3.4218	100	0	0.0000	0.0000	0.3995	0.0001	0.3979	0.0001	0.0000	0.0000	0.0000	0.6203	0.0025	0.0040	0.6216	0.0029	0.0040	40240
113 $	110.19	22.97	3.4219	100	0	0.0000	0.0000	0.3996	0.0001	0.3979	0.0001	0.0000	0.0000	0.0000	0.6203	0.0025	0.0040	0.6216	0.0029	0.0040	40250
114 $	70.605	22.96	5.4481	64	0	0.0000	0.0000	1.0206	0.0004	1.0177	0.0002	0.0000	0.0000	0.0000	0.6179	0.0010	0.0018	0.6188	0.0011	0.0018	64069
115 $	69.543	22.96	5.4458	63	0	0.0000	0.0000	1.0193	0.0003	1.0166	0.0004	0.0000	0.0000	0.0000	0.6181	0.0010	0.0018	0.6189	0.0011	0.0018	64042
116 $	69.459	22.96	5.4466	63	0	0.0000	0.0000	1.0197	0.0002	1.0175	0.0002	0.0000	0.0000	0.0000	0.6181	0.0010	0.0018	0.6187	0.0011	0.0018	64051
117 $	300.49	22.95	5.4606	149	0	0.0000	0.0000	1.0267	0.0001	1.0240	0.0001	0.0000	0.0000	0.0000	0.6175	0.0010	0.0018	0.6183	0.0011	0.0018	64201
118 $	300.59	22.96	5.4462	149	1	0.0000	0.0000	1.0207	0.0002	1.0184	0.0001	0.0000	0.0000	0.0000	0.6177	0.0010	0.0018	0.6184	0.0011	0.0018	64046
119 $	300.67	22.97	5.4449	149	0	0.0000	0.0000	1.0201	0.0001	1.0179	0.0001	0.0000	0.0000	0.0000	0.6177	0.0010	0.0018	0.6184	0.0011	0.0018	64046
120 $	109.96	22.98	3.4255	100	0	0.0000	0.0000	0.4003	0.0001	0.3997	0.0001	0.0000	0.0000	0.0000	0.6204	0.0025	0.0040	0.6209	0.0028	0.0040	40302
121 $	109.49	22.99	3.4181	99	0	0.0000	0.0000	0.3981	0.0001	0.3976	0.0001	0.0000	0.0000	0.0000	0.6208	0.0025	0.0041	0.6212	0.0029	0.0041	40225
122 $	110.46	23.00	3.4167	100	0	0.0000	0.0000	0.3978	0.0001	0.3973	0.0001	0.0000	0.0000	0.0000	0.6208	0.0025	0.0041	0.6211	0.0029	0.0041	40218
123 $	70.924	23.01	5.4312	64	0	0.0000	0.0000	1.0145	0.0003	1.0126	0.0003	0.0000	0.0000	0.0000	0.6179	0.0010	0.0018	0.6185	0.0012	0.0018	63945
124 $	69.799	22.99	5.4295	63	0	0.0000	0.0000	1.0128	0.0003	1.0123	0.0004	0.0000	0.0000	0.0000	0.6182	0.0010	0.0018	0.6184	0.0012	0.0018	63895
125 $	69.974	23.00	5.4303	63	0	0.0000	0.0000	1.0133	0.0004	1.0115	0.0003	0.0000	0.0000	0.0000	0.6181	0.0010	0.0018	0.6187	0.0012	0.0018	63919
126 $	300.90	23.00	5.4437	150	0	0.0000	0.0000	1.0196	0.0001	1.0183	0.0001	0.0000	0.0000	0.0000	0.6177	0.0010	0.0018	0.6182	0.0011	0.0018	64077
127 $	300.53	23.01	5.4420	149	0	0.0000	0.0000	1.0191	0.0002	1.0177	0.0001	0.0000	0.0000	0.0000	0.6177	0.0010	0.0018	0.6181	0.0011	0.0018	64072
128 $	300.85	23.01	5.4429	149	0	0.0000	0.0000	1.0192	0.0002	1.0177	0.0002	0.0000	0.0000	0.0000	0.6178	0.0010	0.0018	0.6182	0.0011	0.0018	64083

[Test Run Date Codes # - 02/03/87 $ - 02/05/87]

Table 38E. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-5A Diameter 1.3750 Inches, Beta Ratio = 0.66371

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
129 #	190.01	23.01	9.3930	171	0	0.0000	0.0000	3.0664	0.0004	3.0625	0.0003	0.0000	0.0000	0.0000	0.6146	0.0003	0.0008	0.6150	0.0004	0.0008	110590
130 #	189.89	23.02	9.3942	170	0	0.0000	0.0000	3.0624	0.0004	3.0593	0.0004	0.0000	0.0000	0.0000	0.6151	0.0003	0.0008	0.6154	0.0004	0.0008	110630
131 #	190.02	23.02	9.3949	171	0	0.0000	0.0000	3.0630	0.0004	3.0593	0.0003	0.0000	0.0000	0.0000	0.6151	0.0003	0.0008	0.6155	0.0004	0.0008	110638
132 #	190.95	23.11	9.4128	171	0	0.0000	0.0000	3.0762	0.0053	3.0726	0.0053	0.0000	0.0000	0.0000	0.6150	0.0006	0.0008	0.6153	0.0007	0.0008	111083
133 #	189.73	23.16	9.3929	169	2	0.0000	0.0000	3.0644	0.0066	3.0582	0.0071	0.0000	0.0000	0.0000	0.6149	0.0008	0.0008	0.6155	0.0008	0.0008	110978
134 #	190.68	23.21	9.3980	171	6	0.0000	0.0000	3.0688	0.0026	3.0657	0.0028	0.0000	0.0000	0.0000	0.6147	0.0004	0.0008	0.6151	0.0005	0.0008	111168
135 #	110.67	23.37	16.896	100	0	0.0000	0.0000	9.980	0.0164	9.966	0.0140	0.0000	0.0000	0.0000	0.6129	0.0005	0.0005	0.6133	0.0005	0.0005	200610
136 #	109.72	23.40	16.907	99	0	0.0000	0.0000	9.994	0.0099	9.979	0.0093	0.0000	0.0000	0.0000	0.6128	0.0004	0.0005	0.6133	0.0003	0.0005	200876
137 #	109.82	23.41	16.859	99	0	0.0000	0.0000	9.936	0.0268	9.921	0.0274	0.0000	0.0000	0.0000	0.6129	0.0008	0.0005	0.6134	0.0009	0.0005	200363
138 #	65.408	23.43	28.227	59	0	0.0000	0.0000	27.983	0.0052	27.934	0.0079	0.0000	0.0000	0.0000	0.6115	0.0003	0.0004	0.6120	0.0003	0.0004	335622
139 #	64.718	23.46	28.224	58	0	0.0000	0.0000	27.970	0.0107	27.933	0.0121	0.0000	0.0000	0.0000	0.6115	0.0003	0.0004	0.6119	0.0003	0.0004	335809
140 #	65.559	23.46	28.221	59	0	0.0000	0.0000	27.966	0.0108	27.922	0.0045	0.0000	0.0000	0.0000	0.6115	0.0003	0.0004	0.6120	0.0003	0.0004	335779

[Test Run Date Codes # - 02/05/87]

Table 38F. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-6A Diameter 1.5002 Inches, Beta Ratio = 0.72414

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	159.96	37.14	11.693	198	0	3.0255	0.0043	3.0264	0.0048	3.0160	0.0048	0.6148	0.0006	0.0008	0.6147	0.0006	0.0008	0.6158	0.0006	0.0008	186130
2	#	160.37	37.16	11.670	199	0	3.0151	0.0051	3.0131	0.0056	3.0036	0.0057	0.6146	0.0007	0.0008	0.6148	0.0007	0.0008	0.6158	0.0007	0.0008	185830
3	#	159.93	37.18	11.652	198	0	3.0040	0.0070	3.0041	0.0070	2.9959	0.0070	0.6148	0.0008	0.0008	0.6148	0.0008	0.0008	0.6156	0.0008	0.0008	185613
4	#	52.999	37.25	35.307	81	0	27.897	0.0079	27.896	0.0098	27.797	0.0072	0.6113	0.0003	0.0004	0.6113	0.0003	0.0004	0.6124	0.0003	0.0004	563210
5	#	53.415	37.26	35.276	82	0	27.852	0.0053	27.856	0.0025	27.756	0.0045	0.6113	0.0003	0.0004	0.6112	0.0003	0.0004	0.6123	0.0003	0.0004	562813
6	#	52.801	37.27	35.284	76	0	27.854	0.0061	27.862	0.0041	27.766	0.0080	0.6114	0.0003	0.0004	0.6113	0.0003	0.0004	0.6124	0.0003	0.0004	563055
7	#	271.19	37.25	6.8023	168	0	1.0169	0.0018	1.0188	0.0018	1.0150	0.0020	0.6169	0.0013	0.0018	0.6163	0.0012	0.0018	0.6175	0.0012	0.0018	108508
8	#	271.05	37.26	6.7799	168	0	1.0091	0.0019	1.0110	0.0026	1.0073	0.0026	0.6173	0.0013	0.0018	0.6167	0.0014	0.0018	0.6178	0.0013	0.0018	108172
9	#	270.88	37.27	6.7951	168	0	1.0151	0.0019	1.0160	0.0025	1.0124	0.0024	0.6168	0.0013	0.0018	0.6165	0.0013	0.0018	0.6176	0.0013	0.0018	108435
10	#	85.332	37.32	21.181	131	0	9.998	0.0114	9.999	0.0131	9.965	0.0154	0.6126	0.0004	0.0005	0.6126	0.0005	0.0005	0.6136	0.0005	0.0005	338325
11	#	84.761	37.34	21.145	129	0	9.966	0.0095	9.967	0.0124	9.934	0.0112	0.6126	0.0004	0.0005	0.6125	0.0004	0.0005	0.6136	0.0004	0.0005	337888
12	#	84.756	37.35	21.170	130	0	9.988	0.0093	9.988	0.0110	9.958	0.0136	0.6126	0.0004	0.0005	0.6126	0.0004	0.0005	0.6135	0.0005	0.0005	338348
13	#	90.340	37.30	4.3294	139	0	0.4090	0.0009	0.4105	0.0008	0.4076	0.0008	0.6192	0.0029	0.0040	0.6180	0.0028	0.0040	0.6202	0.0026	0.0040	69128
14	#	90.336	37.30	4.3201	139	0	0.4069	0.0009	0.4085	0.0013	0.4060	0.0012	0.6194	0.0029	0.0040	0.6182	0.0029	0.0040	0.6201	0.0027	0.0040	68980
15	#	90.028	37.31	4.3385	133	0	0.4105	0.0012	0.4121	0.0012	0.4093	0.0011	0.6193	0.0030	0.0040	0.6181	0.0028	0.0039	0.6202	0.0026	0.0039	69287
16	$	440.64	34.91	4.3668	156	0	0.4164	0.0017	0.4165	0.0018	0.4123	0.0018	0.6187	0.0030	0.0039	0.6186	0.0028	0.0039	0.6218	0.0030	0.0039	66517
17	$	440.73	34.95	4.4207	156	0	0.4254	0.0009	0.4276	0.0013	0.4228	0.0012	0.6197	0.0027	0.0038	0.6181	0.0026	0.0038	0.6216	0.0027	0.0038	67392
18	$	440.63	34.98	4.3412	156	0	0.4109	0.0008	0.4115	0.0007	0.4079	0.0007	0.6192	0.0028	0.0040	0.6187	0.0026	0.0039	0.6214	0.0027	0.0039	66220
19	$	84.401	35.08	21.258	130	0	10.092	0.0106	10.087	0.0135	10.022	0.0110	0.6118	0.0004	0.0005	0.6119	0.0005	0.0005	0.6139	0.0004	0.0005	324905
20	$	85.166	35.10	21.175	131	0	10.002	0.0116	10.005	0.0121	9.942	0.0140	0.6121	0.0004	0.0005	0.6120	0.0004	0.0005	0.6140	0.0005	0.0005	323770
21	$	84.459	35.12	21.201	127	0	10.031	0.0128	10.031	0.0126	9.967	0.0129	0.6120	0.0005	0.0005	0.6120	0.0004	0.0005	0.6140	0.0005	0.0005	324305
22	$	269.63	35.13	6.8788	167	0	1.0403	0.0029	1.0413	0.0030	1.0330	0.0031	0.6166	0.0014	0.0018	0.6163	0.0014	0.0018	0.6188	0.0014	0.0018	105242
23	$	270.90	35.16	6.8843	168	0	1.0421	0.0019	1.0425	0.0020	1.0340	0.0021	0.6166	0.0012	0.0018	0.6164	0.0012	0.0018	0.6190	0.0012	0.0018	105389
24	$	270.97	35.18	6.8828	168	0	1.0430	0.0023	1.0426	0.0020	1.0341	0.0020	0.6162	0.0013	0.0018	0.6163	0.0012	0.0018	0.6188	0.0012	0.0018	105408
25	$	160.78	35.21	11.674	199	0	3.0206	0.0056	3.0198	0.0074	2.9987	0.0075	0.6141	0.0007	0.0008	0.6142	0.0008	0.0008	0.6163	0.0009	0.0008	178885
26	$	160.42	35.24	11.816	199	0	3.0959	0.0054	3.0955	0.0072	3.0737	0.0069	0.6140	0.0007	0.0008	0.6140	0.0008	0.0008	0.6162	0.0008	0.0008	181183
27	$	160.49	35.26	11.687	199	0	3.0273	0.0043	3.0272	0.0051	3.0056	0.0053	0.6141	0.0006	0.0008	0.6141	0.0006	0.0008	0.6163	0.0007	0.0008	179275
28	$	52.656	35.33	35.345	81	0	28.002	0.0088	28.005	0.0061	27.831	0.0070	0.6107	0.0003	0.0004	0.6106	0.0003	0.0004	0.6125	0.0003	0.0004	542914
29	$	52.739	35.34	35.378	81	0	28.060	0.0079	28.055	0.0077	27.880	0.0075	0.6106	0.0003	0.0004	0.6107	0.0003	0.0004	0.6126	0.0003	0.0004	543541
30	$	53.356	35.34	35.383	82	0	28.068	0.0060	28.066	0.0054	27.886	0.0073	0.6106	0.0003	0.0004	0.6106	0.0003	0.0004	0.6126	0.0003	0.0004	543610

[Test Run Date Codes # - 07/29/85 $ - 08/07/85]

Table 3&F. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-6A Diameter 1.5002 Inches, Beta Ratio = 0.72414

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	89.892	21.21	4.3442	107	0	0.4087	0.0013	0.4061	0.0018	0.4050	0.0015	0.6204	0.2065	0.0040	0.6223	0.0029	0.0040	0.6231	0.0027	0.0040	49004
32 #	90.089	21.25	4.3481	110	0	0.4095	0.0010	0.4067	0.0013	0.4056	0.0011	0.6203	0.2061	0.0040	0.6224	0.0027	0.0040	0.6232	0.0026	0.0040	49095
33 #	90.163	21.27	4.3452	107	4	0.4085	0.0009	0.4074	0.0006	0.4051	0.0009	0.6207	0.2067	0.0040	0.6215	0.0025	0.0040	0.6232	0.0026	0.0040	49086
34 #	269.68	21.35	6.7831	167	0	1.0059	0.0024	1.0004	0.0025	0.9971	0.0023	0.6174	0.0835	0.0018	0.6191	0.0013	0.0018	0.6201	0.0012	0.0018	76774
35 #	271.31	21.39	6.7842	168	0	1.0065	0.0015	1.0006	0.0018	0.9970	0.0017	0.6173	0.0835	0.0018	0.6191	0.0012	0.0018	0.6203	0.0011	0.0018	76860
36 #	271.30	21.43	6.7828	168	0	1.0062	0.0018	1.0002	0.0016	0.9967	0.0018	0.6173	0.0835	0.0018	0.6191	0.0011	0.0018	0.6202	0.0011	0.0018	76918
37 #	160.40	21.46	11.679	195	3	3.0106	0.0035	2.9944	0.0040	2.9867	0.0034	0.6144	0.0278	0.0008	0.6161	0.0005	0.0008	0.6169	0.0005	0.0008	132533
38 #	160.75	21.50	11.666	195	0	3.0034	0.0053	2.9872	0.0064	2.9779	0.0066	0.6145	0.0278	0.0008	0.6162	0.0008	0.0008	0.6171	0.0008	0.0008	132516
39 #	160.26	21.53	11.667	194	7	3.0029	0.0045	2.9908	0.0032	2.9825	0.0026	0.6146	0.0279	0.0008	0.6158	0.0005	0.0008	0.6167	0.0004	0.0008	132622
40 #	85.123	21.59	21.284	104	0	10.075	0.0075	10.025	0.0084	9.992	0.0091	0.6121	0.0083	0.0005	0.6136	0.0003	0.0005	0.6147	0.0004	0.0005	242292
41 #	85.102	21.61	21.290	104	0	10.082	0.0112	10.030	0.0114	9.997	0.0112	0.6121	0.0083	0.0005	0.6137	0.0004	0.0005	0.6147	0.0004	0.0005	242472
42 #	84.959	21.63	21.278	104	0	10.074	0.0092	10.022	0.0089	9.987	0.0095	0.6120	0.0083	0.0005	0.6136	0.0004	0.0005	0.6146	0.0004	0.0005	242456
43 #	53.126	21.71	35.448	65	0	27.782	0.0356	27.945	0.0572	27.838	0.0587	0.6139	0.0030	0.0004	0.6121	0.0007	0.0004	0.6133	0.0007	0.0004	404694
44 #	53.225	21.73	35.375	65	0	27.704	0.0205	27.838	0.0230	27.736	0.0166	0.6135	0.0030	0.0004	0.6121	0.0004	0.0004	0.6132	0.0004	0.0004	404055
45 #	52.302	21.74	35.335	64	0	27.659	0.0061	27.774	0.0120	27.668	0.0087	0.6133	0.0030	0.0004	0.6121	0.0003	0.0004	0.6132	0.0003	0.0004	403691
46 $	89.533	22.17	4.3254	81	0	0.0000	0.0000	0.4009	0.0001	0.4016	0.0002	0.0000	0.0000	0.0000	0.6236	0.0030	0.0041	0.6231	0.0027	0.0041	49926
47 $	90.561	22.18	4.3340	82	0	0.0000	0.0000	0.4026	0.0001	0.4032	0.0002	0.0000	0.0000	0.0000	0.6236	0.0030	0.0041	0.6231	0.0027	0.0041	50037
48 $	89.522	22.19	4.3307	81	0	0.0000	0.0000	0.4018	0.0001	0.4022	0.0001	0.0000	0.0000	0.0000	0.6237	0.0030	0.0041	0.6234	0.0027	0.0041	50011
50 $	302.55	22.20	4.3244	150	0	0.0000	0.0000	0.4010	0.0001	0.4013	0.0001	0.0000	0.0000	0.0000	0.6235	0.0030	0.0041	0.6232	0.0027	0.0041	49952
51 $	300.92	22.20	4.3229	150	0	0.0000	0.0000	0.4005	0.0001	0.4008	0.0001	0.0000	0.0000	0.0000	0.6236	0.0030	0.0041	0.6234	0.0028	0.0041	49935
52 $	300.50	22.20	4.3206	149	0	0.0000	0.0000	0.4000	0.0001	0.4003	0.0001	0.0000	0.0000	0.0000	0.6237	0.0030	0.0041	0.6234	0.0028	0.0041	49908
53 @	279.80	22.09	6.8404	173	0	0.0000	0.0000	1.0154	0.0002	1.0158	0.0003	0.0000	0.0000	0.0000	0.6197	0.0011	0.0018	0.6196	0.0011	0.0018	78805
55 @	279.99	22.10	6.8332	173	0	0.0000	0.0000	1.0130	0.0002	1.0136	0.0002	0.0000	0.0000	0.0000	0.6198	0.0011	0.0018	0.6196	0.0011	0.0018	78741
56 @	279.78	22.10	6.8364	173	0	0.0000	0.0000	1.0139	0.0003	1.0142	0.0002	0.0000	0.0000	0.0000	0.6198	0.0011	0.0018	0.6197	0.0011	0.0018	78777
57 @	160.15	22.12	11.845	144	0	0.0000	0.0000	3.0744	0.0006	3.0771	0.0006	0.0000	0.0000	0.0000	0.6167	0.0004	0.0008	0.6165	0.0004	0.0008	136560
58 @	160.06	22.11	11.848	144	0	0.0000	0.0000	3.0758	0.0005	3.0785	0.0006	0.0000	0.0000	0.0000	0.6167	0.0004	0.0008	0.6165	0.0004	0.0008	136559
59 @	159.62	22.11	11.839	144	0	0.0000	0.0000	3.0710	0.0005	3.0731	0.0003	0.0000	0.0000	0.0000	0.6168	0.0004	0.0008	0.6165	0.0004	0.0008	136457
60 @	160.30	22.22	11.879	144	0	0.0000	0.0000	3.0926	0.0070	3.0955	0.0065	0.0000	0.0000	0.0000	0.6167	0.0008	0.0008	0.6164	0.0008	0.0008	137273
61 @	160.50	22.27	11.950	144	3	0.0000	0.0000	3.1318	0.0021	3.1345	0.0026	0.0000	0.0000	0.0000	0.6165	0.0004	0.0008	0.6162	0.0005	0.0008	138266
62 @	160.50	22.30	11.941	144	5	0.0000	0.0000	3.1276	0.0055	3.1319	0.0044	0.0000	0.0000	0.0000	0.6164	0.0007	0.0008	0.6160	0.0006	0.0008	138253

[Test Run Date Codes # - 01/07/86 $ - 02/02/87 @ - 02/03/87]

Table 38F. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-6A Diameter 1.5002 Inches, Beta Ratio = 0.72414

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
63 #	85.518	22.39	21.321	77	0	0.0000	0.0000	10.049	0.0055	10.053	0.0053	0.0000	0.0000	0.0000	0.6140	0.0003	0.0005	0.6139	0.0003	0.0005	247385
64 #	85.419	22.40	21.305	77	0	0.0000	0.0000	10.031	0.0098	10.039	0.0092	0.0000	0.0000	0.0000	0.6141	0.0004	0.0005	0.6139	0.0004	0.0005	247260
65 #	85.499	22.41	21.306	77	2	0.0000	0.0000	10.037	0.0046	10.042	0.0066	0.0000	0.0000	0.0000	0.6140	0.0003	0.0005	0.6138	0.0003	0.0005	247331
67 #	53.356	22.45	35.538	48	0	0.0000	0.0000	28.062	0.0051	28.070	0.0075	0.0000	0.0000	0.0000	0.6124	0.0003	0.0004	0.6124	0.0003	0.0004	412923
68 #	53.348	22.47	35.575	48	0	0.0000	0.0000	28.126	0.0077	28.142	0.0085	0.0000	0.0000	0.0000	0.6124	0.0003	0.0004	0.6122	0.0003	0.0004	413553
69 #	53.343	22.55	35.617	48	0	0.0000	0.0000	28.188	0.0053	28.194	0.0106	0.0000	0.0000	0.0000	0.6125	0.0003	0.0004	0.6124	0.0003	0.0004	414827
70 $	90.216	22.75	4.3343	82	0	0.0000	0.0000	0.4032	0.0002	0.4037	0.0001	0.0000	0.0000	0.0000	0.6231	0.0030	0.0041	0.6228	0.0030	0.0041	50719
71 $	90.261	22.74	4.3329	82	0	0.0000	0.0000	0.4030	0.0001	0.4032	0.0002	0.0000	0.0000	0.0000	0.6231	0.0030	0.0041	0.6230	0.0030	0.0041	50691
72 $	90.207	22.73	4.3264	82	0	0.0000	0.0000	0.4017	0.0001	0.4022	0.0001	0.0000	0.0000	0.0000	0.6232	0.0030	0.0041	0.6228	0.0030	0.0041	50603
73 $	300.40	22.74	4.3385	149	13	0.0000	0.0000	0.4020	0.0007	0.4022	0.0006	0.0000	0.0000	0.0000	0.6247	0.0030	0.0041	0.6245	0.0031	0.0041	50757
74 $	300.64	22.74	4.3081	149	0	0.0000	0.0000	0.3987	0.0001	0.3989	0.0001	0.0000	0.0000	0.0000	0.6229	0.0030	0.0041	0.6227	0.0030	0.0041	50401
76 $	300.45	22.74	4.3157	149	0	0.0000	0.0000	0.3999	0.0001	0.4002	0.0001	0.0000	0.0000	0.0000	0.6231	0.0030	0.0041	0.6228	0.0030	0.0041	50490
77 $	279.82	22.78	6.8542	173	0	0.0000	0.0000	1.0203	0.0002	1.0208	0.0001	0.0000	0.0000	0.0000	0.6195	0.0012	0.0018	0.6194	0.0012	0.0018	80264
78 $	279.93	22.78	6.8487	173	0	0.0000	0.0000	1.0183	0.0002	1.0192	0.0002	0.0000	0.0000	0.0000	0.6196	0.0012	0.0018	0.6194	0.0012	0.0018	80199
79 $	281.47	22.78	6.8479	174	0	0.0000	0.0000	1.0179	0.0002	1.0185	0.0002	0.0000	0.0000	0.0000	0.6197	0.0012	0.0018	0.6195	0.0012	0.0018	80190
80 $	160.53	22.77	11.844	145	0	0.0000	0.0000	3.0758	0.0005	3.0783	0.0007	0.0000	0.0000	0.0000	0.6165	0.0004	0.0008	0.6163	0.0004	0.0008	138658
81 $	160.55	22.79	11.844	145	0	0.0000	0.0000	3.0750	0.0004	3.0794	0.0007	0.0000	0.0000	0.0000	0.6167	0.0004	0.0008	0.6162	0.0004	0.0008	138731
82 $	160.60	22.78	11.844	145	0	0.0000	0.0000	3.0756	0.0006	3.0782	0.0005	0.0000	0.0000	0.0000	0.6166	0.0004	0.0008	0.6163	0.0004	0.0008	138697
83 $	159.46	22.95	11.904	144	1	0.0000	0.0000	3.1074	0.0046	3.1109	0.0051	0.0000	0.0000	0.0000	0.6165	0.0006	0.0008	0.6162	0.0007	0.0008	139951
84 $	159.76	22.98	11.896	144	2	0.0000	0.0000	3.1037	0.0070	3.1081	0.0040	0.0000	0.0000	0.0000	0.6165	0.0008	0.0008	0.6160	0.0006	0.0008	139957
85 $	159.50	23.01	11.882	144	0	0.0000	0.0000	3.0970	0.0079	3.0992	0.0080	0.0000	0.0000	0.0000	0.6164	0.0009	0.0008	0.6162	0.0009	0.0008	139892
86 $	86.174	23.16	21.255	78	0	0.0000	0.0000	9.993	0.0095	9.997	0.0086	0.0000	0.0000	0.0000	0.6139	0.0004	0.0005	0.6137	0.0004	0.0005	251130
87 $	85.100	23.17	21.247	77	1	0.0000	0.0000	9.984	0.0054	9.988	0.0077	0.0000	0.0000	0.0000	0.6139	0.0003	0.0005	0.6138	0.0003	0.0005	251089
88 $	84.987	23.19	21.262	77	0	0.0000	0.0000	9.998	0.0091	10.006	0.0096	0.0000	0.0000	0.0000	0.6139	0.0004	0.0005	0.6137	0.0004	0.0005	251390
89 $	53.216	23.20	35.462	48	0	0.0000	0.0000	27.959	0.0052	27.969	0.0067	0.0000	0.0000	0.0000	0.6123	0.0003	0.0004	0.6122	0.0003	0.0004	419384
90 $	53.251	23.20	35.460	48	0	0.0000	0.0000	27.948	0.0125	27.970	0.0122	0.0000	0.0000	0.0000	0.6124	0.0003	0.0004	0.6122	0.0003	0.0004	419356
91 $	53.298	23.22	35.467	48	0	0.0000	0.0000	27.965	0.0070	27.977	0.0093	0.0000	0.0000	0.0000	0.6123	0.0003	0.0004	0.6122	0.0003	0.0004	419640

[Test Run Date Codes # - 02/03/87 $ - 02/04/87]

Table 38G. Orifice Discharge Coefficient Values - Meter Tube PE-1

Meter Tube PE-1ABC Diameter 2.0717 Inches -- Orifice Plate FE-1/2-7A Diameter 0.2498 Inches, Beta Ratio = 0.12058

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	1206.1	30.88	0.1012	136	4	0.3956	0.0005	0.3953	0.0004	0.3956	0.0003	0.6230	0.0027	0.0048	0.6232	0.0029	0.0049	0.6230	0.0028	0.0049	1419
32	#	1206.0	30.78	0.1009	136	0	0.3923	0.0003	0.3919	0.0003	0.3924	0.0003	0.6235	0.0027	0.0049	0.6238	0.0029	0.0049	0.6234	0.0028	0.0049	1412
33	#	1206.1	30.78	0.1009	136	0	0.3920	0.0003	0.3916	0.0002	0.3922	0.0002	0.6237	0.0028	0.0049	0.6240	0.0029	0.0049	0.6235	0.0028	0.0049	1412
34	#	300.46	32.25	0.8357	149	0	27.791	0.0150	27.788	0.0156	27.789	0.0159	0.6136	0.0002	0.0011	0.6136	0.0002	0.0011	0.6136	0.0002	0.0011	12059
35	#	300.29	32.28	0.8247	149	0	27.054	0.0084	27.049	0.0081	27.049	0.0082	0.6137	0.0001	0.0011	0.6138	0.0001	0.0011	0.6138	0.0001	0.0011	11908
36	#	300.06	32.29	0.8248	149	1	27.051	0.0076	27.046	0.0088	27.045	0.0089	0.6139	0.0001	0.0011	0.6139	0.0001	0.0011	0.6139	0.0001	0.0011	11912
37	#	750.47	31.26	0.2755	143	0	2.9849	0.0005	2.9838	0.0005	2.9850	0.0004	0.6173	0.0004	0.0016	0.6174	0.0004	0.0016	0.6173	0.0004	0.0016	3894
38	#	752.18	31.20	0.2767	143	0	2.9901	0.0011	2.9888	0.0012	2.9900	0.0010	0.6194	0.0004	0.0016	0.6195	0.0004	0.0016	0.6194	0.0004	0.0016	3906
39	#	750.65	31.20	0.2763	143	0	3.0019	0.0006	2.9994	0.0006	3.0006	0.0004	0.6172	0.0004	0.0015	0.6174	0.0004	0.0015	0.6173	0.0004	0.0015	3901
40	#	426.36	31.33	0.5028	151	0	10.015	0.0044	10.015	0.0049	10.015	0.0048	0.6149	0.0002	0.0012	0.6150	0.0002	0.0012	0.6150	0.0002	0.0012	7118
41	#	426.10	31.34	0.5007	151	1	9.942	0.0017	9.941	0.0019	9.940	0.0017	0.6146	0.0002	0.0012	0.6146	0.0002	0.0012	0.6146	0.0002	0.0012	7090
42	#	426.29	31.34	0.5031	151	0	10.031	0.0115	10.029	0.0116	10.028	0.0129	0.6149	0.0004	0.0012	0.6149	0.0004	0.0012	0.6149	0.0004	0.0012	7124
43	#	1206.1	31.09	0.1613	136	0	1.0125	0.0003	1.0117	0.0003	1.0119	0.0002	0.6206	0.0011	0.0025	0.6209	0.0011	0.0025	0.6208	0.0011	0.0025	2272
44	#	1206.3	31.06	0.1613	136	0	1.0133	0.0004	1.0116	0.0003	1.0120	0.0003	0.6204	0.0011	0.0025	0.6209	0.0011	0.0025	0.6207	0.0011	0.0025	2271
45	#	1206.3	31.08	0.1613	136	0	1.0116	0.0003	1.0096	0.0002	1.0107	0.0002	0.6209	0.0011	0.0025	0.6215	0.0011	0.0025	0.6212	0.0011	0.0025	2272
46	$	426.35	30.99	0.5042	151	3	10.073	0.0012	10.074	0.0013	10.074	0.0012	0.6148	0.0001	0.0012	0.6148	0.0001	0.0012	0.6148	0.0001	0.0012	7087
47	$	426.19	31.04	0.5045	151	3	10.083	0.0023	10.081	0.0019	10.082	0.0019	0.6149	0.0002	0.0012	0.6149	0.0002	0.0012	0.6149	0.0002	0.0012	7099
48	$	426.68	31.00	0.5036	151	5	10.047	0.0017	10.046	0.0016	10.047	0.0017	0.6150	0.0002	0.0012	0.6150	0.0002	0.0012	0.6150	0.0002	0.0012	7080
49	$	750.44	30.87	0.2769	143	0	3.0154	0.0006	3.0148	0.0006	3.0138	0.0004	0.6172	0.0004	0.0015	0.6173	0.0003	0.0015	0.6174	0.0004	0.0015	3882
50	$	752.18	30.90	0.2771	143	0	3.0181	0.0008	3.0180	0.0005	3.0168	0.0005	0.6174	0.0004	0.0015	0.6174	0.0003	0.0015	0.6175	0.0004	0.0015	3888
51	$	750.99	30.88	0.2773	143	0	3.0218	0.0006	3.0214	0.0006	3.0203	0.0006	0.6174	0.0004	0.0015	0.6174	0.0003	0.0015	0.6175	0.0004	0.0015	3889
52	$	1206.1	30.77	0.1610	136	0	1.0080	0.0002	1.0083	0.0002	1.0071	0.0002	0.6209	0.0010	0.0025	0.6208	0.0010	0.0025	0.6212	0.0010	0.0025	2253
53	$	1206.5	30.75	0.1610	136	0	1.0075	0.0002	1.0078	0.0001	1.0067	0.0001	0.6208	0.0010	0.0025	0.6207	0.0010	0.0025	0.6211	0.0010	0.0025	2252
54	$	1206.0	30.77	0.1611	136	0	1.0085	0.0005	1.0082	0.0003	1.0074	0.0002	0.6209	0.0010	0.0025	0.6210	0.0010	0.0025	0.6212	0.0010	0.0025	2254
55	$	300.05	31.94	0.8337	149	0	27.635	0.0195	27.636	0.0169	27.638	0.0177	0.6139	0.0002	0.0011	0.6138	0.0002	0.0011	0.6138	0.0002	0.0011	11953
56	$	300.07	31.95	0.8377	149	0	27.895	0.0233	27.891	0.0230	27.889	0.0234	0.6139	0.0003	0.0011	0.6140	0.0003	0.0011	0.6140	0.0003	0.0011	12013
57	$	300.00	31.95	0.8375	149	1	27.885	0.0059	27.879	0.0049	27.877	0.0059	0.6139	0.0001	0.0011	0.6140	0.0001	0.0011	0.6140	0.0001	0.0011	12010
58	$	1206.1	30.85	0.1018	136	2	0.4009	0.0005	0.4025	0.0005	0.4003	0.0005	0.6224	0.0025	0.0048	0.6212	0.0024	0.0048	0.6229	0.0025	0.0048	1427
59	$	1206.1	30.67	0.1015	136	1	0.3992	0.0003	0.3994	0.0002	0.3976	0.0002	0.6222	0.0025	0.0048	0.6219	0.0024	0.0048	0.6234	0.0025	0.0048	1417
60	$	1206.0	30.64	0.1031	136	0	0.4108	0.0003	0.4108	0.0002	0.4092	0.0002	0.6227	0.0024	0.0047	0.6226	0.0024	0.0047	0.6239	0.0024	0.0047	1439

[Test Run Date Codes # - 09/03/85 $ - 09/04/85]

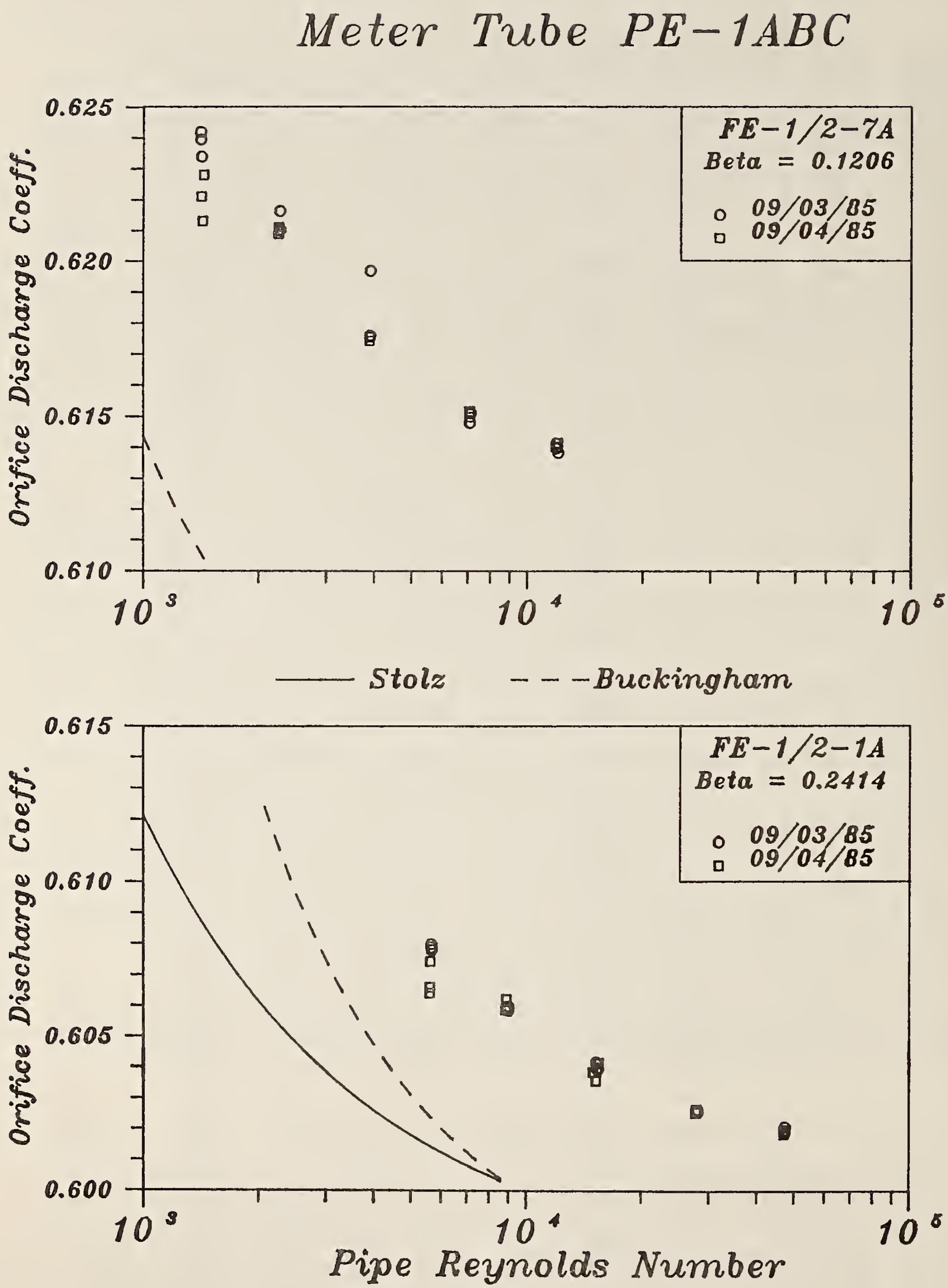


Figure 25A. Discharge Coefficient/Reynolds Number Plots, PE-1ABC 2-Inch Meter Tube, 7 Orifice Plates, Final Data Base

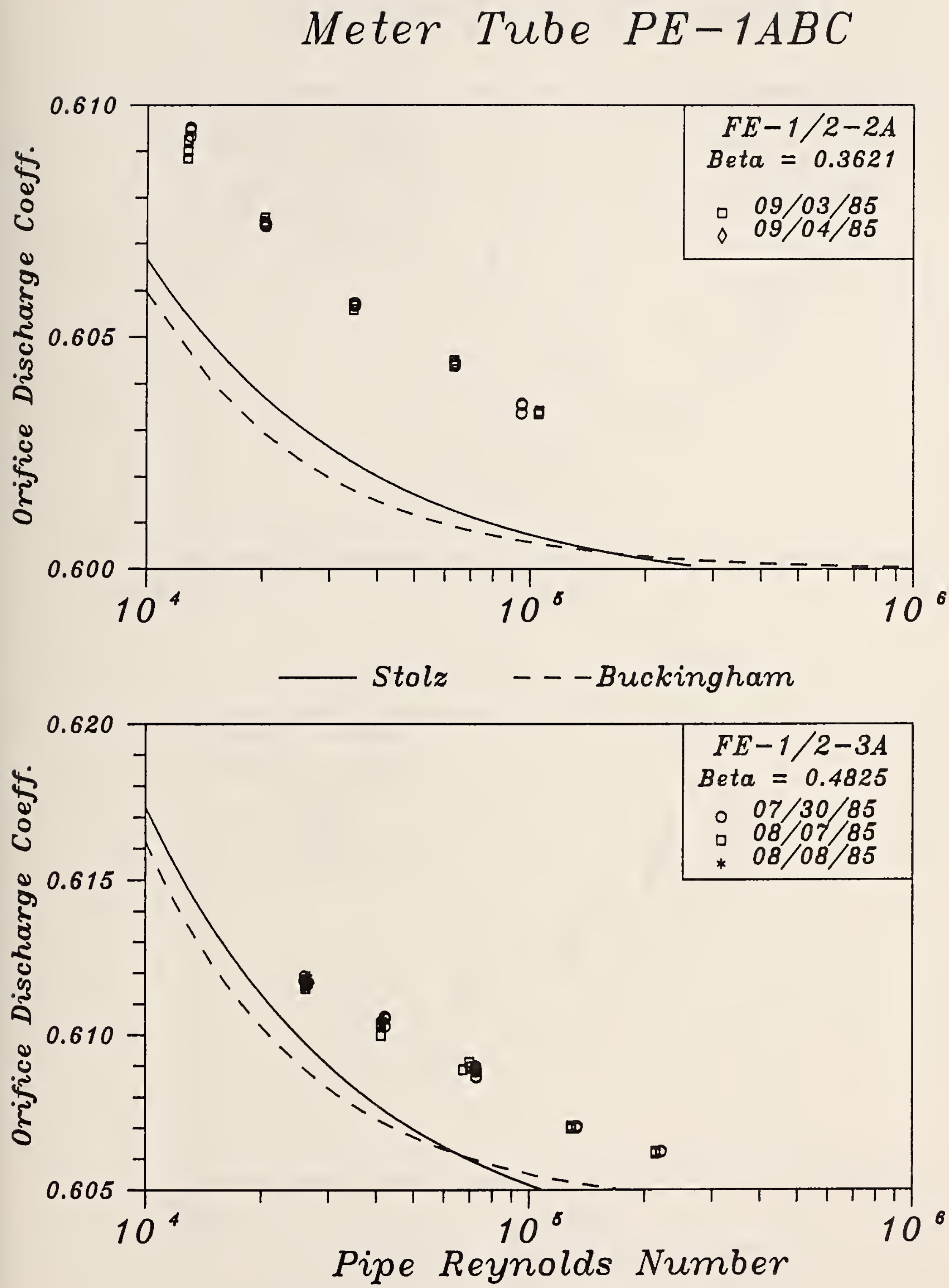


Figure 25B. Discharge Coefficient/Reynolds Number Plots, PE-1ABC 2-Inch Meter Tube, 7 Orifice Plates, Final Data Base

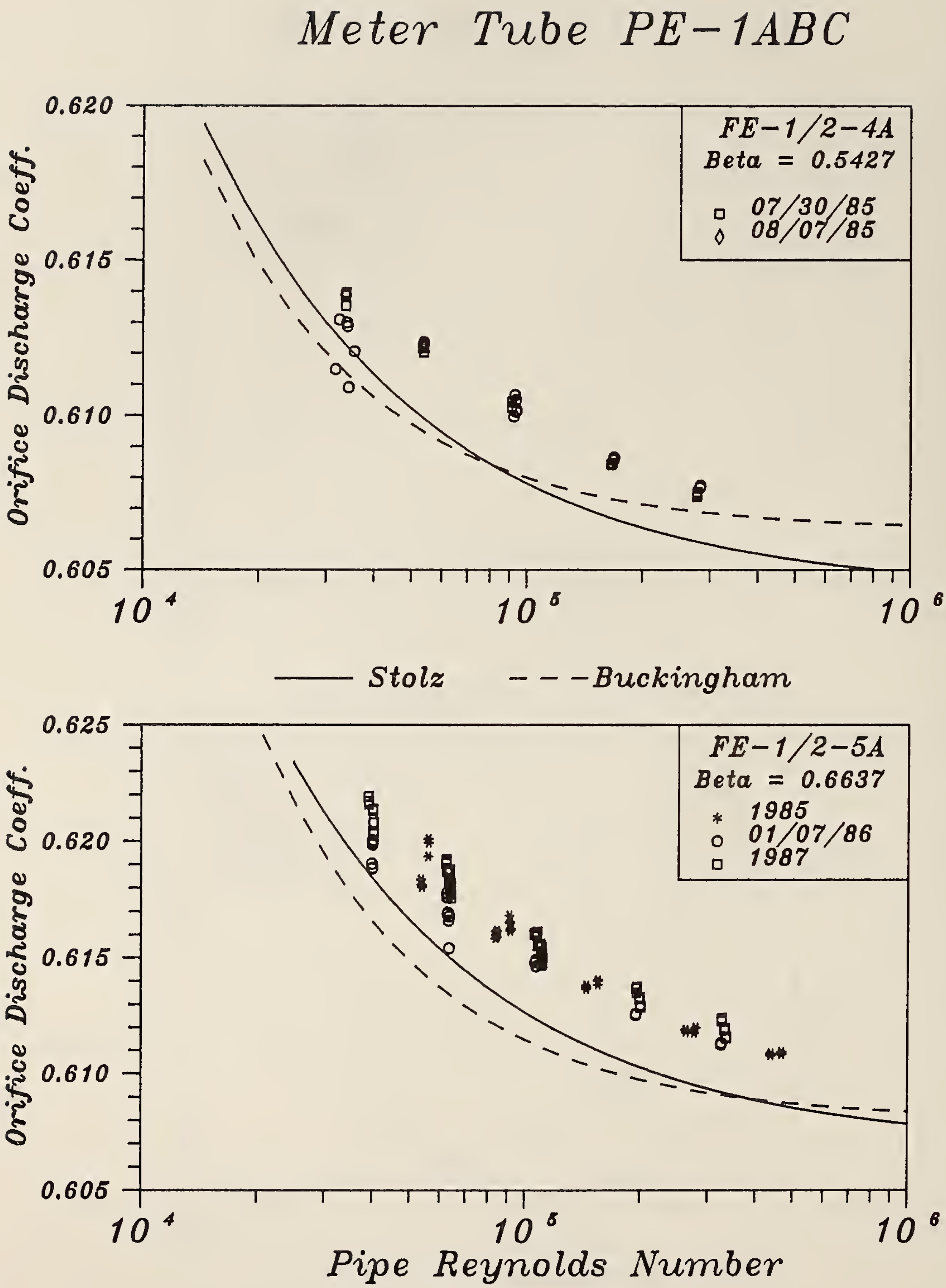


Figure 25C. Discharge Coefficient/Reynolds Number Plots, PE-1ABC 2-Inch Meter Tube, 7 Orifice Plates, Final Data Base

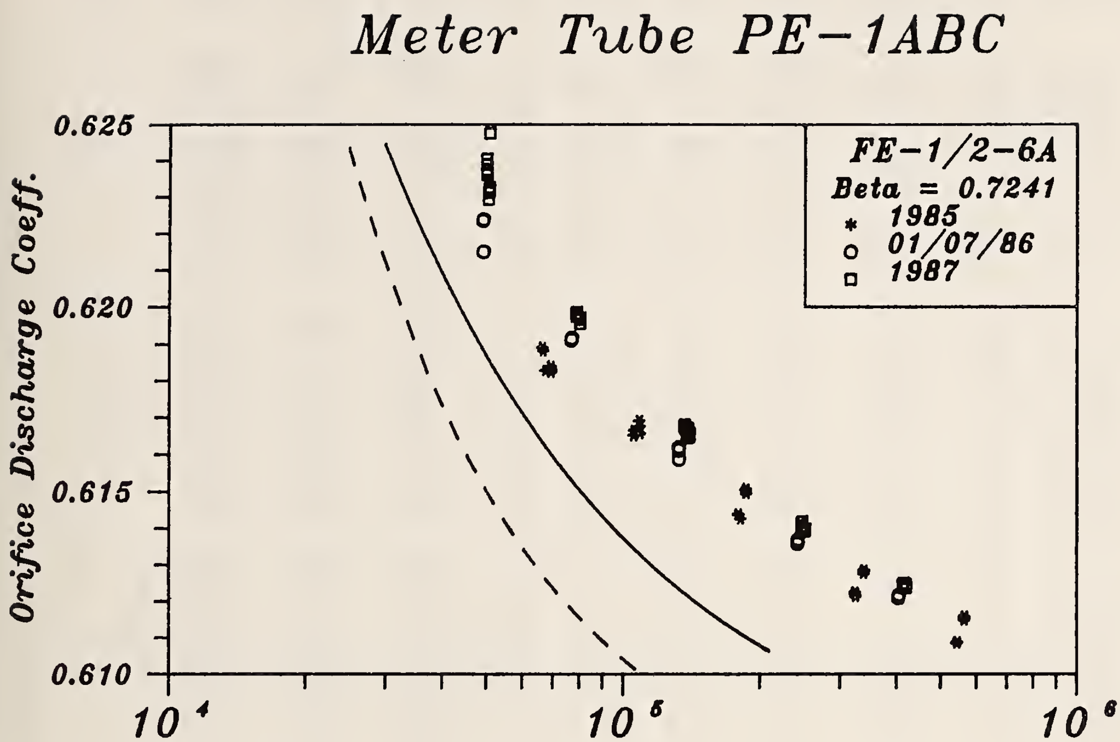


Figure 25D. Discharge Coefficient/Reynolds Number Plots, PE-1ABC 2-Inch Meter Tube, 7 Orifice Plates, Final Data Base

Table 39A. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-1B Diameter 0.5004 Inches, Beta Ratio = 0.24180

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
32 #	511.23	31.83	0.4012	141	1	0.4070	0.0002	0.4060	0.0001	0.4070	0.0001	0.6056	0.0372	0.0041	0.6063	0.0032	0.0041	0.6056	0.0028	0.0041	5745
33 #	511.05	31.82	0.4002	141	0	0.4048	0.0001	0.4037	0.0002	0.4046	0.0002	0.6058	0.0375	0.0041	0.6066	0.0032	0.0042	0.6059	0.0028	0.0042	5730
34 #	511.44	31.83	0.3994	141	0	0.4030	0.0001	0.4018	0.0001	0.4029	0.0001	0.6059	0.0376	0.0042	0.6068	0.0032	0.0042	0.6060	0.0028	0.0042	5720
35 #	501.09	31.86	0.6316	152	0	1.0139	0.0003	1.0125	0.0004	1.0135	0.0003	0.6041	0.0149	0.0020	0.6045	0.0013	0.0020	0.6042	0.0011	0.0020	9050
36 #	500.73	31.87	0.6312	149	0	1.0129	0.0003	1.0111	0.0003	1.0122	0.0002	0.6040	0.0149	0.0020	0.6045	0.0013	0.0020	0.6042	0.0011	0.0020	9046
37 #	501.25	31.86	0.6308	149	1	1.0116	0.0003	1.0102	0.0003	1.0111	0.0003	0.6040	0.0149	0.0020	0.6044	0.0013	0.0020	0.6041	0.0011	0.0020	9039
38 #	351.21	31.93	1.0939	148	4	3.0635	0.0008	3.0610	0.0009	3.0615	0.0009	0.6019	0.0049	0.0010	0.6021	0.0004	0.0010	0.6021	0.0004	0.0010	15697
39 #	352.26	31.94	1.0892	150	1	3.0356	0.0008	3.0329	0.0009	3.0337	0.0009	0.6020	0.0050	0.0010	0.6023	0.0004	0.0010	0.6022	0.0004	0.0010	15633
40 #	350.84	31.91	1.0897	151	0	3.0390	0.0004	3.0367	0.0004	3.0377	0.0005	0.6020	0.0050	0.0010	0.6022	0.0004	0.0010	0.6021	0.0004	0.0010	15631
41 #	500.68	31.78	0.6332	148	1	1.0203	0.0006	1.0214	0.0003	1.0207	0.0002	0.6037	0.0148	0.0020	0.6034	0.0013	0.0020	0.6036	0.0011	0.0020	9058
42 #	499.82	31.77	0.6328	148	4	1.0180	0.0009	1.0190	0.0003	1.0183	0.0003	0.6040	0.0149	0.0020	0.6037	0.0013	0.0020	0.6039	0.0011	0.0020	9051
43 #	501.05	31.77	0.6326	151	6	1.0089	0.0014	1.0181	0.0003	1.0173	0.0003	0.6065	0.0151	0.0020	0.6038	0.0013	0.0020	0.6040	0.0011	0.0020	9048
44 #	511.15	31.65	0.3989	141	0	0.3766	0.0001	0.4031	0.0001	0.4020	0.0001	0.6260	0.0416	0.0046	0.6051	0.0032	0.0042	0.6059	0.0028	0.0042	5691
45 #	511.10	31.66	0.3989	141	10	0.3763	0.0001	0.4033	0.0001	0.4022	0.0001	0.6262	0.0417	0.0046	0.6049	0.0032	0.0042	0.6057	0.0028	0.0042	5692
46 #	511.38	31.65	0.3988	141	1	0.3760	0.0001	0.4031	0.0001	0.4020	0.0001	0.6264	0.0417	0.0046	0.6050	0.0032	0.0042	0.6058	0.0028	0.0042	5690
47 #	351.57	31.78	1.0744	149	19	2.9427	0.0019	2.9686	0.0018	2.9678	0.0023	0.6032	0.0051	0.0010	0.6005	0.0005	0.0010	0.6006	0.0005	0.0010	15370
48 #	351.77	31.78	1.0827	148	0	2.9754	0.0008	3.0014	0.0008	3.0002	0.0008	0.6045	0.0051	0.0010	0.6018	0.0004	0.0010	0.6020	0.0004	0.0010	15488
49 #	349.44	31.78	1.0799	156	1	2.9590	0.0004	2.9852	0.0004	2.9842	0.0005	0.6046	0.0051	0.0010	0.6019	0.0004	0.0010	0.6020	0.0004	0.0010	15448
50 #	173.49	31.87	1.9696	200	0	9.957	0.0013	9.984	0.0015	9.980	0.0016	0.6011	0.0015	0.0007	0.6003	0.0002	0.0007	0.6004	0.0002	0.0007	28229
51 #	184.54	31.85	1.9683	200	4	9.943	0.0013	9.970	0.0015	9.966	0.0011	0.6011	0.0015	0.0007	0.6003	0.0002	0.0007	0.6004	0.0002	0.0007	28198
52 #	184.02	31.85	1.9648	200	0	9.908	0.0009	9.935	0.0010	9.930	0.0010	0.6011	0.0015	0.0007	0.6003	0.0002	0.0007	0.6004	0.0002	0.0007	28148
53 #	113.28	32.52	3.2495	200	2	27.203	0.0051	27.225	0.0049	27.221	0.0042	0.6000	0.0006	0.0006	0.5998	0.0002	0.0006	0.5998	0.0002	0.0006	47203
54 #	114.77	32.47	3.2493	200	3	27.207	0.0041	27.224	0.0045	27.216	0.0033	0.5999	0.0006	0.0006	0.5998	0.0002	0.0006	0.5998	0.0002	0.0006	47152
55 #	114.47	32.47	3.2570	192	0	27.341	0.0042	27.360	0.0049	27.350	0.0037	0.5999	0.0006	0.0006	0.5997	0.0002	0.0006	0.5998	0.0002	0.0006	47263
56 $	110.07	33.38	3.2752	195	2	27.683	0.0095	27.679	0.0107	27.669	0.0090	0.5996	0.0002	0.0006	0.5996	0.0002	0.0006	0.5997	0.0002	0.0006	48423
57 $	110.04	33.39	3.2687	195	2	27.583	0.0064	27.580	0.0072	27.568	0.0058	0.5995	0.0002	0.0006	0.5995	0.0002	0.0006	0.5996	0.0002	0.0006	48337
58 $	110.39	33.38	3.2651	191	10	27.510	0.0044	27.503	0.0045	27.490	0.0052	0.5996	0.0002	0.0006	0.5997	0.0002	0.0006	0.5998	0.0002	0.0006	48273
59 $	559.98	32.61	0.6228	139	0	0.9899	0.0002	0.9908	0.0002	0.9892	0.0002	0.6029	0.0020	0.0020	0.6026	0.0013	0.0020	0.6031	0.0012	0.0020	9064
60 $	564.08	32.60	0.6221	140	0	0.9834	0.0004	0.9849	0.0003	0.9836	0.0004	0.6042	0.0021	0.0020	0.6038	0.0013	0.0020	0.6041	0.0012	0.0020	9052
61 $	560.10	32.57	0.6194	139	1	0.9753	0.0002	0.9765	0.0002	0.9752	0.0002	0.6041	0.0021	0.0020	0.6037	0.0013	0.0020	0.6041	0.0012	0.0020	9007

[Test Run Date Codes # - 08/27/85 $ - 08/28/85]

Table 39A. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-1B Diameter 0.5004 Inches, Beta Ratio = 0.24180

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
62	#	189.54	32.71	1.9649	191	1	9.944	0.0021	9.945	0.0017	9.940	0.0021	0.6001	0.0002	0.0007	0.6001	0.0002	0.0007	0.6002	0.0002	0.0007	28655
63	#	189.99	32.71	1.9594	196	3	9.885	0.0016	9.886	0.0014	9.882	0.0014	0.6002	0.0002	0.0007	0.6002	0.0002	0.0007	0.6003	0.0002	0.0007	28574
64	#	189.72	32.70	1.9641	197	1	9.932	0.0015	9.933	0.0018	9.927	0.0013	0.6002	0.0002	0.0007	0.6002	0.0002	0.0007	0.6004	0.0002	0.0007	28637
65	#	349.61	32.63	1.0858	148	0	3.0204	0.0006	3.0215	0.0006	3.0197	0.0006	0.6017	0.0007	0.0010	0.6016	0.0004	0.0010	0.6018	0.0004	0.0010	15808
66	#	350.75	32.63	1.0849	149	0	3.0151	0.0013	3.0164	0.0014	3.0147	0.0018	0.6017	0.0007	0.0010	0.6016	0.0005	0.0010	0.6018	0.0004	0.0010	15795
67	#	350.65	32.62	1.0836	151	2	3.0082	0.0003	3.0090	0.0003	3.0071	0.0003	0.6017	0.0007	0.0010	0.6016	0.0004	0.0010	0.6018	0.0004	0.0010	15773
68	#	559.98	32.48	0.3979	139	0	0.3976	0.0005	0.3996	0.0004	0.3978	0.0004	0.6077	0.0051	0.0042	0.6062	0.0032	0.0042	0.6075	0.0029	0.0042	5775
69	#	559.85	32.45	0.3941	139	2	0.3940	0.0001	0.3959	0.0001	0.3942	0.0001	0.6047	0.0051	0.0042	0.6033	0.0032	0.0042	0.6046	0.0029	0.0042	5717
70	#	560.16	32.42	0.3982	139	4	0.4019	0.0001	0.4036	0.0001	0.4021	0.0001	0.6050	0.0050	0.0042	0.6037	0.0031	0.0041	0.6049	0.0028	0.0041	5772

[Test Run Date Codes # - 08/28/85]

Table 39B. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-2B Diameter 0.7502 Inches, Beta Ratio = 0.36250

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
43 #	85.004	31.81	4.4925	146	0	10.032	0.0012	10.029	0.0013	10.024	0.0015	0.6035	0.0015	0.0005	0.6035	0.0002	0.0005	0.6037	0.0002	0.0005	64307
44 #	84.410	31.80	4.4907	150	0	10.023	0.0014	10.020	0.0013	10.013	0.0018	0.6035	0.0015	0.0005	0.6036	0.0002	0.0005	0.6038	0.0002	0.0005	64268
45 #	85.524	31.81	4.4880	152	0	10.009	0.0016	10.007	0.0018	10.003	0.0015	0.6035	0.0015	0.0005	0.6036	0.0002	0.0005	0.6037	0.0002	0.0005	64242
46 #	249.70	31.76	1.4284	155	0	1.0223	0.0007	1.0052	0.0004	1.0050	0.0005	0.6011	0.0147	0.0018	0.6062	0.0013	0.0018	0.6062	0.0011	0.0018	20425
47 #	249.87	31.77	1.4258	155	0	1.0204	0.0006	1.0010	0.0003	1.0010	0.0003	0.6006	0.0147	0.0018	0.6063	0.0013	0.0019	0.6063	0.0011	0.0019	20392
48 #	249.61	31.77	1.4264	155	0	1.0220	0.0006	1.0020	0.0003	1.0021	0.0003	0.6003	0.0147	0.0018	0.6063	0.0013	0.0018	0.6062	0.0011	0.0018	20401
49 #	144.94	31.78	2.4722	180	0	3.0439	0.0010	3.0236	0.0010	3.0238	0.0008	0.6029	0.0050	0.0009	0.6049	0.0005	0.0009	0.6049	0.0004	0.0009	35366
50 #	145.10	31.75	2.4387	180	25	2.9588	0.0008	2.9307	0.0008	2.9311	0.0008	0.6032	0.0051	0.0009	0.6061	0.0005	0.0009	0.6060	0.0004	0.0009	34865
51 #	145.57	31.76	2.4566	181	0	3.0040	0.0005	2.9843	0.0008	2.9841	0.0008	0.6030	0.0050	0.0009	0.6050	0.0005	0.0009	0.6050	0.0004	0.0009	35128
52 #	270.80	31.69	0.9058	168	0	0.4188	0.0003	0.4010	0.0002	0.4019	0.0002	0.5955	0.0356	0.0038	0.6086	0.0032	0.0040	0.6079	0.0028	0.0040	12934
53 #	269.54	31.68	0.9039	167	0	0.4180	0.0005	0.3994	0.0004	0.4003	0.0004	0.5948	0.0356	0.0038	0.6085	0.0032	0.0041	0.6078	0.0029	0.0041	12904
54 #	271.06	31.65	0.9002	168	0	0.4146	0.0004	0.3960	0.0002	0.3969	0.0002	0.5948	0.0359	0.0038	0.6086	0.0033	0.0041	0.6079	0.0029	0.0041	12843
55 #	400.85	31.78	4.4839	152	0	10.013	0.0023	9.996	0.0021	9.990	0.0022	0.6029	0.0015	0.0005	0.6034	0.0002	0.0005	0.6036	0.0002	0.0005	64144
56 #	400.95	31.81	4.4802	147	1	9.998	0.0012	9.980	0.0011	9.973	0.0014	0.6028	0.0015	0.0005	0.6034	0.0002	0.0005	0.6036	0.0001	0.0005	64131
57 #	401.83	31.82	4.4745	147	1	9.972	0.0026	9.955	0.0011	9.951	0.0007	0.6028	0.0015	0.0005	0.6034	0.0002	0.0005	0.6035	0.0001	0.0005	64063
58 #	251.36	32.01	6.7284	156	0	22.581	0.0031	22.560	0.0022	22.551	0.0023	0.6024	0.0007	0.0005	0.6027	0.0001	0.0005	0.6028	0.0001	0.0005	96713
59 #	249.72	32.02	6.7388	155	0	22.656	0.0035	22.629	0.0022	22.615	0.0023	0.6024	0.0007	0.0005	0.6027	0.0001	0.0005	0.6029	0.0001	0.0005	96883
60 #	249.94	32.01	6.7497	155	0	22.730	0.0031	22.704	0.0023	22.691	0.0016	0.6023	0.0007	0.0005	0.6027	0.0001	0.0005	0.6029	0.0001	0.0005	97019
61 $	250.93	32.58	1.4280	156	1	1.0063	0.0002	1.0051	0.0002	1.0059	0.0002	0.6057	0.0020	0.0018	0.6061	0.0013	0.0018	0.6058	0.0011	0.0018	20769
62 $	249.73	32.59	1.4228	155	0	0.9990	0.0003	0.9976	0.0003	0.9984	0.0003	0.6057	0.0020	0.0019	0.6061	0.0013	0.0019	0.6059	0.0012	0.0019	20698
63 $	249.81	32.58	1.4389	155	7	1.0374	0.0032	1.0220	0.0002	1.0225	0.0002	0.6011	0.0021	0.0018	0.6056	0.0012	0.0018	0.6055	0.0011	0.0018	20928
64 $	85.404	32.69	4.4884	151	0	10.046	0.0020	10.022	0.0015	10.017	0.0015	0.6026	0.0003	0.0005	0.6033	0.0002	0.0005	0.6034	0.0002	0.0005	65428
65 $	84.998	32.69	4.4864	151	0	10.037	0.0015	10.015	0.0025	10.010	0.0020	0.6026	0.0003	0.0005	0.6032	0.0002	0.0005	0.6034	0.0002	0.0005	65399
66 $	84.949	32.68	4.4842	151	0	10.036	0.0013	10.005	0.0012	9.998	0.0018	0.6023	0.0003	0.0005	0.6032	0.0002	0.0005	0.6034	0.0002	0.0005	65354
67 $	270.80	32.54	0.9077	168	0	0.4311	0.0004	0.4043	0.0001	0.4042	0.0001	0.5882	0.0046	0.0037	0.6074	0.0031	0.0040	0.6075	0.0028	0.0040	13191
68 $	271.09	32.53	0.9094	168	0	0.4346	0.0002	0.4053	0.0001	0.4053	0.0001	0.5870	0.0045	0.0036	0.6078	0.0031	0.0040	0.6078	0.0028	0.0040	13213
69 $	269.46	32.52	0.9088	167	0	0.4310	0.0003	0.4054	0.0002	0.4053	0.0002	0.5890	0.0046	0.0037	0.6074	0.0031	0.0040	0.6074	0.0028	0.0040	13201
70 $	144.95	32.59	2.4706	180	0	3.0543	0.0008	3.0248	0.0006	3.0239	0.0006	0.6015	0.0007	0.0009	0.6044	0.0004	0.0009	0.6045	0.0004	0.0009	35940
71 $	144.96	32.57	2.4675	180	0	3.0493	0.0007	3.0183	0.0005	3.0170	0.0005	0.6013	0.0007	0.0009	0.6043	0.0004	0.0009	0.6045	0.0004	0.0009	35881
72 $	144.27	32.58	2.4668	179	0	3.0468	0.0007	3.0159	0.0007	3.0146	0.0005	0.6013	0.0007	0.0009	0.6044	0.0004	0.0009	0.6045	0.0004	0.0009	35878

[Test Run Date Codes # - 08/27/85 $ - 08/28/85]

Table 39B. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-2B Diameter 0.7502 Inches, Beta Ratio = 0.36250

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
73 #	249.75	32.88	6.7832	155	1	22.976	0.0032	22.965	0.0021	22.953	0.0019	0.6022	0.0001	0.0005	0.6023	0.0001	0.0005	0.6025	0.0001	0.0005	99267
74 #	249.79	32.86	6.7840	155	0	22.980	0.0029	22.973	0.0029	22.956	0.0024	0.6022	0.0001	0.0005	0.6023	0.0001	0.0005	0.6025	0.0001	0.0005	99238
75 #	251.43	32.87	6.7879	156	0	23.001	0.0018	22.993	0.0016	22.981	0.0023	0.6022	0.0001	0.0005	0.6023	0.0001	0.0005	0.6025	0.0001	0.0005	99315

[Test Run Date Codes # - 08/28/85]

Table 39C. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-3B Diameter 0.9998 Inches, Beta Ratio = 0.48311

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	225.33	33.01	8.2090	186	0	10.130	0.0160	10.131	0.0194	10.116	0.0194	0.6061	0.0005	0.0005	0.6061	0.0006	0.0005	0.6065	0.0006	0.0005	120453
2 #	225.21	33.04	8.1958	186	0	10.098	0.0127	10.098	0.0159	10.082	0.0193	0.6061	0.0004	0.0005	0.6061	0.0005	0.0005	0.6066	0.0006	0.0005	120333
3 #	225.13	33.08	8.2011	186	0	10.107	0.0205	10.111	0.0202	10.095	0.0218	0.6062	0.0006	0.0005	0.6061	0.0006	0.0005	0.6066	0.0007	0.0005	120510
4 #	225.37	33.14	8.1505	186	0	9.990	0.0168	9.987	0.0180	9.970	0.0191	0.6060	0.0005	0.0005	0.6061	0.0006	0.0005	0.6066	0.0006	0.0005	119913
5 #	224.17	33.17	8.1486	185	0	9.976	0.0164	9.979	0.0212	9.966	0.0221	0.6063	0.0005	0.0005	0.6062	0.0007	0.0005	0.6066	0.0007	0.0005	119959
6 #	224.27	33.19	8.1627	185	0	10.013	0.0153	10.014	0.0187	10.002	0.0196	0.6062	0.0005	0.0005	0.6062	0.0006	0.0005	0.6066	0.0006	0.0005	120216
7 #	400.82	33.24	4.4837	152	0	3.0086	0.0077	3.0077	0.0073	3.0043	0.0073	0.6075	0.0008	0.0008	0.6076	0.0008	0.0008	0.6079	0.0008	0.0008	66101
8 #	401.39	33.26	4.5069	152	0	3.0397	0.0051	3.0376	0.0047	3.0335	0.0052	0.6075	0.0006	0.0008	0.6077	0.0006	0.0008	0.6081	0.0006	0.0008	66470
9 #	400.03	33.29	4.5026	151	0	3.0331	0.0063	3.0323	0.0072	3.0282	0.0068	0.6076	0.0007	0.0008	0.6077	0.0008	0.0008	0.6081	0.0008	0.0008	66447
10 #	131.21	33.37	13.620	200	0	27.982	0.0149	27.977	0.0176	27.935	0.0170	0.6051	0.0002	0.0004	0.6052	0.0002	0.0004	0.6056	0.0002	0.0004	201332
11 #	130.89	33.39	13.640	200	0	28.062	0.0226	28.061	0.0263	28.016	0.0241	0.6051	0.0003	0.0004	0.6052	0.0003	0.0004	0.6056	0.0003	0.0004	201709
12 #	132.95	33.42	13.627	200	0	28.000	0.0111	27.996	0.0127	27.961	0.0113	0.6052	0.0002	0.0004	0.6052	0.0002	0.0004	0.6056	0.0002	0.0004	201628
13 #	81.668	33.43	4.5658	126	0	3.1197	0.0072	3.1191	0.0068	3.1138	0.0069	0.6075	0.0008	0.0008	0.6076	0.0008	0.0008	0.6081	0.0008	0.0008	67573
14 #	82.153	33.44	4.4965	127	0	3.0248	0.0092	3.0232	0.0104	3.0202	0.0101	0.6076	0.0010	0.0008	0.6078	0.0011	0.0008	0.6081	0.0011	0.0008	66561
15 #	82.156	33.45	4.4931	127	0	3.0218	0.0073	3.0175	0.0093	3.0142	0.0103	0.6075	0.0008	0.0008	0.6079	0.0010	0.0008	0.6082	0.0011	0.0008	66524
16 #	230.18	33.40	1.6551	190	0	0.4070	0.0009	0.4061	0.0009	0.4061	0.0009	0.6098	0.0025	0.0039	0.6104	0.0027	0.0039	0.6104	0.0024	0.0039	24480
17 #	230.08	33.41	1.6539	190	0	0.4062	0.0011	0.4050	0.0009	0.4053	0.0009	0.6099	0.0026	0.0039	0.6108	0.0027	0.0040	0.6106	0.0024	0.0040	24467
18 #	230.25	33.43	1.6486	190	0	0.4027	0.0006	0.4020	0.0009	0.4026	0.0008	0.6105	0.0025	0.0040	0.6111	0.0027	0.0040	0.6107	0.0024	0.0040	24399
19 #	144.94	33.51	2.6042	180	0	1.0093	0.0024	1.0084	0.0037	1.0084	0.0036	0.6092	0.0012	0.0018	0.6095	0.0015	0.0018	0.6095	0.0014	0.0018	38604
20 #	145.12	33.53	2.6307	180	0	1.0295	0.0025	1.0291	0.0032	1.0283	0.0031	0.6094	0.0012	0.0018	0.6095	0.0014	0.0018	0.6097	0.0013	0.0018	39013
21 #	144.87	33.54	2.6227	180	0	1.0236	0.0024	1.0218	0.0025	1.0219	0.0025	0.6093	0.0012	0.0018	0.6098	0.0013	0.0018	0.6097	0.0012	0.0018	38902
22 $	144.93	37.50	2.6296	180	0	1.0313	0.0031	1.0305	0.0032	1.0299	0.0032	0.6089	0.0014	0.0017	0.6092	0.0016	0.0017	0.6093	0.0015	0.0017	42195
23 $	145.26	37.51	2.6245	180	0	1.0264	0.0023	1.0257	0.0026	1.0252	0.0024	0.6092	0.0012	0.0018	0.6094	0.0015	0.0018	0.6095	0.0013	0.0018	42122
24 $	144.32	37.52	2.6354	179	0	1.0349	0.0020	1.0339	0.0023	1.0334	0.0023	0.6092	0.0012	0.0017	0.6095	0.0015	0.0017	0.6096	0.0013	0.0017	42305
25 $	230.18	37.50	1.6544	190	0	0.4065	0.0010	0.4051	0.0011	0.4059	0.0010	0.6102	0.0027	0.0039	0.6112	0.0034	0.0040	0.6107	0.0030	0.0040	26547
26 $	230.04	37.51	1.6566	190	0	0.4081	0.0009	0.4062	0.0010	0.4068	0.0010	0.6098	0.0027	0.0039	0.6112	0.0034	0.0039	0.6108	0.0029	0.0039	26587
27 $	230.31	37.54	1.6540	190	0	0.4077	0.0012	0.4047	0.0011	0.4054	0.0011	0.6092	0.0027	0.0039	0.6114	0.0035	0.0040	0.6109	0.0030	0.0040	26561
28 $	79.523	37.65	4.4920	122	0	3.0242	0.0094	3.0192	0.0113	3.0154	0.0121	0.6074	0.0010	0.0008	0.6079	0.0012	0.0008	0.6083	0.0013	0.0008	72289
29 $	79.933	37.67	4.4838	123	0	3.0127	0.0083	3.0097	0.0099	3.0044	0.0085	0.6075	0.0009	0.0008	0.6078	0.0011	0.0008	0.6083	0.0010	0.0008	72185
30 $	79.275	37.68	4.5095	122	0	3.0475	0.0076	3.0459	0.0092	3.0416	0.0084	0.6075	0.0009	0.0008	0.6076	0.0010	0.0008	0.6080	0.0010	0.0008	72613

[Test Run Date Codes # - 08/06/85 $ - 08/12/85]

Table 39C. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-3B Diameter 0.9998 Inches, Beta Ratio = 0.48311

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	401.21	37.72	4.5075	152	0	3.0463	0.0065	3.0438	0.0064	3.0396	0.0065	0.6073	0.0007	0.0008	0.6076	0.0008	0.0008	0.6080	0.0008	0.0008	72637
32 #	401.73	37.74	4.5066	152	0	3.0472	0.0057	3.0444	0.0068	3.0393	0.0066	0.6071	0.0007	0.0008	0.6074	0.0008	0.0008	0.6079	0.0008	0.0008	72651
33 #	400.10	37.75	4.5065	152	0	3.0449	0.0049	3.0426	0.0050	3.0371	0.0052	0.6073	0.0006	0.0008	0.6076	0.0007	0.0008	0.6081	0.0007	0.0008	72663
34 #	131.22	37.83	13.623	200	1	28.036	0.0102	28.036	0.0141	27.980	0.0126	0.6050	0.0002	0.0004	0.6051	0.0002	0.0004	0.6057	0.0002	0.0004	220004
35 #	131.90	37.85	13.632	200	0	28.073	0.0115	28.071	0.0146	28.014	0.0165	0.6050	0.0002	0.0004	0.6051	0.0002	0.0004	0.6057	0.0002	0.0004	220233
36 #	130.51	37.87	13.617	200	0	28.014	0.0159	28.006	0.0168	27.949	0.0163	0.6050	0.0002	0.0004	0.6051	0.0002	0.0004	0.6057	0.0002	0.0004	220071
37 #	225.36	37.90	8.1461	186	0	9.998	0.0163	9.997	0.0200	9.975	0.0197	0.6059	0.0005	0.0005	0.6059	0.0006	0.0005	0.6066	0.0006	0.0005	131729
38 #	225.56	37.92	8.1513	186	0	10.014	0.0166	10.010	0.0148	9.990	0.0153	0.6058	0.0005	0.0005	0.6059	0.0005	0.0005	0.6065	0.0005	0.0005	131864
39 #	225.16	37.93	8.1545	186	0	10.024	0.0158	10.019	0.0160	9.997	0.0164	0.6057	0.0005	0.0005	0.6059	0.0005	0.0005	0.6065	0.0005	0.0005	131941
40 $	225.38	31.57	8.1514	186	0	9.978	0.0124	9.981	0.0139	9.965	0.0154	0.6063	0.0004	0.0005	0.6062	0.0005	0.0005	0.6067	0.0005	0.0005	116099
41 $	225.40	31.62	8.1386	186	0	9.949	0.0158	9.951	0.0181	9.937	0.0197	0.6062	0.0005	0.0005	0.6062	0.0006	0.0005	0.6066	0.0006	0.0005	116038
42 $	225.06	31.66	8.1796	186	0	10.050	0.0144	10.051	0.0145	10.035	0.0148	0.6062	0.0005	0.0005	0.6062	0.0005	0.0005	0.6067	0.0005	0.0005	116720
43 $	401.60	31.70	4.4958	156	0	3.0188	0.0053	3.0209	0.0049	3.0179	0.0051	0.6080	0.0009	0.0008	0.6078	0.0007	0.0008	0.6081	0.0006	0.0008	64207
44 $	402.44	31.73	4.4844	154	0	3.0099	0.0065	3.0036	0.0062	3.0012	0.0061	0.6073	0.0009	0.0008	0.6080	0.0008	0.0008	0.6082	0.0007	0.0008	64084
45 $	400.10	31.76	4.5125	153	0	3.0537	0.0043	3.0426	0.0044	3.0395	0.0047	0.6067	0.0008	0.0008	0.6078	0.0006	0.0008	0.6082	0.0006	0.0008	64526

[Test Run Date Codes # - 08/12/85 $ - 08/28/85]

Table 39D. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-4B Diameter 1.1248 Inches, Beta Ratio = 0.54351

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	161.71	33.58	2.1395	200	0	0.4055	0.0012	0.4047	0.0013	0.4053	0.0013	0.6130	0.0026	0.0039	0.6136	0.0028	0.0040	0.6132	0.0025	0.0040	31761
2 #	161.71	33.60	2.1482	200	0	0.4086	0.0010	0.4083	0.0013	0.4080	0.0011	0.6131	0.0026	0.0039	0.6134	0.0027	0.0039	0.6136	0.0025	0.0039	31903
3 #	162.11	33.62	2.1473	200	0	0.4083	0.0009	0.4077	0.0010	0.4074	0.0010	0.6131	0.0025	0.0039	0.6136	0.0027	0.0039	0.6138	0.0025	0.0039	31903
4 #	64.320	33.82	5.8376	99	0	3.0486	0.0076	3.0466	0.0101	3.0436	0.0095	0.6100	0.0009	0.0008	0.6102	0.0011	0.0008	0.6105	0.0010	0.0008	87083
5 #	65.114	33.83	5.8212	100	0	3.0294	0.0078	3.0277	0.0099	3.0250	0.0088	0.6102	0.0009	0.0008	0.6104	0.0011	0.0008	0.6106	0.0010	0.0008	86856
6 #	65.046	33.84	5.8409	100	0	3.0543	0.0073	3.0496	0.0111	3.0456	0.0106	0.6098	0.0008	0.0008	0.6102	0.0012	0.0008	0.6106	0.0011	0.0008	87167
7 #	109.82	33.84	3.4024	168	0	1.0310	0.0027	1.0289	0.0031	1.0286	0.0026	0.6114	0.0013	0.0017	0.6120	0.0014	0.0017	0.6121	0.0012	0.0017	50776
8 #	109.96	33.86	3.3964	169	0	1.0263	0.0024	1.0247	0.0033	1.0241	0.0032	0.6117	0.0012	0.0017	0.6122	0.0014	0.0018	0.6123	0.0013	0.0018	50707
9 #	110.48	33.88	3.3957	164	0	1.0261	0.0024	1.0245	0.0028	1.0245	0.0028	0.6116	0.0012	0.0017	0.6121	0.0013	0.0018	0.6121	0.0013	0.0018	50717
10 #	300.10	33.94	5.8471	149	0	3.0623	0.0067	3.0593	0.0059	3.0557	0.0061	0.6096	0.0007	0.0008	0.6099	0.0007	0.0008	0.6103	0.0007	0.0008	87437
11 #	300.13	33.96	5.8352	149	0	3.0495	0.0071	3.0472	0.0078	3.0445	0.0081	0.6097	0.0008	0.0008	0.6099	0.0009	0.0008	0.6102	0.0009	0.0008	87294
12 #	300.31	33.98	5.8270	149	0	3.0409	0.0043	3.0377	0.0056	3.0340	0.0057	0.6097	0.0006	0.0008	0.6100	0.0007	0.0008	0.6104	0.0007	0.0008	87207
13 #	104.55	34.05	17.536	161	0	27.771	0.0106	27.764	0.0123	27.720	0.0101	0.6071	0.0002	0.0004	0.6072	0.0002	0.0004	0.6077	0.0002	0.0004	262812
14 #	104.18	34.06	17.574	160	0	27.882	0.0134	27.879	0.0154	27.839	0.0166	0.6072	0.0002	0.0004	0.6073	0.0002	0.0004	0.6077	0.0002	0.0004	263439
15 #	105.17	34.08	17.575	162	2	27.896	0.0118	27.889	0.0146	27.841	0.0181	0.6071	0.0002	0.0004	0.6072	0.0002	0.0004	0.6077	0.0003	0.0004	263556
16 #	161.75	34.11	10.579	200	0	10.072	0.0164	10.073	0.0171	10.056	0.0155	0.6082	0.0005	0.0005	0.6081	0.0005	0.0005	0.6086	0.0005	0.0005	158737
17 #	161.67	34.13	10.584	200	0	10.082	0.0167	10.080	0.0192	10.064	0.0203	0.6082	0.0005	0.0005	0.6082	0.0006	0.0005	0.6087	0.0006	0.0005	158879
18 #	161.76	34.14	10.575	200	0	10.065	0.0124	10.063	0.0154	10.045	0.0160	0.6082	0.0004	0.0005	0.6082	0.0005	0.0005	0.6088	0.0005	0.0005	158784
19 $	301.31	37.87	5.8270	150	0	3.0434	0.0053	3.0434	0.0078	3.0379	0.0085	0.6098	0.0007	0.0008	0.6097	0.0009	0.0008	0.6103	0.0010	0.0008	94173
20 $	301.13	37.89	5.8111	150	0	3.0311	0.0063	3.0265	0.0071	3.0202	0.0069	0.6093	0.0008	0.0008	0.6098	0.0009	0.0008	0.6104	0.0008	0.0008	93952
21 $	300.15	37.91	5.8195	149	0	3.0328	0.0074	3.0343	0.0066	3.0285	0.0063	0.6100	0.0009	0.0008	0.6099	0.0008	0.0008	0.6105	0.0008	0.0008	94124
22 $	105.44	37.99	17.557	162	0	27.860	0.0152	27.859	0.0153	27.801	0.0129	0.6072	0.0002	0.0004	0.6072	0.0002	0.0004	0.6079	0.0002	0.0004	284411
23 $	104.30	38.00	17.547	160	0	27.823	0.0115	27.822	0.0160	27.758	0.0174	0.6073	0.0002	0.0004	0.6073	0.0002	0.0004	0.6080	0.0003	0.0004	284294
24 $	105.45	38.02	17.532	162	0	27.781	0.0170	27.774	0.0192	27.713	0.0173	0.6072	0.0003	0.0004	0.6073	0.0003	0.0004	0.6080	0.0003	0.0004	284167
25 $	161.74	38.05	10.549	200	0	10.029	0.0342	10.036	0.0387	10.015	0.0401	0.6081	0.0011	0.0005	0.6079	0.0012	0.0005	0.6086	0.0012	0.0005	171078
26 $	161.87	38.07	10.605	200	0	10.134	0.0179	10.131	0.0241	10.106	0.0229	0.6082	0.0006	0.0005	0.6082	0.0007	0.0005	0.6090	0.0007	0.0005	172049
27 $	161.77	38.09	10.605	200	0	10.132	0.0167	10.131	0.0186	10.108	0.0184	0.6082	0.0005	0.0005	0.6083	0.0006	0.0005	0.6089	0.0006	0.0005	172121
28 $	64.330	38.08	5.8450	99	0	3.0637	0.0064	3.0626	0.0076	3.0541	0.0080	0.6096	0.0008	0.0008	0.6097	0.0009	0.0008	0.6106	0.0010	0.0008	94847
29 $	64.445	38.09	5.8157	99	0	3.0319	0.0098	3.0318	0.0117	3.0231	0.0130	0.6097	0.0011	0.0008	0.6098	0.0013	0.0008	0.6106	0.0014	0.0008	94390
30 $	65.085	38.09	5.8456	100	0	3.0624	0.0067	3.0620	0.0089	3.0539	0.0088	0.6098	0.0008	0.0008	0.6099	0.0010	0.0008	0.6107	0.0010	0.0008	94875

[Test Run Date Codes # - 08/06/85 $ - 08/09/85]

Table 39D. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-4B Diameter 1.1248 Inches, Beta Ratio = 0.54351

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	161.73	38.13	2.1436	200	2	0.4070	0.0008	0.4057	0.0012	0.4064	0.0013	0.6134	0.0034	0.0039	0.6144	0.0035	0.0040	0.6139	0.0035	0.0040	34818
32 #	162.74	38.14	2.1506	200	0	0.4102	0.0013	0.4088	0.0013	0.4089	0.0012	0.6131	0.0035	0.0039	0.6141	0.0036	0.0039	0.6140	0.0034	0.0039	34938
33 #	162.21	38.16	2.1514	200	0	0.4103	0.0007	0.4091	0.0009	0.4092	0.0010	0.6132	0.0034	0.0039	0.6141	0.0035	0.0039	0.6140	0.0034	0.0039	34965
34 #	110.00	38.24	3.4010	169	0	1.0305	0.0026	1.0292	0.0033	1.0288	0.0033	0.6117	0.0016	0.0017	0.6120	0.0017	0.0017	0.6122	0.0016	0.0017	55358
35 #	109.92	38.25	3.4046	169	0	1.0333	0.0021	1.0313	0.0020	1.0307	0.0021	0.6115	0.0015	0.0017	0.6120	0.0015	0.0017	0.6122	0.0015	0.0017	55427
36 #	110.55	38.26	3.3911	170	1	1.0245	0.0022	1.0232	0.0031	1.0229	0.0026	0.6117	0.0015	0.0017	0.6120	0.0017	0.0018	0.6121	0.0015	0.0018	55218

[Test Run Date Codes # - 08/09/85]

Table 39E. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-5B Diameter 1.3746 Inches, Beta Ratio = 0.66422

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	69.723	32.35	5.4524	107	0	1.0323	0.0025	1.0334	0.0037	1.0299	0.0032	0.6157	0.0015	0.0018	0.6153	0.0018	0.0017	0.6164	0.0016	0.0017	78926
2	#	69.561	32.36	5.4260	107	0	1.0264	0.0034	1.0230	0.0028	1.0195	0.0030	0.6145	0.0016	0.0018	0.6155	0.0017	0.0018	0.6165	0.0016	0.0018	78560
3	#	69.474	32.37	5.4235	105	0	1.0259	0.0029	1.0227	0.0030	1.0179	0.0027	0.6144	0.0016	0.0018	0.6153	0.0017	0.0018	0.6167	0.0016	0.0018	78540
4	#	110.01	32.36	3.4386	170	0	0.4056	0.0024	0.4084	0.0008	0.4069	0.0008	0.6198	0.0037	0.0040	0.6173	0.0037	0.0039	0.6185	0.0033	0.0039	49785
5	#	109.30	32.38	3.4190	169	0	0.3994	0.0023	0.4041	0.0013	0.4025	0.0012	0.6210	0.0037	0.0041	0.6171	0.0038	0.0040	0.6183	0.0034	0.0040	49522
6	#	110.10	32.41	3.4117	170	0	0.4011	0.0023	0.4015	0.0015	0.4007	0.0013	0.6184	0.0037	0.0040	0.6178	0.0039	0.0040	0.6184	0.0035	0.0040	49447
7	#	300.49	32.48	5.3804	150	0	1.0053	0.0027	1.0059	0.0022	1.0033	0.0020	0.6157	0.0015	0.0018	0.6155	0.0016	0.0018	0.6163	0.0015	0.0018	78093
8	#	299.83	32.50	5.3869	150	0	1.0102	0.0022	1.0085	0.0018	1.0058	0.0022	0.6150	0.0015	0.0018	0.6154	0.0016	0.0018	0.6163	0.0015	0.0018	78219
9	#	300.24	32.51	5.3830	149	0	1.0101	0.0026	1.0074	0.0021	1.0043	0.0021	0.6145	0.0015	0.0018	0.6153	0.0016	0.0018	0.6163	0.0015	0.0018	78179
10	#	109.85	32.56	16.782	164	0	9.927	0.0127	9.924	0.0162	9.898	0.0137	0.6111	0.0004	0.0005	0.6112	0.0005	0.0005	0.6120	0.0005	0.0005	243976
11	#	110.40	32.58	16.870	164	0	10.023	0.0110	10.026	0.0151	9.996	0.0158	0.6114	0.0004	0.0005	0.6113	0.0005	0.0005	0.6122	0.0005	0.0005	245357
12	#	109.92	32.59	16.845	169	0	9.997	0.0140	9.997	0.0157	9.968	0.0160	0.6113	0.0005	0.0005	0.6113	0.0005	0.0005	0.6121	0.0005	0.0005	245054
13	#	189.97	32.62	9.3724	192	0	3.0769	0.0077	3.0770	0.0075	3.0686	0.0084	0.6130	0.0009	0.0008	0.6130	0.0009	0.0008	0.6139	0.0010	0.0008	136427
14	#	187.76	32.63	9.3419	200	0	3.0556	0.0058	3.0552	0.0068	3.0476	0.0069	0.6132	0.0007	0.0008	0.6132	0.0009	0.0008	0.6140	0.0008	0.0008	136011
15	#	190.38	32.65	9.3403	194	0	3.0541	0.0057	3.0552	0.0053	3.0469	0.0059	0.6132	0.0007	0.0008	0.6131	0.0007	0.0008	0.6139	0.0007	0.0008	136044
16	#	64.991	32.73	28.078	100	0	27.869	0.0103	27.872	0.0123	27.789	0.0083	0.6102	0.0003	0.0004	0.6102	0.0003	0.0004	0.6111	0.0003	0.0004	409631
17	#	65.007	32.74	28.079	100	0	27.874	0.0072	27.864	0.0098	27.785	0.0085	0.6102	0.0003	0.0004	0.6103	0.0003	0.0004	0.6112	0.0003	0.0004	409738
18	#	64.276	32.75	28.086	99	0	27.891	0.0111	27.889	0.0115	27.808	0.0068	0.6102	0.0003	0.0004	0.6102	0.0003	0.0004	0.6111	0.0003	0.0004	409925
19	$	110.76	37.52	17.121	169	0	10.346	0.0184	10.347	0.0212	10.308	0.0242	0.6111	0.0006	0.0005	0.6111	0.0007	0.0005	0.6122	0.0007	0.0005	274830
20	$	109.84	37.55	17.314	169	0	10.587	0.0127	10.588	0.0127	10.546	0.0113	0.6110	0.0004	0.0005	0.6109	0.0004	0.0005	0.6121	0.0004	0.0005	278102
21	$	110.49	37.57	17.304	170	0	10.580	0.0130	10.577	0.0136	10.534	0.0140	0.6108	0.0004	0.0005	0.6109	0.0004	0.0005	0.6121	0.0005	0.0005	278038
22	$	65.241	37.62	28.110	100	0	27.990	0.0093	27.990	0.0110	27.879	0.0114	0.6100	0.0003	0.0004	0.6100	0.0003	0.0004	0.6112	0.0003	0.0004	452115
23	$	65.313	37.63	28.129	100	0	28.036	0.0091	28.031	0.0048	27.917	0.0070	0.6099	0.0003	0.0004	0.6100	0.0003	0.0004	0.6112	0.0003	0.0004	452506
24	$	65.307	37.64	28.130	97	0	28.039	0.0132	28.030	0.0115	27.916	0.0131	0.6099	0.0003	0.0004	0.6100	0.0003	0.0004	0.6113	0.0003	0.0004	452607
25	$	335.01	37.63	5.4819	166	0	1.0486	0.0021	1.0490	0.0023	1.0452	0.0023	0.6146	0.0015	0.0017	0.6145	0.0015	0.0017	0.6156	0.0015	0.0017	88186
26	$	335.16	37.64	5.4830	166	0	1.0494	0.0026	1.0491	0.0029	1.0450	0.0028	0.6145	0.0015	0.0017	0.6146	0.0016	0.0017	0.6158	0.0015	0.0017	88221
27	$	336.88	37.65	5.4866	167	0	1.0519	0.0029	1.0504	0.0025	1.0463	0.0024	0.6142	0.0016	0.0017	0.6146	0.0015	0.0017	0.6158	0.0015	0.0017	88296
28	$	195.34	37.70	9.2259	163	0	2.9862	0.0062	2.9872	0.0059	2.9758	0.0061	0.6130	0.0008	0.0008	0.6129	0.0008	0.0008	0.6140	0.0008	0.0008	148616
29	$	195.33	37.72	9.2204	162	0	2.9850	0.0074	2.9842	0.0093	2.9729	0.0090	0.6127	0.0009	0.0008	0.6128	0.0011	0.0008	0.6140	0.0010	0.0008	148584
30	$	195.59	37.73	9.2776	162	0	3.0271	0.0064	3.0221	0.0052	3.0101	0.0052	0.6122	0.0008	0.0008	0.6127	0.0007	0.0008	0.6140	0.0007	0.0008	149535

[Test Run Date Codes # - 08/05/85 $ - 08/09/85]

Table 39E. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-5B Diameter 1.3746 Inches, Beta Ratio = 0.66422

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	69.437	37.76	5.3895	103	0	1.0116	0.0043	1.0117	0.0055	1.0077	0.0048	0.6153	0.0019	0.0018	0.6152	0.0022	0.0018	0.6164	0.0020	0.0018	86918
32	#	70.129	37.78	5.4507	106	0	1.0375	0.0029	1.0358	0.0035	1.0317	0.0029	0.6144	0.0016	0.0017	0.6149	0.0017	0.0017	0.6161	0.0016	0.0017	87938
33	#	70.500	37.79	5.4390	107	0	1.0304	0.0023	1.0307	0.0023	1.0266	0.0023	0.6152	0.0015	0.0018	0.6151	0.0015	0.0018	0.6163	0.0015	0.0018	87767
34	#	109.50	37.77	3.3858	169	0	0.3970	0.0011	0.3966	0.0014	0.3954	0.0012	0.6170	0.0036	0.0041	0.6173	0.0037	0.0041	0.6182	0.0036	0.0041	54614
35	#	110.14	37.78	3.4000	170	0	0.4004	0.0010	0.4001	0.0014	0.3988	0.0013	0.6169	0.0035	0.0040	0.6172	0.0037	0.0040	0.6181	0.0036	0.0040	54854
36	#	110.19	37.79	3.4031	170	0	0.4009	0.0011	0.4005	0.0013	0.3993	0.0014	0.6171	0.0035	0.0040	0.6174	0.0036	0.0040	0.6183	0.0036	0.0040	54914

[Test Run Date Codes # - 08/09/85]

Table 39F. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-6B Diameter 1.5004 Inches, Beta Ratio = 0.72501

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	271.29	31.89	6.9651	168	0	1.0648	0.0028	1.0634	0.0031	1.0588	0.0032	0.6162	0.0015	0.0017	0.6165	0.0017	0.0017	0.6179	0.0016	0.0017	99866
2	#	271.14	31.94	6.9702	168	0	1.0668	0.0026	1.0652	0.0021	1.0601	0.0020	0.6161	0.0014	0.0017	0.6164	0.0015	0.0017	0.6179	0.0014	0.0017	100043
3	#	271.21	31.98	6.9496	168	0	1.0608	0.0025	1.0588	0.0021	1.0543	0.0023	0.6160	0.0014	0.0017	0.6165	0.0015	0.0017	0.6178	0.0014	0.0017	99831
4	#	52.911	32.04	35.411	81	0	28.008	0.0139	28.008	0.0118	27.894	0.0178	0.6108	0.0003	0.0004	0.6107	0.0003	0.0004	0.6120	0.0004	0.0004	509306
5	#	53.471	32.05	35.384	82	0	27.980	0.0070	27.974	0.0046	27.851	0.0063	0.6106	0.0003	0.0004	0.6107	0.0003	0.0004	0.6120	0.0003	0.0004	509022
6	#	52.359	32.06	35.378	80	0	27.957	0.0086	27.949	0.0087	27.836	0.0076	0.6108	0.0003	0.0004	0.6108	0.0003	0.0004	0.6121	0.0003	0.0004	509048
7	#	85.301	32.10	21.225	128	0	10.025	0.0099	10.027	0.0119	9.984	0.0118	0.6119	0.0004	0.0005	0.6118	0.0004	0.0005	0.6131	0.0004	0.0005	305650
8	#	84.700	32.12	21.233	130	0	10.029	0.0088	10.032	0.0102	9.990	0.0106	0.6120	0.0004	0.0005	0.6119	0.0004	0.0005	0.6132	0.0004	0.0005	305902
9	#	85.345	32.14	21.268	129	0	10.058	0.0057	10.063	0.0043	10.022	0.0049	0.6121	0.0003	0.0005	0.6120	0.0003	0.0005	0.6132	0.0003	0.0005	306524
10	#	440.60	32.15	4.3363	156	0	0.4104	0.0018	0.4090	0.0009	0.4071	0.0009	0.6181	0.0034	0.0040	0.6189	0.0037	0.0040	0.6204	0.0033	0.0040	62511
11	#	440.43	32.16	4.3350	156	0	0.4088	0.0020	0.4078	0.0008	0.4064	0.0008	0.6191	0.0035	0.0040	0.6197	0.0037	0.0040	0.6207	0.0033	0.0040	62505
12	#	440.50	32.19	4.3195	156	0	0.4085	0.0012	0.4054	0.0007	0.4036	0.0007	0.6170	0.0033	0.0040	0.6193	0.0037	0.0040	0.6206	0.0033	0.0040	62320
13	#	159.99	32.24	11.621	198	1	2.9804	0.0041	2.9825	0.0048	2.9707	0.0047	0.6145	0.0006	0.0008	0.6142	0.0007	0.0008	0.6155	0.0007	0.0008	167837
14	#	160.48	32.27	11.630	199	0	2.9895	0.0061	2.9869	0.0069	2.9756	0.0070	0.6140	0.0008	0.0008	0.6142	0.0009	0.0008	0.6154	0.0009	0.0008	168064
15	#	159.87	32.29	11.652	198	0	2.9990	0.0077	2.9980	0.0067	2.9871	0.0072	0.6142	0.0009	0.0008	0.6143	0.0009	0.0008	0.6154	0.0009	0.0008	168454
16	#	90.058	32.29	4.3224	139	0	0.4044	0.0013	0.4038	0.0011	0.4038	0.0011	0.6206	0.0034	0.0040	0.6209	0.0038	0.0040	0.6209	0.0034	0.0040	62491
17	#	90.145	32.30	4.3256	139	0	0.4074	0.0015	0.4046	0.0014	0.4046	0.0012	0.6188	0.0034	0.0040	0.6208	0.0039	0.0040	0.6208	0.0034	0.0040	62550
18	#	90.371	32.32	4.3160	139	0	0.4047	0.0019	0.4023	0.0017	0.4026	0.0015	0.6194	0.0036	0.0040	0.6211	0.0040	0.0040	0.6209	0.0035	0.0040	62437
19	$	89.786	38.54	4.3152	139	0	0.4057	0.0010	0.4064	0.0012	0.4038	0.0010	0.6190	0.0035	0.0040	0.6184	0.0036	0.0040	0.6204	0.0035	0.0040	70644
20	$	90.152	38.54	4.3141	140	0	0.4054	0.0008	0.4059	0.0012	0.4034	0.0011	0.6191	0.0035	0.0040	0.6187	0.0036	0.0040	0.6206	0.0035	0.0040	70626
21	$	89.372	38.55	4.3080	139	0	0.4044	0.0011	0.4048	0.0013	0.4021	0.0011	0.6190	0.0035	0.0040	0.6186	0.0036	0.0040	0.6207	0.0035	0.0040	70539
22	$	400.80	38.58	4.2938	152	0	0.4018	0.0007	0.4017	0.0006	0.3993	0.0005	0.6189	0.0035	0.0040	0.6190	0.0035	0.0040	0.6208	0.0034	0.0040	70347
23	$	400.95	38.60	4.2916	151	0	0.4008	0.0009	0.4013	0.0011	0.3990	0.0010	0.6194	0.0035	0.0040	0.6189	0.0036	0.0040	0.6208	0.0035	0.0040	70338
24	$	399.78	38.61	4.2966	150	0	0.4030	0.0010	0.4024	0.0010	0.4001	0.0009	0.6184	0.0035	0.0040	0.6188	0.0036	0.0040	0.6206	0.0035	0.0040	70433
25	$	159.99	38.69	11.574	198	0	2.9680	0.0060	2.9671	0.0069	2.9570	0.0070	0.6138	0.0008	0.0008	0.6139	0.0009	0.0008	0.6150	0.0009	0.0008	190021
26	$	160.46	38.70	11.570	199	0	2.9679	0.0056	2.9644	0.0077	2.9543	0.0086	0.6136	0.0008	0.0008	0.6140	0.0009	0.0008	0.6150	0.0010	0.0008	189993
27	$	160.54	38.71	11.633	199	0	2.9978	0.0062	2.9964	0.0067	2.9851	0.0066	0.6139	0.0008	0.0008	0.6140	0.0008	0.0008	0.6152	0.0008	0.0008	191059
28	$	270.04	38.72	6.8047	167	0	1.0182	0.0022	1.0178	0.0027	1.0135	0.0026	0.6161	0.0015	0.0018	0.6163	0.0016	0.0018	0.6176	0.0016	0.0018	111783
29	$	270.97	38.74	6.6615	168	0	0.9756	0.0025	0.9751	0.0025	0.9705	0.0025	0.6162	0.0016	0.0019	0.6164	0.0016	0.0019	0.6178	0.0016	0.0019	109472
30	$	271.23	38.76	6.6534	168	0	0.9737	0.0026	0.9720	0.0029	0.9680	0.0028	0.6161	0.0016	0.0019	0.6166	0.0017	0.0019	0.6179	0.0017	0.0019	109381

[Test Run Date Codes # - 08/05/85 $ - 08/09/85]

Table 39F. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-6B Diameter 1.5004 Inches, Beta Ratio = 0.72501

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	53.178	38.84	35.340	82	0	27.953	0.0105	27.953	0.0108	27.830	0.0077	0.6107	0.0003	0.0004	0.6107	0.0003	0.0004	0.6121	0.0003	0.0004	581875
32	#	53.268	38.85	35.337	82	0	27.952	0.0117	27.951	0.0094	27.829	0.0066	0.6107	0.0003	0.0004	0.6107	0.0003	0.0004	0.6120	0.0003	0.0004	581931
33	#	52.650	38.86	35.189	81	0	27.720	0.0078	27.718	0.0092	27.599	0.0089	0.6107	0.0003	0.0004	0.6107	0.0003	0.0004	0.6120	0.0003	0.0004	579608
34	#	84.321	38.86	21.134	125	0	9.962	0.0128	9.961	0.0168	9.919	0.0196	0.6118	0.0005	0.0005	0.6118	0.0006	0.0005	0.6131	0.0007	0.0005	348099
35	#	85.237	38.88	21.145	131	0	9.971	0.0129	9.974	0.0162	9.932	0.0171	0.6118	0.0005	0.0005	0.6117	0.0006	0.0005	0.6130	0.0006	0.0005	348421
36	#	85.827	38.89	21.164	132	0	9.991	0.0116	9.992	0.0133	9.953	0.0145	0.6118	0.0004	0.0005	0.6117	0.0005	0.0005	0.6130	0.0005	0.0005	348801

[Test Run Date Codes # - 08/09/85]

Table 39G. Orifice Discharge Coefficient Values - Meter Tube PE-2

Meter Tube PE-2ABC Diameter 2.0695 Inches -- Orifice Plate FE-1/2-7B Diameter 0.2504 Inches, Beta Ratio = 0.12100

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
70 #	426.36	31.94	0.5004	151	0	10.010	0.0158	10.005	0.0157	10.006	0.0166	0.6093	0.0016	0.0012	0.6095	0.0005	0.0012	0.6095	0.0005	0.0012	7182
71 #	426.02	31.94	0.5024	151	1	10.066	0.0017	10.045	0.0008	10.046	0.0008	0.6100	0.0015	0.0012	0.6106	0.0002	0.0012	0.6106	0.0002	0.0012	7211
72 #	426.31	31.94	0.5032	151	0	10.082	0.0029	10.078	0.0029	10.079	0.0030	0.6106	0.0015	0.0012	0.6107	0.0002	0.0012	0.6107	0.0002	0.0012	7222
73 #	750.45	31.76	0.2756	143	1	3.0035	0.0009	3.0005	0.0008	3.0008	0.0007	0.6125	0.0051	0.0015	0.6128	0.0005	0.0015	0.6128	0.0004	0.0015	3941
74 #	754.75	31.73	0.2762	144	0	3.0166	0.0016	3.0129	0.0018	3.0135	0.0017	0.6125	0.0051	0.0015	0.6129	0.0005	0.0015	0.6129	0.0004	0.0015	3947
75 #	749.70	31.74	0.2768	143	1	3.0290	0.0005	3.0264	0.0005	3.0272	0.0004	0.6127	0.0051	0.0015	0.6129	0.0004	0.0015	0.6128	0.0004	0.0015	3956
76 #	1206.1	31.54	0.1647	136	12	1.0656	0.0006	1.0644	0.0006	1.0648	0.0006	0.6145	0.0144	0.0024	0.6149	0.0012	0.0024	0.6148	0.0011	0.0024	2344
77 #	1206.2	31.52	0.1647	136	0	1.0642	0.0011	1.0623	0.0011	1.0628	0.0011	0.6151	0.0145	0.0024	0.6156	0.0013	0.0024	0.6155	0.0011	0.0024	2343
78 #	1205.9	31.51	0.1645	136	0	1.0610	0.0015	1.0594	0.0016	1.0598	0.0015	0.6153	0.0145	0.0024	0.6158	0.0013	0.0024	0.6157	0.0012	0.0024	2340
79 #	1206.1	31.27	0.1022	136	0	0.4085	0.0016	0.4071	0.0017	0.4068	0.0016	0.6164	0.0378	0.0047	0.6174	0.0035	0.0047	0.6176	0.0031	0.0047	1447
80 #	1205.9	31.23	0.1026	136	0	0.4098	0.0005	0.4085	0.0005	0.4083	0.0005	0.6176	0.0377	0.0047	0.6186	0.0032	0.0047	0.6187	0.0029	0.0047	1451
81 #	1206.0	31.23	0.1024	136	2	0.4158	0.0011	0.4077	0.0005	0.4076	0.0004	0.6121	0.0369	0.0046	0.6181	0.0032	0.0047	0.6182	0.0029	0.0047	1448
82 #	300.06	32.87	0.8384	149	0	28.061	0.0113	28.054	0.0113	28.055	0.0123	0.6097	0.0006	0.0011	0.6098	0.0002	0.0011	0.6098	0.0002	0.0011	12267
83 #	300.13	32.90	0.8387	149	0	28.072	0.0182	28.066	0.0222	28.065	0.0235	0.6099	0.0006	0.0011	0.6099	0.0003	0.0011	0.6099	0.0003	0.0011	12279
84 #	300.21	32.90	0.8366	149	0	27.916	0.0097	27.906	0.0095	27.906	0.0095	0.6101	0.0006	0.0011	0.6102	0.0001	0.0011	0.6102	0.0001	0.0011	12248
85 $	1206.1	31.59	0.1641	136	0	1.0560	0.0004	1.0552	0.0003	1.0551	0.0002	0.6153	0.0011	0.0024	0.6156	0.0011	0.0025	0.6156	0.0010	0.0025	2338
86 $	1206.1	31.58	0.1643	136	1	1.0567	0.0005	1.0564	0.0005	1.0561	0.0004	0.6157	0.0011	0.0024	0.6157	0.0011	0.0024	0.6158	0.0010	0.0024	2341
87 $	1206.0	31.58	0.1646	136	2	1.0608	0.0008	1.0606	0.0008	1.0606	0.0007	0.6157	0.0011	0.0024	0.6158	0.0011	0.0024	0.6158	0.0010	0.0024	2345
88 $	301.26	32.99	0.8348	150	0	27.818	0.0188	27.821	0.0196	27.818	0.0221	0.6098	0.0002	0.0011	0.6097	0.0002	0.0011	0.6098	0.0003	0.0011	12244
89 $	300.09	33.04	0.8335	150	0	27.719	0.0050	27.720	0.0050	27.718	0.0051	0.6099	0.0001	0.0011	0.6099	0.0001	0.0011	0.6099	0.0001	0.0011	12238
90 $	299.17	33.05	0.8311	149	0	27.562	0.0048	27.561	0.0047	27.557	0.0049	0.6099	0.0001	0.0011	0.6099	0.0001	0.0011	0.6099	0.0001	0.0011	12205
91 $	1206.1	31.72	0.1014	136	0	0.3997	0.0006	0.4014	0.0006	0.4005	0.0007	0.6180	0.0030	0.0048	0.6167	0.0028	0.0047	0.6174	0.0026	0.0047	1449
92 $	1206.0	31.39	0.1019	136	0	0.4023	0.0003	0.4035	0.0003	0.4029	0.0002	0.6188	0.0030	0.0047	0.6179	0.0027	0.0047	0.6184	0.0025	0.0047	1446
93 $	1205.8	31.34	0.1018	136	0	0.4024	0.0002	0.4024	0.0002	0.4021	0.0002	0.6187	0.0030	0.0047	0.6187	0.0028	0.0047	0.6189	0.0026	0.0047	1443
94 $	426.35	31.94	0.5028	151	0	10.061	0.0036	10.061	0.0038	10.060	0.0040	0.6106	0.0002	0.0012	0.6106	0.0002	0.0012	0.6107	0.0002	0.0012	7217
95 $	425.97	31.97	0.5026	151	0	10.055	0.0011	10.055	0.0011	10.053	0.0009	0.6105	0.0002	0.0012	0.6105	0.0002	0.0012	0.6106	0.0001	0.0012	7218
96 $	426.02	31.96	0.5029	151	0	10.064	0.0016	10.062	0.0011	10.061	0.0010	0.6107	0.0002	0.0012	0.6108	0.0002	0.0012	0.6108	0.0001	0.0012	7221
97 $	903.15	31.80	0.2778	140	1	3.0491	0.0007	3.0481	0.0007	3.0478	0.0007	0.6130	0.0004	0.0015	0.6131	0.0004	0.0015	0.6131	0.0004	0.0015	3976
98 $	903.11	31.79	0.2778	140	0	3.0492	0.0005	3.0482	0.0006	3.0479	0.0004	0.6129	0.0004	0.0015	0.6130	0.0004	0.0015	0.6130	0.0004	0.0015	3975
99 $	902.94	31.80	0.2779	140	0	3.0517	0.0008	3.0501	0.0004	3.0500	0.0003	0.6128	0.0004	0.0015	0.6129	0.0004	0.0015	0.6130	0.0004	0.0015	3977

[Test Run Date Codes # - 08/27/85 $ - 08/29/85]

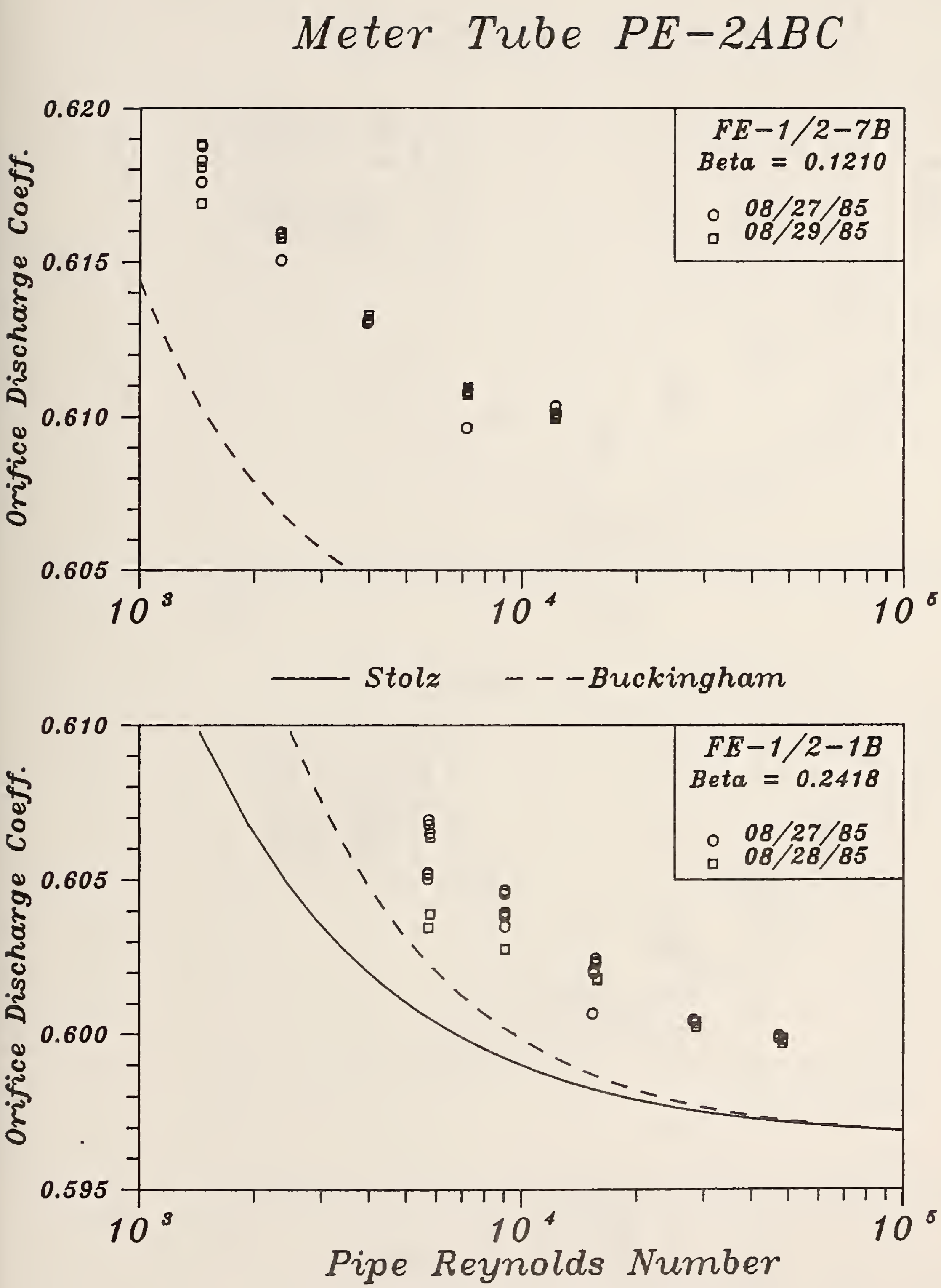


Figure 26A. Discharge Coefficient/Reynolds Number Plots, PE-2ABC 2-Inch Meter Tube, 7 Orifice Plates, Final Data Base

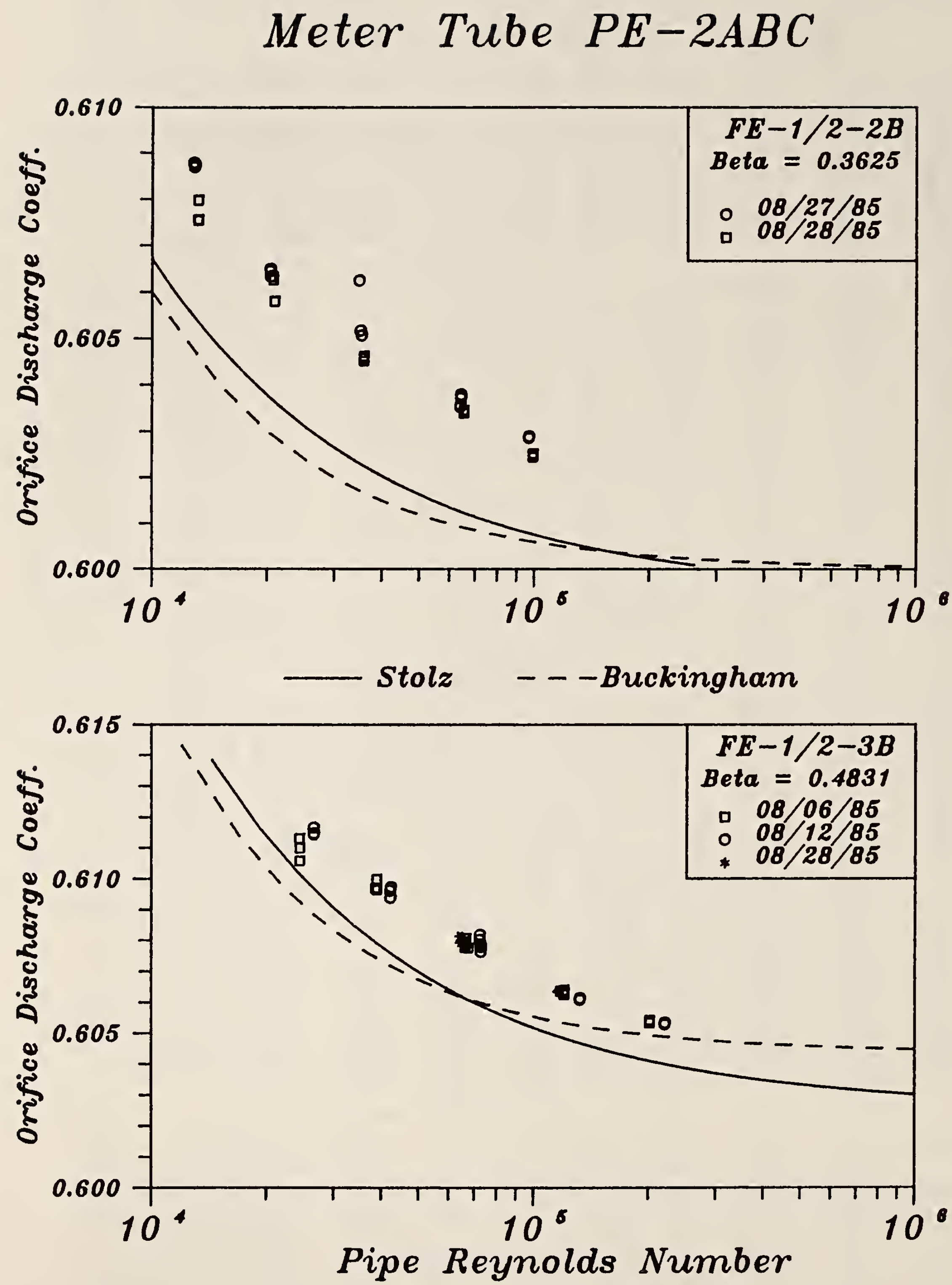


Figure 26B. Discharge Coefficient/Reynolds Number Plots, PE-2ABC 2-Inch Meter Tube, 7 Orifice Plates, Final Data Base

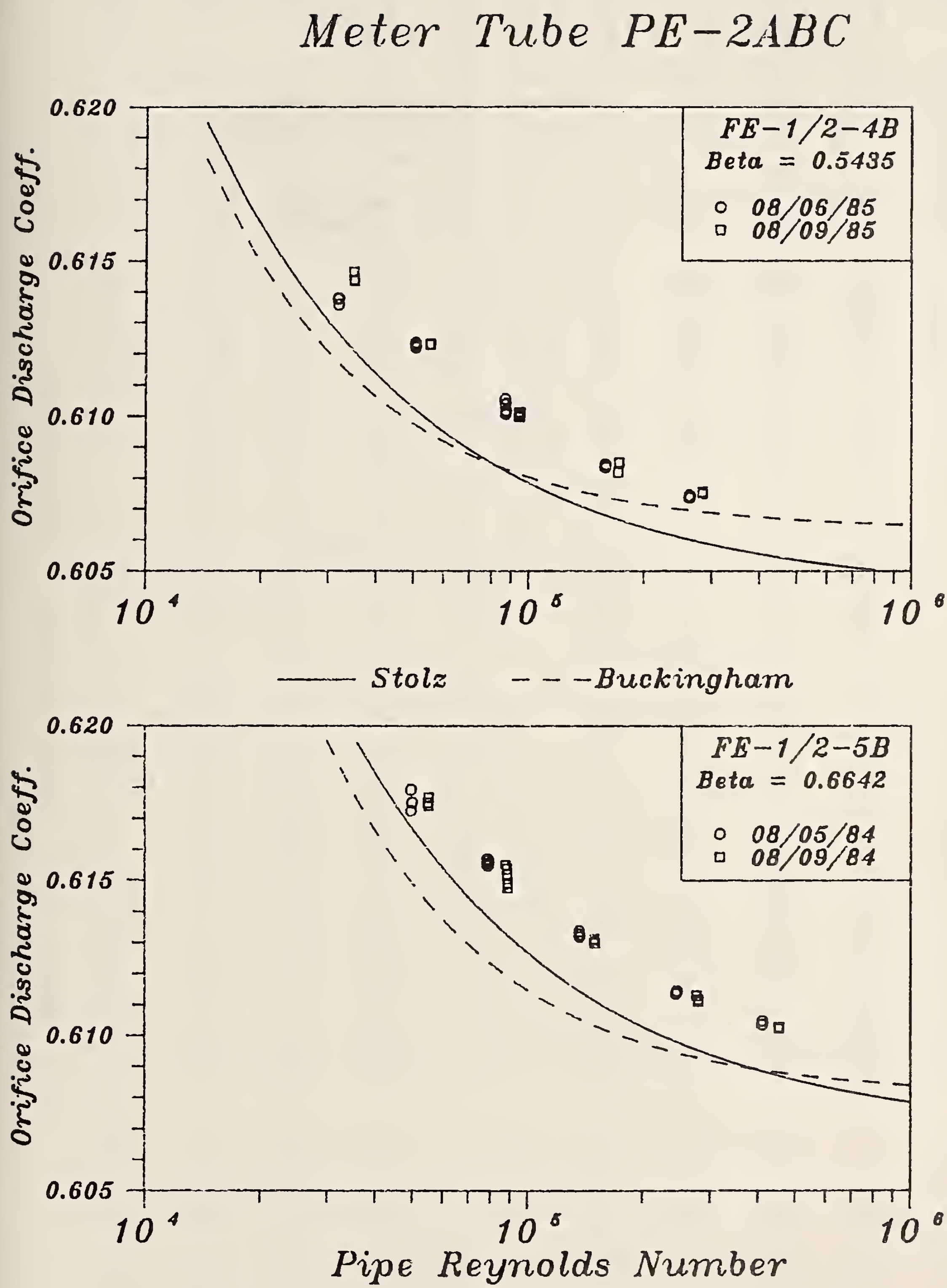


Figure 26C. Discharge Coefficient/Reynolds Number Plots, PE-2ABC 2-Inch Meter Tube, 7 Orifice Plates, Final Data Base

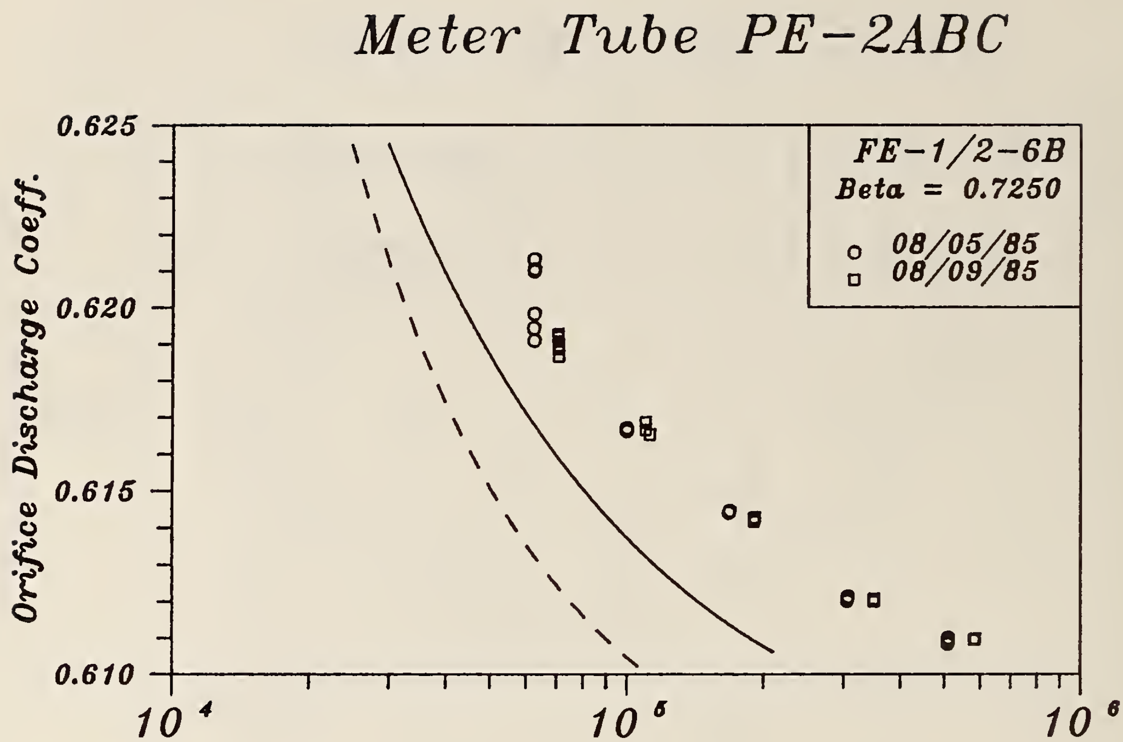


Figure 26D. Discharge Coefficient/Reynolds Number Plots, PE-2ABC 2-Inch Meter Tube, 7 Orifice Plates, Final Data Base

Table 40A. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-1B Diameter 0.6247 Inches, Beta Ratio = 0.20337

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	69.660	30.84	4.9738	97	1	26.418	0.0040	26.416	0.0043	26.416	0.0035	0.5984	0.0002	0.0005	0.5984	0.0002	0.0005	0.5984	0.0002	0.0005	47001
32 #	70.367	30.84	4.9571	94	0	26.233	0.0070	26.233	0.0074	26.234	0.0088	0.5985	0.0002	0.0005	0.5985	0.0002	0.0005	0.5984	0.0003	0.0005	46844
33 #	70.425	30.84	4.9251	98	0	25.901	0.0117	25.898	0.0116	25.900	0.0102	0.5984	0.0003	0.0005	0.5984	0.0003	0.0005	0.5984	0.0003	0.0005	46541
34 #	401.96	30.30	0.6177	152	11	0.4005	0.0002	0.4018	0.0001	0.4014	0.0002	0.6036	0.0027	0.0041	0.6026	0.0023	0.0041	0.6029	0.0023	0.0041	5771
35 #	399.99	30.31	0.6168	154	16	0.3987	0.0002	0.3997	0.0002	0.3993	0.0002	0.6040	0.0027	0.0041	0.6033	0.0023	0.0041	0.6036	0.0023	0.0041	5764
36 #	401.20	30.30	0.6174	154	13	0.3992	0.0001	0.3998	0.0002	0.3997	0.0001	0.6042	0.0027	0.0041	0.6037	0.0023	0.0041	0.6038	0.0023	0.0041	5768
37 #	115.04	30.39	1.6815	159	0	3.0000	0.0018	3.0000	0.0018	2.9999	0.0017	0.6003	0.0004	0.0009	0.6003	0.0004	0.0009	0.6003	0.0004	0.0009	15739
38 #	115.20	30.40	1.6839	160	4	3.0092	0.0012	3.0092	0.0012	3.0081	0.0011	0.6002	0.0004	0.0009	0.6002	0.0004	0.0009	0.6003	0.0004	0.0009	15765
39 #	115.23	30.38	1.6822	160	9	3.0015	0.0010	3.0012	0.0012	3.0005	0.0016	0.6004	0.0004	0.0009	0.6004	0.0004	0.0009	0.6005	0.0004	0.0009	15743
40 #	64.772	30.47	3.0709	90	0	10.047	0.0025	10.048	0.0026	10.047	0.0024	0.5991	0.0003	0.0006	0.5990	0.0003	0.0006	0.5990	0.0003	0.0006	28794
41 #	65.435	30.48	3.0675	91	1	10.023	0.0023	10.024	0.0021	10.023	0.0027	0.5991	0.0003	0.0006	0.5991	0.0003	0.0006	0.5991	0.0003	0.0006	28768
42 #	65.458	30.47	3.0661	91	4	10.016	0.0034	10.017	0.0029	10.016	0.0034	0.5990	0.0003	0.0006	0.5990	0.0003	0.0006	0.5990	0.0003	0.0006	28749
43 #	200.95	30.34	0.9857	166	0	1.0277	0.0005	1.0287	0.0005	1.0273	0.0006	0.6012	0.0011	0.0019	0.6009	0.0009	0.0019	0.6013	0.0009	0.0019	9217
44 #	200.94	30.35	0.9867	166	0	1.0382	0.0015	1.0299	0.0008	1.0286	0.0008	0.5988	0.0011	0.0018	0.6011	0.0009	0.0019	0.6015	0.0009	0.0018	9228
45 #	200.57	30.36	0.9872	166	0	1.0302	0.0006	1.0311	0.0006	1.0297	0.0007	0.6014	0.0011	0.0019	0.6011	0.0009	0.0019	0.6016	0.0009	0.0019	9235
46 $	401.17	29.28	0.6215	152	22	0.4044	0.0003	0.4035	0.0003	0.4041	0.0002	0.6043	0.0025	0.0040	0.6050	0.0027	0.0041	0.6045	0.0025	0.0040	5681
47 $	401.73	29.29	0.6191	152	22	0.4022	0.0002	0.4008	0.0002	0.4018	0.0003	0.6035	0.0025	0.0041	0.6046	0.0028	0.0041	0.6038	0.0025	0.0041	5661
48 $	400.87	29.30	0.6182	152	17	0.4019	0.0002	0.4005	0.0001	0.4013	0.0002	0.6029	0.0025	0.0041	0.6040	0.0028	0.0041	0.6033	0.0025	0.0040	5654
49 $	220.44	29.41	1.6887	182	1	3.0224	0.0011	3.0204	0.0010	3.0204	0.0016	0.6005	0.0004	0.0009	0.6007	0.0004	0.0009	0.6007	0.0004	0.0009	15480
50 $	220.52	29.40	1.6814	182	1	2.9964	0.0006	2.9940	0.0006	2.9939	0.0008	0.6005	0.0004	0.0009	0.6008	0.0004	0.0009	0.6008	0.0004	0.0009	15410
51 $	220.55	29.39	1.6770	182	1	2.9830	0.0005	2.9804	0.0006	2.9810	0.0005	0.6003	0.0004	0.0009	0.6006	0.0004	0.0009	0.6005	0.0004	0.0009	15366
52 $	119.78	29.47	3.0667	168	6	10.019	0.0013	10.017	0.0011	10.018	0.0012	0.5990	0.0002	0.0006	0.5991	0.0002	0.0006	0.5990	0.0002	0.0006	28148
53 $	120.52	29.46	3.0631	169	2	9.989	0.0020	9.987	0.0018	9.988	0.0021	0.5992	0.0002	0.0006	0.5992	0.0002	0.0006	0.5992	0.0002	0.0006	28109
54 $	119.74	29.46	3.0621	168	3	9.982	0.0015	9.979	0.0020	9.980	0.0022	0.5992	0.0002	0.0006	0.5993	0.0002	0.0006	0.5993	0.0002	0.0006	28100
55 $	69.790	29.84	4.7899	98	0	24.479	0.0044	24.476	0.0052	24.483	0.0047	0.5986	0.0002	0.0005	0.5986	0.0002	0.0005	0.5985	0.0002	0.0005	44314
56 $	69.703	29.83	4.7884	94	0	24.465	0.0032	24.461	0.0041	24.463	0.0046	0.5985	0.0002	0.0005	0.5986	0.0002	0.0005	0.5986	0.0002	0.0005	44290
57 $	69.849	29.84	4.7887	98	2	24.468	0.0049	24.463	0.0045	24.462	0.0051	0.5985	0.0002	0.0005	0.5986	0.0002	0.0005	0.5986	0.0002	0.0005	44303
58 $	200.54	29.36	0.9742	166	0	1.0186	0.0011	1.0025	0.0004	1.0030	0.0004	0.5968	0.0010	0.0019	0.6016	0.0011	0.0019	0.6014	0.0010	0.0018	8921
59 $	200.83	29.37	0.9738	166	0	1.0032	0.0003	1.0005	0.0003	1.0010	0.0003	0.6011	0.0010	0.0019	0.6019	0.0011	0.0019	0.6018	0.0010	0.0019	8919
60 $	200.59	29.39	0.9731	166	0	1.0018	0.0004	0.9989	0.0004	0.9995	0.0005	0.6011	0.0010	0.0019	0.6019	0.0011	0.0019	0.6018	0.0010	0.0019	8916

[Test Run Date Codes # - 09/11/85 $ - 09/13/85]

Table 40B. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-2B Diameter 1.1251 Inches, Beta Ratio = 0.36627

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	117.66	34.31	3.2496	185	0	1.0411	0.0031	1.0407	0.0027	1.0413	0.0027	0.6025	0.0013	0.0017	0.6025	0.0013	0.0017	0.6024	0.0012	0.0017	32984
2	#	118.44	34.34	3.2369	178	0	1.0310	0.0026	1.0320	0.0024	1.0327	0.0024	0.6030	0.0012	0.0017	0.6027	0.0013	0.0017	0.6025	0.0012	0.0017	32875
3	#	118.41	34.36	3.2296	178	0	1.0268	0.0021	1.0271	0.0028	1.0280	0.0029	0.6029	0.0011	0.0017	0.6028	0.0013	0.0017	0.6025	0.0013	0.0017	32814
4	#	67.464	34.44	5.4928	103	0	2.9793	0.0079	2.9778	0.0100	2.9803	0.0093	0.6020	0.0009	0.0008	0.6021	0.0011	0.0008	0.6019	0.0010	0.0008	55899
5	#	68.251	34.45	5.5099	108	0	2.9969	0.0096	2.9982	0.0120	3.0013	0.0132	0.6021	0.0011	0.0008	0.6019	0.0013	0.0008	0.6016	0.0014	0.0008	56084
6	#	67.818	34.46	5.5194	107	0	3.0078	0.0068	3.0090	0.0096	3.0108	0.0095	0.6020	0.0008	0.0008	0.6019	0.0011	0.0008	0.6017	0.0010	0.0008	56192
7	#	326.87	34.50	5.5459	162	0	3.0442	0.0070	3.0420	0.0072	3.0435	0.0071	0.6013	0.0008	0.0008	0.6015	0.0008	0.0008	0.6013	0.0008	0.0008	56507
8	#	326.83	34.52	5.5398	162	0	3.0307	0.0064	3.0324	0.0057	3.0343	0.0059	0.6020	0.0007	0.0008	0.6018	0.0007	0.0008	0.6016	0.0007	0.0008	56468
9	#	327.05	34.53	5.5331	162	0	3.0267	0.0056	3.0264	0.0051	3.0291	0.0053	0.6016	0.0007	0.0008	0.6016	0.0006	0.0008	0.6014	0.0006	0.0008	56411
10	#	109.49	34.61	16.758	174	0	27.926	0.0153	27.925	0.0170	27.926	0.0164	0.5999	0.0002	0.0003	0.5999	0.0002	0.0003	0.5999	0.0002	0.0003	171125
11	#	110.57	34.62	16.754	176	1	27.913	0.0101	27.913	0.0109	27.911	0.0099	0.5998	0.0002	0.0003	0.5998	0.0002	0.0003	0.5999	0.0002	0.0003	171118
12	#	110.45	34.64	16.726	176	0	27.819	0.0110	27.821	0.0151	27.823	0.0138	0.5999	0.0002	0.0003	0.5998	0.0002	0.0003	0.5998	0.0002	0.0003	170900
13	#	161.75	34.66	10.029	200	0	9.983	0.0126	9.981	0.0170	9.983	0.0172	0.6004	0.0004	0.0004	0.6005	0.0005	0.0004	0.6004	0.0005	0.0004	102511
14	#	162.08	34.68	9.992	200	0	9.901	0.0148	9.904	0.0212	9.904	0.0215	0.6006	0.0005	0.0004	0.6006	0.0007	0.0004	0.6006	0.0007	0.0004	102172
15	#	162.26	34.70	10.046	200	0	10.021	0.0175	10.018	0.0195	10.018	0.0198	0.6003	0.0005	0.0004	0.6004	0.0006	0.0004	0.6004	0.0006	0.0004	102767
16	$	163.38	34.68	2.0427	200	1	0.4098	0.0013	0.4086	0.0008	0.4103	0.0008	0.6037	0.0026	0.0038	0.6045	0.0026	0.0038	0.6032	0.0023	0.0038	20888
17	$	163.31	34.70	2.0361	200	0	0.4081	0.0014	0.4056	0.0011	0.4074	0.0008	0.6030	0.0026	0.0038	0.6048	0.0027	0.0039	0.6034	0.0024	0.0038	20829
18	$	165.07	34.72	2.0345	200	0	0.4064	0.0011	0.4052	0.0007	0.4063	0.0009	0.6037	0.0025	0.0039	0.6047	0.0026	0.0039	0.6038	0.0024	0.0039	20821
19	@	67.786	42.60	5.5786	105	1	3.0877	0.0086	3.0902	0.0129	3.0901	0.0135	0.6013	0.0010	0.0008	0.6010	0.0014	0.0008	0.6010	0.0014	0.0008	66343
20	@	68.418	42.66	5.5943	106	0	3.1117	0.0112	3.1085	0.0117	3.1111	0.0113	0.6007	0.0012	0.0007	0.6010	0.0013	0.0007	0.6007	0.0012	0.0007	66602
21	@	68.471	42.67	5.6079	106	0	3.1199	0.0079	3.1215	0.0093	3.1225	0.0095	0.6013	0.0009	0.0007	0.6012	0.0011	0.0007	0.6011	0.0011	0.0007	66776
22	@	149.81	42.56	2.0549	186	0	0.4173	0.0010	0.4174	0.0012	0.4170	0.0011	0.6025	0.0034	0.0038	0.6024	0.0040	0.0038	0.6027	0.0037	0.0037	24420
23	@	149.91	42.55	2.0457	186	0	0.4140	0.0009	0.4134	0.0010	0.4135	0.0009	0.6021	0.0034	0.0038	0.6026	0.0041	0.0038	0.6025	0.0037	0.0038	24306
24	@	150.60	42.56	2.0513	187	0	0.4160	0.0011	0.4153	0.0014	0.4152	0.0013	0.6024	0.0035	0.0038	0.6029	0.0041	0.0038	0.6029	0.0037	0.0038	24377
25	@	99.58	42.65	3.2583	154	0	1.0520	0.0032	1.0510	0.0038	1.0522	0.0034	0.6017	0.0016	0.0017	0.6020	0.0019	0.0017	0.6016	0.0017	0.0017	38784
26	@	100.27	42.66	3.2637	155	0	1.0560	0.0027	1.0546	0.0030	1.0557	0.0031	0.6016	0.0015	0.0017	0.6019	0.0018	0.0017	0.6016	0.0017	0.0017	38855
27	@	99.59	42.66	3.2586	154	0	1.0538	0.0023	1.0515	0.0026	1.0525	0.0025	0.6012	0.0015	0.0017	0.6019	0.0017	0.0017	0.6016	0.0016	0.0017	38795
28	@	324.88	42.76	5.5248	161	0	3.0368	0.0048	3.0320	0.0054	3.0329	0.0051	0.6005	0.0007	0.0008	0.6009	0.0008	0.0008	0.6008	0.0007	0.0008	65894
29	@	326.82	42.77	5.5280	162	0	3.0352	0.0051	3.0358	0.0057	3.0358	0.0060	0.6010	0.0007	0.0008	0.6009	0.0008	0.0008	0.6009	0.0008	0.0008	65944
30	@	324.84	42.78	5.5282	161	0	3.0324	0.0062	3.0345	0.0070	3.0364	0.0072	0.6013	0.0008	0.0008	0.6011	0.0009	0.0008	0.6009	0.0009	0.0008	65958

[Test Run Date Codes # - 07/24/85 $ - 07/25/85 @ - 08/02/85]

Table 40B. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-2B Diameter 1.1251 Inches, Beta Ratio = 0.36627

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	162.18	42.91	10.052	200	0	10.070	0.0185	10.074	0.0224	10.073	0.0212	0.6000	0.0006	0.0004	0.5999	0.0007	0.0004	0.5999	0.0007	0.0004	120221
32 #	161.97	42.92	10.011	200	0	9.986	0.0144	9.991	0.0169	9.992	0.0179	0.6000	0.0005	0.0004	0.5999	0.0005	0.0004	0.5998	0.0006	0.0004	119745
33 #	162.31	42.93	10.042	200	0	10.053	0.0168	10.050	0.0216	10.051	0.0226	0.5999	0.0005	0.0004	0.6000	0.0007	0.0004	0.5999	0.0007	0.0004	120136
34 #	109.85	42.98	16.730	170	0	27.960	0.0166	27.958	0.0180	27.957	0.0152	0.5993	0.0002	0.0003	0.5993	0.0003	0.0003	0.5993	0.0002	0.0003	200338
35 #	110.50	43.00	16.738	171	0	27.979	0.0123	27.982	0.0131	27.986	0.0140	0.5993	0.0002	0.0003	0.5993	0.0002	0.0003	0.5993	0.0002	0.0003	200499
36 #	110.55	43.01	16.754	171	0	28.037	0.0172	28.034	0.0175	28.041	0.0137	0.5993	0.0002	0.0003	0.5993	0.0002	0.0003	0.5993	0.0002	0.0003	200735
37 $	68.427	30.30	5.5361	93	0	3.0244	0.0009	3.0240	0.0009	3.0271	0.0008	0.6018	0.0004	0.0008	0.6019	0.0004	0.0008	0.6016	0.0004	0.0008	51721
38 $	67.243	30.30	5.5305	92	1	3.0180	0.0013	3.0177	0.0011	3.0180	0.0014	0.6019	0.0005	0.0008	0.6019	0.0004	0.0008	0.6019	0.0004	0.0008	51669
39 $	68.283	30.29	5.5236	94	1	3.0097	0.0010	3.0094	0.0009	3.0115	0.0010	0.6019	0.0004	0.0008	0.6020	0.0004	0.0008	0.6017	0.0004	0.0008	51593
40 $	163.81	30.26	2.0173	200	0	0.3981	0.0002	0.3977	0.0002	0.3984	0.0001	0.6045	0.0027	0.0039	0.6047	0.0023	0.0039	0.6042	0.0023	0.0039	18831
41 $	168.90	30.28	2.0122	200	0	0.3960	0.0002	0.3955	0.0002	0.3962	0.0002	0.6046	0.0027	0.0040	0.6049	0.0023	0.0040	0.6044	0.0023	0.0040	18791
42 $	169.09	30.30	2.0117	200	0	0.3957	0.0002	0.3952	0.0002	0.3958	0.0002	0.6046	0.0027	0.0040	0.6050	0.0023	0.0040	0.6045	0.0023	0.0040	18794
43 $	118.18	30.31	3.2092	164	0	1.0127	0.0003	1.0122	0.0002	1.0122	0.0002	0.6029	0.0011	0.0017	0.6030	0.0009	0.0017	0.6030	0.0009	0.0017	29988
44 $	117.49	30.30	3.2140	163	4	1.0149	0.0003	1.0143	0.0004	1.0151	0.0003	0.6032	0.0011	0.0017	0.6033	0.0009	0.0017	0.6031	0.0009	0.0017	30027
45 $	118.09	30.30	3.2107	164	0	1.0128	0.0002	1.0122	0.0002	1.0131	0.0003	0.6032	0.0011	0.0017	0.6033	0.0009	0.0017	0.6031	0.0009	0.0017	29996
46 @	161.75	29.45	10.075	200	2	10.058	0.0017	10.058	0.0017	10.059	0.0012	0.6005	0.0002	0.0004	0.6005	0.0002	0.0004	0.6005	0.0002	0.0004	92432
47 @	161.85	29.45	10.091	200	1	10.088	0.0013	10.088	0.0013	10.087	0.0014	0.6006	0.0002	0.0004	0.6006	0.0002	0.0004	0.6006	0.0002	0.0004	92583
48 @	161.83	29.44	10.091	200	4	10.084	0.0020	10.084	0.0021	10.086	0.0019	0.6007	0.0002	0.0004	0.6007	0.0002	0.0004	0.6006	0.0002	0.0004	92557
49 @	67.800	29.41	5.4848	95	0	2.9693	0.0013	2.9693	0.0017	2.9701	0.0014	0.6017	0.0004	0.0008	0.6017	0.0005	0.0008	0.6016	0.0004	0.0008	50278
50 @	68.344	29.42	5.4247	96	0	2.9043	0.0019	2.9041	0.0021	2.9052	0.0020	0.6017	0.0005	0.0008	0.6017	0.0005	0.0008	0.6016	0.0005	0.0008	49737
51 @	68.382	29.42	5.5043	96	4	2.9908	0.0013	2.9900	0.0012	2.9906	0.0015	0.6017	0.0004	0.0008	0.6017	0.0005	0.0008	0.6017	0.0004	0.0008	50467
52 @	167.01	29.39	2.0158	200	0	0.3975	0.0002	0.3978	0.0002	0.3977	0.0002	0.6044	0.0025	0.0039	0.6042	0.0028	0.0039	0.6043	0.0025	0.0039	18470
53 @	171.25	29.41	2.0067	200	0	0.3940	0.0001	0.3941	0.0002	0.3937	0.0002	0.6044	0.0026	0.0040	0.6043	0.0028	0.0040	0.6046	0.0025	0.0040	18395
54 @	169.74	29.41	2.0261	200	0	0.4014	0.0002	0.4014	0.0002	0.4015	0.0002	0.6046	0.0025	0.0039	0.6045	0.0028	0.0039	0.6045	0.0025	0.0039	18573
55 @	117.84	29.42	3.2168	161	0	1.0174	0.0003	1.0172	0.0004	1.0179	0.0005	0.6029	0.0010	0.0017	0.6029	0.0011	0.0017	0.6027	0.0010	0.0017	29494
56 @	118.41	29.42	3.2139	163	0	1.0158	0.0003	1.0154	0.0003	1.0160	0.0003	0.6028	0.0010	0.0017	0.6029	0.0011	0.0017	0.6027	0.0010	0.0017	29467
57 @	118.02	29.41	3.1931	162	0	1.0020	0.0006	1.0018	0.0006	1.0028	0.0005	0.6030	0.0010	0.0017	0.6031	0.0011	0.0017	0.6028	0.0010	0.0017	29270

[Test Run Date Codes # - 08/02/85 $ - 09/11/85 @ - 09/13/85]

Table 40C. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-3B Diameter 1.4997 Inches, Beta Ratio = 0.48822

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	161.75	33.99	10.133	200	0	3.0378	0.0042	3.0377	0.0048	3.0408	0.0048	0.6065	0.0006	0.0007	0.6065	0.0006	0.0007	0.6062	0.0006	0.0007	102186
2 #	161.61	34.03	10.116	200	0	3.0306	0.0059	3.0279	0.0059	3.0306	0.0067	0.6063	0.0007	0.0007	0.6065	0.0007	0.0007	0.6062	0.0008	0.0007	102097
3 #	161.78	34.04	10.133	200	0	3.0399	0.0039	3.0393	0.0047	3.0415	0.0049	0.6063	0.0005	0.0007	0.6064	0.0006	0.0007	0.6062	0.0006	0.0007	102287
4 #	474.31	34.05	3.7070	147	0	0.4045	0.0007	0.4034	0.0005	0.4038	0.0005	0.6081	0.0025	0.0039	0.6089	0.0027	0.0039	0.6086	0.0023	0.0038	37430
5 #	477.41	34.08	3.6952	148	0	0.4015	0.0008	0.4002	0.0007	0.4013	0.0006	0.6085	0.0025	0.0039	0.6095	0.0027	0.0039	0.6086	0.0024	0.0039	37333
6 #	477.19	34.11	3.6987	148	0	0.4020	0.0009	0.4008	0.0008	0.4020	0.0007	0.6087	0.0025	0.0039	0.6095	0.0027	0.0039	0.6086	0.0024	0.0039	37391
7 #	310.22	34.17	5.8916	154	0	1.0248	0.0035	1.0229	0.0037	1.0234	0.0038	0.6073	0.0014	0.0017	0.6078	0.0015	0.0017	0.6077	0.0015	0.0017	59632
8 #	310.29	34.20	5.9647	154	0	1.0500	0.0023	1.0488	0.0017	1.0497	0.0015	0.6073	0.0011	0.0016	0.6077	0.0011	0.0016	0.6074	0.0010	0.0016	60408
9 #	310.40	34.22	5.9575	154	0	1.0476	0.0017	1.0464	0.0019	1.0470	0.0019	0.6073	0.0011	0.0016	0.6076	0.0012	0.0016	0.6074	0.0011	0.0016	60360
10 #	98.699	34.28	18.417	155	0	10.088	0.0146	10.083	0.0192	10.090	0.0201	0.6050	0.0005	0.0004	0.6051	0.0006	0.0004	0.6049	0.0006	0.0004	186820
11 #	99.382	34.30	18.439	156	0	10.105	0.0126	10.111	0.0153	10.113	0.0155	0.6052	0.0004	0.0004	0.6050	0.0005	0.0004	0.6050	0.0005	0.0004	187118
12 #	98.683	34.31	18.454	152	0	10.118	0.0107	10.124	0.0137	10.127	0.0153	0.6053	0.0004	0.0004	0.6051	0.0005	0.0004	0.6050	0.0005	0.0004	187306
13 #	60.136	34.38	30.670	95	0	28.067	0.0070	28.062	0.0064	28.070	0.0100	0.6040	0.0003	0.0003	0.6041	0.0003	0.0003	0.6040	0.0003	0.0003	311741
14 #	59.755	34.38	30.659	94	0	28.042	0.0118	28.029	0.0145	28.040	0.0083	0.6041	0.0003	0.0003	0.6042	0.0003	0.0003	0.6041	0.0003	0.0003	311633
15 #	59.654	34.40	30.662	94	0	28.022	0.0131	28.032	0.0126	28.036	0.0136	0.6043	0.0003	0.0003	0.6042	0.0003	0.0003	0.6042	0.0003	0.0003	311789
16 $	60.048	41.89	30.524	93	0	27.875	0.0111	27.875	0.0100	27.868	0.0106	0.6039	0.0003	0.0003	0.6039	0.0003	0.0003	0.6040	0.0003	0.0003	358334
17 $	60.077	41.91	30.525	93	0	27.869	0.0136	27.866	0.0154	27.870	0.0145	0.6040	0.0003	0.0003	0.6040	0.0003	0.0003	0.6040	0.0003	0.0003	358474
18 $	60.052	41.92	30.501	93	0	27.825	0.0146	27.819	0.0084	27.824	0.0119	0.6040	0.0003	0.0003	0.6040	0.0003	0.0003	0.6040	0.0003	0.0003	358253
19 $	98.869	41.91	18.343	148	0	10.035	0.0143	10.038	0.0196	10.041	0.0210	0.6048	0.0005	0.0004	0.6048	0.0006	0.0004	0.6047	0.0007	0.0004	215413
20 $	98.781	41.92	18.347	153	0	10.041	0.0141	10.044	0.0202	10.047	0.0213	0.6048	0.0005	0.0004	0.6047	0.0006	0.0004	0.6046	0.0007	0.0004	215502
21 $	98.890	41.91	18.330	147	0	10.026	0.0180	10.024	0.0219	10.027	0.0201	0.6047	0.0006	0.0004	0.6047	0.0007	0.0004	0.6047	0.0006	0.0004	215261
22 $	162.17	41.89	10.062	200	0	3.0108	0.0053	3.0091	0.0074	3.0080	0.0073	0.6057	0.0006	0.0007	0.6059	0.0009	0.0007	0.6060	0.0008	0.0007	118122
23 $	162.05	41.90	10.040	200	1	2.9926	0.0049	2.9960	0.0066	2.9957	0.0061	0.6062	0.0006	0.0007	0.6059	0.0008	0.0007	0.6059	0.0007	0.0007	117880
24 $	161.98	41.89	10.058	200	0	3.0069	0.0060	3.0062	0.0063	3.0063	0.0056	0.6059	0.0007	0.0007	0.6059	0.0008	0.0007	0.6059	0.0007	0.0007	118069
25 $	310.27	41.85	5.8477	154	0	1.0130	0.0026	1.0134	0.0022	1.0120	0.0019	0.6069	0.0013	0.0017	0.6068	0.0013	0.0017	0.6072	0.0012	0.0017	68597
26 $	312.56	41.85	5.8393	155	0	1.0102	0.0022	1.0104	0.0027	1.0086	0.0029	0.6069	0.0012	0.0017	0.6068	0.0014	0.0017	0.6073	0.0014	0.0017	68499
27 $	310.64	41.87	5.8366	154	0	1.0106	0.0020	1.0095	0.0019	1.0072	0.0021	0.6065	0.0012	0.0017	0.6068	0.0013	0.0017	0.6075	0.0013	0.0017	68492
28 $	64.660	41.88	5.8657	100	0	1.0193	0.0028	1.0185	0.0025	1.0164	0.0021	0.6069	0.0014	0.0017	0.6071	0.0014	0.0017	0.6078	0.0013	0.0017	68846
29 $	65.222	41.89	5.8439	101	0	1.0114	0.0042	1.0104	0.0043	1.0088	0.0045	0.6070	0.0017	0.0017	0.6073	0.0017	0.0017	0.6078	0.0018	0.0017	68603
30 $	65.284	41.89	5.8782	101	0	1.0243	0.0022	1.0233	0.0027	1.0214	0.0029	0.6067	0.0012	0.0017	0.6070	0.0014	0.0017	0.6076	0.0014	0.0017	69006

[Test Run Date Codes # - 07/24/85 $ - 08/02/85]

Table 40C. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-3B Diameter 1.4997 Inches, Beta Ratio = 0.48822

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	100.13	41.85	3.6777	155	0	0.3990	0.0011	0.3986	0.0014	0.3987	0.0014	0.6082	0.0028	0.0039	0.6085	0.0031	0.0039	0.6084	0.0029	0.0039	43142
32 #	100.53	41.85	3.6769	156	0	0.3990	0.0013	0.3983	0.0014	0.3984	0.0013	0.6081	0.0028	0.0039	0.6086	0.0031	0.0039	0.6085	0.0029	0.0039	43132
33 #	100.11	41.86	3.6699	155	0	0.3971	0.0013	0.3966	0.0015	0.3966	0.0013	0.6083	0.0028	0.0039	0.6087	0.0031	0.0039	0.6087	0.0029	0.0039	43058

[Test Run Date Codes # - 08/02/85]

Table 40D. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-4B Diameter 1.7496 Inches, Beta Ratio = 0.56957

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	70.313	33.39	25.861	104	0	10.092	0.0093	10.095	0.0087	10.096	0.0107	0.6077	0.0004	0.0004	0.6076	0.0004	0.0004	0.6076	0.0004	0.0004	257643
2	#	69.526	33.41	25.860	109	0	10.093	0.0099	10.095	0.0089	10.093	0.0113	0.6077	0.0004	0.0004	0.6076	0.0004	0.0004	0.6077	0.0004	0.0004	257734
3	#	69.609	33.43	25.904	103	0	10.132	0.0117	10.127	0.0150	10.133	0.0095	0.6075	0.0004	0.0004	0.6077	0.0005	0.0004	0.6075	0.0004	0.0004	258279
4	#	69.930	33.44	5.2301	110	0	0.4074	0.0013	0.4078	0.0013	0.4061	0.0011	0.6118	0.0026	0.0038	0.6115	0.0028	0.0038	0.6127	0.0025	0.0038	52159
5	#	69.352	33.46	5.2498	109	0	0.4098	0.0013	0.4106	0.0011	0.4088	0.0008	0.6123	0.0026	0.0038	0.6116	0.0027	0.0038	0.6130	0.0024	0.0038	52376
6	#	70.613	33.48	5.2408	111	0	0.4093	0.0008	0.4090	0.0011	0.4072	0.0011	0.6116	0.0025	0.0038	0.6118	0.0027	0.0038	0.6132	0.0025	0.0038	52308
7	#	352.01	33.56	5.2587	150	0	0.4117	0.0009	0.4119	0.0007	0.4104	0.0006	0.6119	0.0025	0.0038	0.6117	0.0026	0.0038	0.6128	0.0023	0.0038	52572
8	#	349.42	33.57	5.2490	149	0	0.4103	0.0009	0.4097	0.0008	0.4087	0.0008	0.6118	0.0025	0.0038	0.6122	0.0027	0.0038	0.6130	0.0024	0.0038	52486
9	#	349.91	33.60	5.2467	148	0	0.4097	0.0009	0.4093	0.0006	0.4083	0.0006	0.6120	0.0025	0.0038	0.6123	0.0026	0.0038	0.6131	0.0024	0.0038	52495
10	#	162.06	33.65	8.4572	200	0	1.0679	0.0014	1.0674	0.0020	1.0673	0.0022	0.6110	0.0010	0.0016	0.6111	0.0012	0.0016	0.6112	0.0011	0.0016	84703
11	#	161.73	33.67	8.4797	200	0	1.0744	0.0025	1.0733	0.0029	1.0732	0.0027	0.6108	0.0012	0.0016	0.6111	0.0013	0.0016	0.6111	0.0012	0.0016	84963
12	#	161.63	33.69	8.4777	200	0	1.0751	0.0023	1.0721	0.0021	1.0727	0.0025	0.6105	0.0011	0.0016	0.6113	0.0012	0.0016	0.6111	0.0011	0.0016	84977
13	#	129.12	33.74	14.243	200	0	3.0466	0.0065	3.0446	0.0074	3.0466	0.0066	0.6093	0.0007	0.0007	0.6094	0.0008	0.0007	0.6092	0.0007	0.0007	142916
14	#	129.81	33.76	14.232	193	0	3.0443	0.0064	3.0415	0.0071	3.0439	0.0064	0.6090	0.0007	0.0007	0.6093	0.0008	0.0007	0.6090	0.0007	0.0007	142859
15	#	130.29	33.79	14.236	197	0	3.0394	0.0057	3.0406	0.0058	3.0431	0.0053	0.6096	0.0007	0.0007	0.6095	0.0007	0.0007	0.6093	0.0006	0.0007	142983
16	#	161.67	33.82	8.2562	200	0	1.0179	0.0024	1.0160	0.0025	1.0170	0.0024	0.6110	0.0012	0.0017	0.6115	0.0013	0.0017	0.6112	0.0012	0.0017	82976
17	#	161.34	33.84	8.2469	200	0	1.0158	0.0022	1.0142	0.0028	1.0155	0.0028	0.6109	0.0012	0.0017	0.6114	0.0014	0.0017	0.6110	0.0013	0.0017	82916
18	#	161.70	33.85	8.2342	200	0	1.0129	0.0021	1.0111	0.0019	1.0123	0.0021	0.6108	0.0012	0.0017	0.6114	0.0012	0.0017	0.6110	0.0011	0.0017	82805
19	#	230.21	33.88	8.2443	190	0	1.0166	0.0020	1.0133	0.0020	1.0145	0.0018	0.6105	0.0011	0.0017	0.6115	0.0012	0.0017	0.6111	0.0011	0.0017	82957
20	#	230.20	33.90	8.2473	190	0	1.0166	0.0018	1.0139	0.0021	1.0151	0.0020	0.6107	0.0011	0.0017	0.6115	0.0012	0.0017	0.6111	0.0011	0.0017	83021
21	#	230.18	33.91	8.2335	190	0	1.0131	0.0017	1.0109	0.0022	1.0115	0.0020	0.6107	0.0011	0.0017	0.6114	0.0012	0.0017	0.6112	0.0011	0.0017	82898
22	#	43.140	34.01	42.988	68	0	27.975	0.0134	27.982	0.0086	28.001	0.0092	0.6068	0.0004	0.0003	0.6067	0.0004	0.0003	0.6065	0.0004	0.0003	433701
23	#	43.173	34.01	42.969	68	0	27.967	0.0118	27.961	0.0128	27.967	0.0136	0.6066	0.0004	0.0003	0.6067	0.0004	0.0003	0.6066	0.0004	0.0003	433510
24	#	43.072	34.01	42.961	65	0	27.939	0.0125	27.946	0.0129	27.953	0.0093	0.6068	0.0004	0.0003	0.6067	0.0004	0.0003	0.6067	0.0004	0.0003	433423
25	$	43.439	42.52	43.032	67	0	28.142	0.0150	28.144	0.0138	28.144	0.0162	0.6064	0.0004	0.0003	0.6064	0.0004	0.0003	0.6064	0.0004	0.0003	511002
26	$	42.673	42.53	42.985	66	0	28.052	0.0143	28.066	0.0132	28.082	0.0168	0.6067	0.0004	0.0003	0.6066	0.0004	0.0003	0.6064	0.0004	0.0003	510538
27	$	42.655	42.53	42.970	66	0	28.037	0.0076	28.039	0.0115	28.061	0.0114	0.6067	0.0004	0.0003	0.6067	0.0004	0.0003	0.6064	0.0004	0.0003	510367
28	$	129.34	42.50	14.166	191	0	3.0195	0.0054	3.0259	0.0053	3.0302	0.0054	0.6095	0.0007	0.0007	0.6088	0.0008	0.0007	0.6084	0.0008	0.0007	168161
29	$	129.67	42.52	14.128	200	0	3.0095	0.0054	3.0094	0.0057	3.0117	0.0064	0.6088	0.0007	0.0007	0.6088	0.0008	0.0007	0.6086	0.0008	0.0007	167767
30	$	129.50	42.53	14.172	193	0	3.0231	0.0060	3.0268	0.0062	3.0301	0.0055	0.6093	0.0008	0.0007	0.6090	0.0009	0.0007	0.6086	0.0008	0.0007	168318

[Test Run Date Codes # - 07/24/85 $ - 08/02/85]

Table 40D. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-4B Diameter 1.7496 Inches, Beta Ratio = 0.56957

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	69.938	42.56	25.724	108	0	10.028	0.0085	10.027	0.0141	10.034	0.0137	0.6073	0.0004	0.0004	0.6073	0.0005	0.0004	0.6071	0.0005	0.0004	305701
32	#	70.619	42.56	25.704	109	0	10.010	0.0098	10.012	0.0131	10.019	0.0129	0.6074	0.0004	0.0004	0.6073	0.0005	0.0004	0.6071	0.0005	0.0004	305456
33	#	70.686	42.57	25.657	109	0	9.966	0.0097	9.970	0.0121	9.977	0.0119	0.6076	0.0004	0.0004	0.6074	0.0005	0.0004	0.6072	0.0005	0.0004	304951
34	#	219.68	42.55	8.2201	181	0	1.0149	0.0023	1.0163	0.0021	1.0145	0.0020	0.6100	0.0016	0.0017	0.6096	0.0018	0.0017	0.6101	0.0016	0.0017	97668
35	#	220.44	42.55	8.2318	182	0	1.0172	0.0026	1.0185	0.0030	1.0174	0.0029	0.6102	0.0016	0.0017	0.6098	0.0019	0.0017	0.6101	0.0017	0.0017	97807
36	#	220.41	42.55	8.2379	182	0	1.0189	0.0023	1.0195	0.0022	1.0186	0.0024	0.6101	0.0016	0.0017	0.6099	0.0018	0.0017	0.6102	0.0017	0.0017	97879
37	#	350.86	42.54	5.2455	155	0	0.4117	0.0008	0.4119	0.0008	0.4116	0.0009	0.6112	0.0035	0.0038	0.6110	0.0041	0.0038	0.6112	0.0037	0.0038	62313
38	#	350.11	42.56	5.2489	150	0	0.4121	0.0007	0.4124	0.0008	0.4122	0.0008	0.6113	0.0035	0.0038	0.6111	0.0041	0.0038	0.6112	0.0037	0.0038	62376
39	#	350.20	42.56	5.2406	149	0	0.4115	0.0009	0.4112	0.0008	0.4106	0.0007	0.6108	0.0035	0.0038	0.6110	0.0041	0.0038	0.6114	0.0037	0.0038	62278

[Test Run Date Codes # - 08/02/85]

Table 40E. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-5B Diameter 2.0001 Inches, Beta Ratio = 0.65112

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	99.57	34.94	58.798	159	0	27.995	0.0100	28.005	0.0069	28.018	0.0061	0.6080	0.0002	0.0003	0.6078	0.0001	0.0003	0.6077	0.0001	0.0003	604398
2	#	99.84	34.95	58.813	159	0	28.018	0.0093	28.007	0.0058	28.015	0.0057	0.6078	0.0001	0.0003	0.6080	0.0001	0.0003	0.6079	0.0001	0.0003	604673
3	#	100.02	34.96	58.812	158	0	28.000	0.0113	28.001	0.0073	28.020	0.0048	0.6080	0.0002	0.0003	0.6080	0.0001	0.0003	0.6078	0.0001	0.0003	604788
4	#	161.88	34.95	35.338	200	0	10.076	0.0056	10.076	0.0044	10.077	0.0064	0.6090	0.0002	0.0004	0.6090	0.0002	0.0004	0.6090	0.0002	0.0004	363318
5	#	161.44	34.97	35.267	200	0	10.041	0.0051	10.035	0.0051	10.035	0.0052	0.6089	0.0002	0.0004	0.6091	0.0002	0.0004	0.6091	0.0002	0.0004	362732
6	#	161.38	34.98	35.245	200	0	10.023	0.0035	10.023	0.0040	10.028	0.0046	0.6090	0.0002	0.0004	0.6090	0.0002	0.0004	0.6089	0.0002	0.0004	362582
7	#	200.53	34.95	7.1471	166	0	0.4064	0.0007	0.4059	0.0009	0.4064	0.0008	0.6133	0.0025	0.0039	0.6137	0.0027	0.0039	0.6134	0.0024	0.0039	73482
8	#	200.76	34.97	7.1219	166	0	0.4024	0.0010	0.4023	0.0011	0.4031	0.0011	0.6142	0.0026	0.0039	0.6143	0.0028	0.0039	0.6137	0.0025	0.0039	73252
9	#	199.49	34.99	7.1285	165	0	0.4038	0.0007	0.4027	0.0009	0.4036	0.0008	0.6137	0.0025	0.0039	0.6145	0.0027	0.0039	0.6139	0.0024	0.0039	73349
10	#	95.587	35.04	19.214	146	0	2.9612	0.0037	2.9587	0.0045	2.9618	0.0053	0.6109	0.0005	0.0007	0.6111	0.0006	0.0007	0.6108	0.0007	0.0007	197901
11	#	96.186	35.05	19.227	152	0	2.9640	0.0053	2.9629	0.0057	2.9653	0.0048	0.6110	0.0007	0.0007	0.6111	0.0007	0.0007	0.6108	0.0006	0.0007	198070
12	#	95.404	35.06	19.229	149	0	2.9648	0.0060	2.9633	0.0058	2.9668	0.0059	0.6110	0.0007	0.0007	0.6111	0.0007	0.0007	0.6108	0.0007	0.0007	198133
13	#	53.599	35.10	35.262	84	1	10.032	0.0095	10.030	0.0067	10.028	0.0067	0.6091	0.0004	0.0004	0.6091	0.0004	0.0004	0.6092	0.0004	0.0004	363625
14	#	53.785	35.11	35.262	85	0	10.022	0.0100	10.022	0.0081	10.032	0.0063	0.6094	0.0004	0.0004	0.6094	0.0004	0.0004	0.6091	0.0004	0.0004	363698
15	#	54.034	35.12	35.237	83	0	10.013	0.0096	10.010	0.0079	10.023	0.0103	0.6092	0.0004	0.0004	0.6093	0.0004	0.0004	0.6089	0.0004	0.0004	363515
16	#	161.62	35.12	11.189	200	0	0.9976	0.0019	0.9971	0.0022	0.9987	0.0018	0.6129	0.0012	0.0017	0.6130	0.0013	0.0017	0.6125	0.0011	0.0017	115429
17	#	161.56	35.13	11.194	200	0	0.9984	0.0019	0.9981	0.0021	0.9991	0.0022	0.6129	0.0012	0.0017	0.6130	0.0013	0.0017	0.6127	0.0012	0.0017	115503
18	#	161.36	35.14	11.209	200	0	1.0013	0.0015	1.0013	0.0020	1.0018	0.0022	0.6129	0.0011	0.0017	0.6129	0.0012	0.0017	0.6127	0.0012	0.0017	115683
19	$	96.125	41.73	19.420	149	0	3.0361	0.0072	3.0339	0.0083	3.0389	0.0099	0.6104	0.0008	0.0007	0.6106	0.0009	0.0007	0.6101	0.0011	0.0007	227308
20	$	95.653	41.75	19.193	146	0	2.9634	0.0031	2.9617	0.0042	2.9650	0.0049	0.6106	0.0005	0.0007	0.6108	0.0006	0.0007	0.6104	0.0007	0.0007	224739
21	$	96.193	41.76	19.199	149	0	2.9678	0.0039	2.9628	0.0044	2.9666	0.0039	0.6103	0.0006	0.0007	0.6108	0.0006	0.0007	0.6105	0.0006	0.0007	224850
22	$	53.674	41.80	35.264	83	0	10.060	0.0062	10.061	0.0090	10.069	0.0090	0.6089	0.0004	0.0004	0.6089	0.0004	0.0004	0.6086	0.0004	0.0004	413292
23	$	53.602	41.80	35.255	83	0	10.050	0.0115	10.048	0.0112	10.057	0.0086	0.6090	0.0005	0.0004	0.6091	0.0005	0.0004	0.6088	0.0004	0.0004	413188
24	$	54.348	41.81	35.226	84	0	10.041	0.0083	10.039	0.0089	10.052	0.0075	0.6088	0.0004	0.0004	0.6089	0.0004	0.0004	0.6085	0.0004	0.0004	412924
25	$	200.57	41.76	7.0939	166	0	0.3994	0.0009	0.3996	0.0011	0.3995	0.0010	0.6147	0.0027	0.0039	0.6146	0.0030	0.0039	0.6146	0.0028	0.0039	83079
26	$	200.88	41.75	7.0351	166	0	0.3932	0.0009	0.3927	0.0009	0.3928	0.0009	0.6144	0.0028	0.0040	0.6149	0.0030	0.0040	0.6148	0.0029	0.0040	82375
27	$	200.84	41.76	7.0534	166	0	0.3953	0.0011	0.3944	0.0011	0.3946	0.0011	0.6144	0.0028	0.0040	0.6151	0.0031	0.0040	0.6150	0.0029	0.0040	82605
28	$	161.70	41.80	11.325	200	0	1.0249	0.0019	1.0247	0.0021	1.0244	0.0023	0.6126	0.0012	0.0017	0.6127	0.0013	0.0017	0.6128	0.0013	0.0017	132726
29	$	161.67	41.80	11.339	200	0	1.0278	0.0015	1.0272	0.0018	1.0264	0.0017	0.6125	0.0011	0.0017	0.6127	0.0013	0.0017	0.6129	0.0012	0.0017	132892
30	$	161.78	41.82	11.334	200	0	1.0265	0.0022	1.0258	0.0026	1.0256	0.0024	0.6127	0.0012	0.0017	0.6129	0.0014	0.0017	0.6129	0.0013	0.0017	132882

[Test Run Date Codes # - 07/25/85 $ - 08/02/85]

Table 40E. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-5B Diameter 2.0001 Inches, Beta Ratio = 0.65112

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	109.64	41.92	58.676	170	0	27.948	0.0056	27.948	0.0050	28.001	0.0059	0.6079	0.0001	0.0003	0.6078	0.0001	0.0003	0.6073	0.0001	0.0003	689188
32	#	109.48	41.92	58.674	170	1	27.957	0.0057	27.953	0.0055	27.993	0.0053	0.6077	0.0001	0.0003	0.6078	0.0001	0.0003	0.6073	0.0001	0.0003	689166
33	#	109.70	41.93	58.683	170	0	27.976	0.0077	27.967	0.0061	27.999	0.0059	0.6076	0.0001	0.0003	0.6077	0.0001	0.0003	0.6074	0.0001	0.0003	689398

[Test Run Date Codes # - 08/02/85]

Table 40F. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-6B Diameter 2.2499 Inches, Beta Ratio = 0.73244

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	120.44	33.07	15.762	188	0	1.0708	0.0031	1.0700	0.0037	1.0725	0.0034	0.6135	0.0013	0.0016	0.6137	0.0015	0.0016	0.6130	0.0013	0.0016	156010
2 #	120.36	33.09	15.549	186	0	1.0420	0.0023	1.0403	0.0025	1.0436	0.0027	0.6135	0.0012	0.0017	0.6140	0.0013	0.0017	0.6130	0.0012	0.0017	153962
3 #	119.77	33.10	15.538	183	0	1.0397	0.0019	1.0384	0.0020	1.0431	0.0021	0.6138	0.0011	0.0017	0.6141	0.0012	0.0017	0.6127	0.0011	0.0017	153886
4 #	173.49	33.13	9.976	200	0	0.4245	0.0014	0.4242	0.0019	0.4252	0.0018	0.6168	0.0026	0.0037	0.6170	0.0029	0.0037	0.6163	0.0026	0.0037	98861
5 #	174.54	33.16	9.788	200	0	0.4089	0.0007	0.4084	0.0008	0.4095	0.0008	0.6165	0.0025	0.0039	0.6169	0.0027	0.0039	0.6161	0.0024	0.0039	97058
6 #	174.29	33.18	9.775	200	0	0.4079	0.0007	0.4074	0.0009	0.4081	0.0010	0.6165	0.0025	0.0039	0.6168	0.0027	0.0039	0.6163	0.0025	0.0039	96969
7 #	38.310	33.24	47.900	60	0	10.039	0.0056	10.033	0.0088	10.051	0.0036	0.6089	0.0005	0.0004	0.6091	0.0005	0.0004	0.6085	0.0004	0.0004	475749
8 #	38.056	33.24	47.905	59	0	10.036	0.0078	10.036	0.0040	10.058	0.0030	0.6090	0.0005	0.0004	0.6090	0.0005	0.0004	0.6084	0.0004	0.0004	475797
9 #	37.667	33.24	47.900	59	0	10.022	0.0041	10.030	0.0053	10.062	0.0045	0.6094	0.0005	0.0004	0.6092	0.0005	0.0004	0.6082	0.0005	0.0004	475748
10 #	70.233	33.29	26.744	110	0	3.1035	0.0111	3.1038	0.0145	3.1076	0.0123	0.6115	0.0012	0.0007	0.6114	0.0015	0.0007	0.6111	0.0013	0.0007	265901
11 #	70.203	33.30	26.511	109	0	3.0518	0.0033	3.0495	0.0045	3.0590	0.0043	0.6112	0.0005	0.0007	0.6115	0.0006	0.0007	0.6105	0.0006	0.0007	263634
12 #	69.461	33.31	26.531	109	0	3.0556	0.0054	3.0530	0.0080	3.0640	0.0075	0.6113	0.0007	0.0007	0.6116	0.0009	0.0007	0.6105	0.0008	0.0007	263891
16 #	79.509	33.40	79.706	126	0	27.923	0.0113	27.913	0.0075	27.983	0.0053	0.6075	0.0002	0.0003	0.6076	0.0001	0.0003	0.6069	0.0001	0.0003	794240
17 #	80.021	33.40	79.673	126	0	27.896	0.0083	27.890	0.0069	27.963	0.0067	0.6076	0.0001	0.0003	0.6076	0.0001	0.0003	0.6068	0.0001	0.0003	793912
18 #	79.468	33.39	79.704	125	0	27.918	0.0060	27.908	0.0041	27.986	0.0058	0.6076	0.0001	0.0003	0.6077	0.0001	0.0003	0.6068	0.0001	0.0003	794059
19 #	129.51	33.35	47.634	192	3	9.931	0.0052	9.929	0.0046	9.952	0.0039	0.6088	0.0002	0.0004	0.6089	0.0002	0.0004	0.6082	0.0002	0.0004	474170
20 #	129.93	33.38	47.935	199	0	10.051	0.0044	10.049	0.0043	10.080	0.0043	0.6090	0.0002	0.0004	0.6090	0.0002	0.0004	0.6081	0.0002	0.0004	477464
21 #	129.89	33.39	48.006	197	0	10.079	0.0054	10.079	0.0045	10.107	0.0046	0.6090	0.0002	0.0004	0.6090	0.0002	0.0004	0.6082	0.0002	0.0004	478267
22 $	38.395	41.87	47.726	59	0	10.008	0.0061	10.006	0.0051	10.048	0.0082	0.6084	0.0005	0.0004	0.6085	0.0005	0.0004	0.6072	0.0005	0.0004	560066
23 $	37.776	41.88	47.789	58	1	10.027	0.0048	10.031	0.0066	10.077	0.0064	0.6086	0.0005	0.0004	0.6085	0.0005	0.0004	0.6071	0.0005	0.0004	560904
24 $	37.781	41.89	47.794	58	0	10.032	0.0041	10.033	0.0048	10.070	0.0044	0.6085	0.0005	0.0004	0.6085	0.0005	0.0004	0.6074	0.0005	0.0004	561070
25 $	174.69	41.86	9.779	200	0	0.4111	0.0010	0.4121	0.0011	0.4123	0.0010	0.6151	0.0027	0.0038	0.6143	0.0029	0.0038	0.6141	0.0028	0.0039	114734
26 $	184.35	41.89	9.819	200	0	0.4143	0.0010	0.4158	0.0013	0.4154	0.0013	0.6153	0.0027	0.0038	0.6142	0.0029	0.0038	0.6144	0.0028	0.0038	115274
27 $	185.76	41.92	9.796	200	0	0.4122	0.0009	0.4131	0.0011	0.4133	0.0009	0.6153	0.0027	0.0038	0.6147	0.0029	0.0038	0.6146	0.0027	0.0038	115060
28 $	69.793	41.98	26.603	107	0	3.0909	0.0043	3.0894	0.0039	3.1003	0.0042	0.6103	0.0006	0.0007	0.6104	0.0006	0.0007	0.6093	0.0006	0.0007	312813
29 $	69.690	41.99	26.624	107	0	3.0982	0.0043	3.0937	0.0038	3.1022	0.0030	0.6100	0.0006	0.0007	0.6104	0.0006	0.0007	0.6096	0.0005	0.0007	313114
30 $	70.325	41.99	26.612	105	0	3.0919	0.0054	3.0929	0.0067	3.1017	0.0064	0.6104	0.0007	0.0007	0.6103	0.0008	0.0007	0.6094	0.0008	0.0007	312976
31 $	120.11	42.00	15.453	180	0	1.0347	0.0018	1.0346	0.0023	1.0370	0.0026	0.6127	0.0012	0.0017	0.6127	0.0013	0.0017	0.6120	0.0013	0.0017	181776
32 $	119.96	42.05	15.445	181	0	1.0329	0.0014	1.0333	0.0025	1.0358	0.0022	0.6129	0.0011	0.0017	0.6128	0.0013	0.0017	0.6120	0.0013	0.0017	181844
33 $	120.27	42.07	15.484	179	0	1.0384	0.0020	1.0385	0.0025	1.0409	0.0020	0.6128	0.0012	0.0017	0.6128	0.0013	0.0017	0.6121	0.0012	0.0017	182367

[Test Run Date Codes # - 07/24/85 $ - 08/01/85]

Table 40F. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-6B Diameter 2.2499 Inches, Beta Ratio = 0.73244

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34	#	129.81	42.11	47.671	193	0	9.994	0.0039	9.991	0.0032	10.025	0.0048	0.6081	0.0002	0.0004	0.6082	0.0002	0.0004	0.6072	0.0002	0.0004	561878
35	#	129.60	42.10	47.889	198	0	10.077	0.0032	10.079	0.0032	10.120	0.0037	0.6084	0.0002	0.0004	0.6083	0.0002	0.0004	0.6071	0.0002	0.0004	564347
36	#	129.64	42.09	47.877	198	0	10.076	0.0064	10.074	0.0060	10.112	0.0058	0.6083	0.0002	0.0004	0.6083	0.0002	0.0004	0.6072	0.0002	0.0004	564097
37	#	79.815	42.15	79.813	123	0	28.127	0.0077	28.129	0.0084	28.213	0.0082	0.6069	0.0001	0.0003	0.6069	0.0001	0.0003	0.6060	0.0001	0.0003	941416
38	#	79.859	42.13	79.680	123	0	28.023	0.0070	28.022	0.0071	28.117	0.0097	0.6070	0.0001	0.0003	0.6071	0.0001	0.0003	0.6060	0.0002	0.0003	939505
39	#	79.379	42.13	79.640	122	0	27.987	0.0088	27.991	0.0095	28.099	0.0107	0.6071	0.0002	0.0003	0.6071	0.0002	0.0003	0.6059	0.0002	0.0003	939026

[Test Run Date Codes # - 08/01/85]

Table 40G. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-7B Diameter 0.3756 Inches, Beta Ratio = 0.12227

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
76	#	1206.5	22.72	0.2297	136	2	0.0000	0.0000	0.4096	0.0002	0.4099	0.0002	0.0000	0.0000	0.0000	0.6139	0.0028	0.0043	0.6138	0.0027	0.0043	1812
77	#	1206.4	22.72	0.2293	136	1	0.0000	0.0000	0.4081	0.0001	0.4084	0.0001	0.0000	0.0000	0.0000	0.6140	0.0029	0.0043	0.6138	0.0027	0.0043	1808
78	#	1206.4	22.72	0.2295	136	0	0.0000	0.0000	0.4087	0.0001	0.4089	0.0001	0.0000	0.0000	0.0000	0.6141	0.0029	0.0043	0.6139	0.0027	0.0043	1810
79	#	702.53	22.70	0.3636	145	0	0.0000	0.0000	1.0364	0.0002	1.0365	0.0002	0.0000	0.0000	0.0000	0.6109	0.0011	0.0021	0.6109	0.0011	0.0021	2866
80	#	703.43	22.70	0.3636	145	1	0.0000	0.0000	1.0363	0.0001	1.0364	0.0001	0.0000	0.0000	0.0000	0.6109	0.0011	0.0021	0.6109	0.0011	0.0021	2866
81	#	701.02	22.69	0.3634	144	1	0.0000	0.0000	1.0352	0.0002	1.0355	0.0002	0.0000	0.0000	0.0000	0.6110	0.0011	0.0021	0.6109	0.0011	0.0021	2864
82	#	572.95	22.69	0.6177	142	5	0.0000	0.0000	3.0104	0.0026	3.0118	0.0022	0.0000	0.0000	0.0000	0.6089	0.0005	0.0012	0.6088	0.0004	0.0012	4868
83	#	572.85	22.69	0.6189	142	7	0.0000	0.0000	3.0217	0.0017	3.0242	0.0026	0.0000	0.0000	0.0000	0.6089	0.0004	0.0012	0.6087	0.0005	0.0012	4877
84	#	572.65	22.69	0.6182	142	4	0.0000	0.0000	3.0183	0.0028	3.0202	0.0024	0.0000	0.0000	0.0000	0.6087	0.0005	0.0012	0.6085	0.0004	0.0012	4872
85	#	310.60	22.71	1.1233	154	0	0.0000	0.0000	10.047	0.0017	10.048	0.0015	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6061	0.0001	0.0009	8857
86	#	310.95	22.71	1.1242	154	0	0.0000	0.0000	10.061	0.0018	10.061	0.0020	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6062	0.0002	0.0009	8864
87	#	311.01	22.70	1.1263	154	0	0.0000	0.0000	10.099	0.0023	10.100	0.0027	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6062	0.0002	0.0009	8878
88	#	311.00	22.27	1.1228	154	0	0.0000	0.0000	10.036	0.0038	10.036	0.0041	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6062	0.0002	0.0009	8761
89	#	310.86	22.28	1.1216	154	0	0.0000	0.0000	10.015	0.0026	10.015	0.0027	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6062	0.0002	0.0009	8754
90	#	310.90	22.28	1.1214	154	0	0.0000	0.0000	10.010	0.0034	10.012	0.0036	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6061	0.0002	0.0009	8752
91	#	185.99	22.73	1.8750	171	0	0.0000	0.0000	28.087	0.0045	28.086	0.0047	0.0000	0.0000	0.0000	0.6051	0.0001	0.0008	0.6051	0.0001	0.0008	14791
92	#	185.08	22.75	1.8694	170	0	0.0000	0.0000	27.915	0.0182	27.911	0.0196	0.0000	0.0000	0.0000	0.6052	0.0002	0.0008	0.6052	0.0002	0.0008	14753
93	#	186.08	22.74	1.8687	171	0	0.0000	0.0000	27.891	0.0097	27.891	0.0097	0.0000	0.0000	0.0000	0.6052	0.0002	0.0008	0.6052	0.0002	0.0008	14744
94	$	185.85	22.78	1.8738	170	12	0.0000	0.0000	28.053	0.0034	28.052	0.0029	0.0000	0.0000	0.0000	0.6051	0.0001	0.0008	0.6051	0.0001	0.0008	14799
95	$	184.62	22.78	1.8760	169	0	0.0000	0.0000	28.108	0.0086	28.107	0.0080	0.0000	0.0000	0.0000	0.6052	0.0001	0.0008	0.6052	0.0001	0.0008	14816
96	$	185.91	22.79	1.8752	170	1	0.0000	0.0000	28.083	0.0107	28.086	0.0101	0.0000	0.0000	0.0000	0.6052	0.0002	0.0008	0.6052	0.0002	0.0008	14813
97	$	311.00	22.24	1.1265	154	0	0.0000	0.0000	10.103	0.0045	10.102	0.0038	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6062	0.0002	0.0009	8784
98	$	311.05	22.24	1.1267	154	1	0.0000	0.0000	10.102	0.0043	10.101	0.0048	0.0000	0.0000	0.0000	0.6063	0.0002	0.0009	0.6063	0.0002	0.0009	8785
99	$	310.82	22.24	1.1266	154	0	0.0000	0.0000	10.100	0.0041	10.098	0.0038	0.0000	0.0000	0.0000	0.6063	0.0002	0.0009	0.6064	0.0002	0.0009	8785
100	$	310.62	22.66	1.1219	154	0	0.0000	0.0000	10.021	0.0026	10.019	0.0026	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6062	0.0002	0.0009	8835
101	$	310.66	22.65	1.1220	154	0	0.0000	0.0000	10.022	0.0025	10.020	0.0028	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6062	0.0002	0.0009	8834
102	$	310.96	22.68	1.1214	154	0	0.0000	0.0000	10.011	0.0019	10.009	0.0023	0.0000	0.0000	0.0000	0.6062	0.0002	0.0009	0.6062	0.0001	0.0009	8836
103	$	572.90	22.64	0.6236	142	7	0.0000	0.0000	3.0713	0.0005	3.0699	0.0005	0.0000	0.0000	0.0000	0.6086	0.0004	0.0012	0.6088	0.0003	0.0012	4909
104	$	572.75	22.64	0.6237	142	8	0.0000	0.0000	3.0715	0.0007	3.0709	0.0007	0.0000	0.0000	0.0000	0.6087	0.0004	0.0012	0.6088	0.0003	0.0012	4910
105	$	572.62	22.65	0.6235	142	4	0.0000	0.0000	3.0734	0.0003	3.0722	0.0003	0.0000	0.0000	0.0000	0.6083	0.0004	0.0012	0.6084	0.0003	0.0012	4909

[Test Run Date Codes # - 01/21/87 $ - 01/22/87]

Table 40G. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-7B Diameter 0.3756 Inches, Beta Ratio = 0.12227

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
107	#	700.09	22.64	0.3672	143	0	0.0000	0.0000	1.0576	0.0012	1.0572	0.0013	0.0000	0.0000	0.0000	0.6108	0.0011	0.0021	0.6110	0.0010	0.0021	2890
108	#	703.44	22.64	0.3669	145	0	0.0000	0.0000	1.0554	0.0009	1.0552	0.0011	0.0000	0.0000	0.0000	0.6110	0.0011	0.0021	0.6110	0.0010	0.0021	2888
109	#	702.78	22.64	0.3668	145	0	0.0000	0.0000	1.0547	0.0013	1.0546	0.0012	0.0000	0.0000	0.0000	0.6110	0.0011	0.0021	0.6110	0.0010	0.0021	2887
110	#	1200.5	22.64	0.2277	135	0	0.0000	0.0000	0.4018	0.0004	0.4018	0.0004	0.0000	0.0000	0.0000	0.6145	0.0029	0.0044	0.6145	0.0024	0.0044	1792
111	#	1206.6	22.64	0.2299	136	0	0.0000	0.0000	0.4101	0.0002	0.4096	0.0002	0.0000	0.0000	0.0000	0.6140	0.0028	0.0043	0.6144	0.0023	0.0043	1810
112	#	1206.6	22.64	0.2299	136	0	0.0000	0.0000	0.4097	0.0002	0.4093	0.0002	0.0000	0.0000	0.0000	0.6143	0.0028	0.0043	0.6146	0.0023	0.0043	1810

[Test Run Date Codes # - 01/22/87]

Table 40H. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-8B Diameter 0.2506 Inches, Beta Ratio = 0.08158

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34 #	702.90	30.42	0.2717	145	0	3.0376	0.0023	3.0366	0.0015	3.0474	0.0005	0.5995	0.0004	0.0015	0.5996	0.0004	0.0015	0.5985	0.0003	0.0015	2545
35 #	701.79	30.54	0.2716	145	0	3.0478	0.0011	3.0471	0.0005	3.0478	0.0005	0.5984	0.0004	0.0015	0.5984	0.0004	0.0015	0.5984	0.0003	0.0015	2550
36 #	700.42	30.54	0.2718	144	1	3.0522	0.0006	3.0511	0.0005	3.0521	0.0004	0.5984	0.0003	0.0015	0.5986	0.0004	0.0015	0.5985	0.0003	0.0015	2552
37 #	412.13	30.66	0.4899	146	0	9.991	0.0063	9.991	0.0057	9.991	0.0064	0.5961	0.0002	0.0012	0.5961	0.0002	0.0012	0.5961	0.0002	0.0012	4612
38 #	412.17	30.68	0.4946	146	0	10.184	0.0214	10.181	0.0214	10.180	0.0217	0.5961	0.0006	0.0012	0.5962	0.0006	0.0012	0.5962	0.0007	0.0012	4658
39 #	411.91	30.68	0.4947	146	0	10.185	0.0039	10.185	0.0036	10.185	0.0038	0.5961	0.0002	0.0012	0.5961	0.0002	0.0012	0.5961	0.0002	0.0012	4659
40 #	236.38	31.58	0.8153	155	0	27.794	0.0089	27.792	0.0117	27.793	0.0119	0.5948	0.0002	0.0011	0.5948	0.0002	0.0011	0.5948	0.0002	0.0011	7825
41 #	245.67	31.62	0.7987	159	0	26.660	0.0246	26.658	0.0241	26.660	0.0288	0.5949	0.0003	0.0011	0.5950	0.0003	0.0011	0.5949	0.0003	0.0011	7672
42 #	245.55	31.64	0.8188	167	0	28.028	0.0021	28.019	0.0026	28.020	0.0026	0.5949	0.0001	0.0011	0.5950	0.0001	0.0011	0.5949	0.0001	0.0011	7868
43 #	1206.1	30.61	0.0993	136	0	0.4073	0.0009	0.4084	0.0008	0.4074	0.0008	0.5986	0.0025	0.0045	0.5977	0.0027	0.0045	0.5985	0.0024	0.0045	934
44 #	1206.3	30.30	0.0994	136	4	0.4103	0.0004	0.4104	0.0003	0.4098	0.0004	0.5970	0.0024	0.0045	0.5969	0.0026	0.0045	0.5974	0.0023	0.0045	929
45 #	1206.5	30.20	0.0992	136	4	0.4087	0.0006	0.4088	0.0003	0.4083	0.0002	0.5971	0.0024	0.0045	0.5970	0.0026	0.0045	0.5974	0.0023	0.0045	925
46 #	1206.1	30.37	0.1592	136	0	1.0424	0.0004	1.0407	0.0003	1.0414	0.0002	0.5999	0.0010	0.0024	0.6004	0.0010	0.0024	0.6002	0.0009	0.0024	1490
47 #	1206.5	30.39	0.1594	136	0	1.0440	0.0010	1.0436	0.0008	1.0442	0.0008	0.6001	0.0010	0.0024	0.6002	0.0011	0.0024	0.6000	0.0009	0.0024	1492
48 #	1206.2	30.41	0.1598	136	0	1.0501	0.0004	1.0489	0.0004	1.0497	0.0004	0.6000	0.0010	0.0024	0.6003	0.0010	0.0024	0.6001	0.0009	0.0024	1496
50 #	1206.1	26.43	0.1101	136	0	0.4881	0.0017	0.4875	0.0016	0.4877	0.0015	0.6065	0.0023	0.0040	0.6069	0.0024	0.0040	0.6068	0.0022	0.0040	945
51 #	1206.1	28.89	0.1097	136	3	0.4906	0.0011	0.4899	0.0009	0.4901	0.0010	0.6030	0.0021	0.0040	0.6034	0.0023	0.0040	0.6032	0.0020	0.0040	994
52 #	1206.1	28.87	0.1565	136	3	1.0066	0.0038	1.0044	0.0037	1.0052	0.0035	0.6002	0.0015	0.0025	0.6008	0.0015	0.0025	0.6005	0.0014	0.0025	1418
53 #	1206.2	28.44	0.1570	136	0	1.0076	0.0020	1.0077	0.0020	1.0060	0.0031	0.6017	0.0012	0.0025	0.6016	0.0012	0.0025	0.6022	0.0013	0.0025	1409
54 #	1206.1	28.39	0.1570	136	1	1.0083	0.0029	1.0061	0.0028	1.0066	0.0026	0.6017	0.0013	0.0025	0.6023	0.0014	0.0025	0.6021	0.0012	0.0025	1408
55 #	703.73	28.45	0.2700	145	2	3.0145	0.0040	3.0114	0.0045	3.0132	0.0046	0.5980	0.0005	0.0015	0.5983	0.0006	0.0015	0.5982	0.0006	0.0015	2424
56 #	703.41	23.43	0.2694	145	0	2.9900	0.0026	2.9880	0.0025	2.9905	0.0025	0.5992	0.0004	0.0015	0.5994	0.0005	0.0015	0.5991	0.0004	0.0015	2418
57 #	703.25	28.43	0.2699	145	1	3.0045	0.0025	3.0020	0.0027	3.0037	0.0026	0.5987	0.0004	0.0015	0.5989	0.0005	0.0015	0.5988	0.0004	0.0015	2422
58 #	412.14	28.36	0.4881	146	0	9.903	0.0286	9.900	0.0294	9.902	0.0297	0.5964	0.0009	0.0012	0.5965	0.0009	0.0012	0.5964	0.0009	0.0012	4374
59 #	411.81	28.33	0.4865	146	2	9.860	0.0311	9.865	0.0330	9.863	0.0323	0.5958	0.0010	0.0012	0.5956	0.0010	0.0012	0.5957	0.0010	0.0012	4357
60 #	412.03	28.27	0.4901	146	1	10.003	0.0220	9.999	0.0249	9.998	0.0260	0.5958	0.0007	0.0012	0.5959	0.0008	0.0012	0.5959	0.0008	0.0012	4383
61 $	1206.1	27.88	0.1571	136	0	1.0090	0.0022	1.0097	0.0024	1.0087	0.0023	0.6014	0.0012	0.0025	0.6012	0.0012	0.0025	0.6015	0.0011	0.0025	1393
62 $	1206.3	27.85	0.1561	136	1	0.9957	0.0017	0.9961	0.0017	0.9956	0.0017	0.6016	0.0012	0.0025	0.6014	0.0011	0.0025	0.6016	0.0010	0.0025	1383
63 $	1206.3	27.58	0.1562	136	2	0.9961	0.0015	0.9965	0.0014	0.9959	0.0014	0.6019	0.0012	0.0025	0.6018	0.0010	0.0025	0.6019	0.0010	0.0025	1376

[Test Run Date Codes # - 09/10/85 $ - 09/11/85]

Table 40H. Orifice Discharge Coefficient Values - Meter Tube PE-3

Meter Tube PE-3ABC Diameter 3.0718 Inches -- Orifice Plate FE-3/4-8B Diameter 0.2506 Inches, Beta Ratio = 0.08158

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
64	#	1206.1	27.42	0.0984	136	3	0.3920	0.0008	0.3929	0.0009	0.3926	0.0008	0.6046	0.0028	0.0047	0.6040	0.0024	0.0047	0.6042	0.0024	0.0047	864
65	#	1206.1	27.37	0.0979	136	0	0.3866	0.0008	0.3871	0.0009	0.3871	0.0008	0.6058	0.0028	0.0048	0.6054	0.0025	0.0048	0.6054	0.0024	0.0048	858
66	#	1206.0	27.32	0.1002	136	0	0.4050	0.0008	0.4048	0.0008	0.4063	0.0012	0.6056	0.0027	0.0046	0.6057	0.0024	0.0046	0.6046	0.0024	0.0046	878
67	#	412.12	27.63	0.4916	146	1	10.052	0.0121	10.053	0.0127	10.052	0.0128	0.5961	0.0004	0.0012	0.5961	0.0004	0.0012	0.5961	0.0004	0.0012	4335
68	#	411.85	27.74	0.4851	146	0	9.782	0.0242	9.785	0.0234	9.785	0.0242	0.5963	0.0008	0.0012	0.5962	0.0007	0.0012	0.5962	0.0008	0.0012	4288
69	#	412.17	27.65	0.4898	146	0	9.972	0.0257	9.971	0.0259	9.971	0.0256	0.5963	0.0008	0.0012	0.5964	0.0008	0.0012	0.5964	0.0008	0.0012	4321
70	#	702.91	27.39	0.2728	145	0	3.0673	0.0063	3.0668	0.0051	3.0667	0.0051	0.5990	0.0007	0.0015	0.5990	0.0006	0.0015	0.5990	0.0006	0.0015	2393
71	#	703.64	27.33	0.2736	145	0	3.0866	0.0054	3.0858	0.0057	3.0858	0.0055	0.5988	0.0006	0.0015	0.5989	0.0006	0.0015	0.5989	0.0006	0.0015	2397
72	#	702.22	27.29	0.2734	145	1	3.0827	0.0082	3.0825	0.0079	3.0824	0.0080	0.5986	0.0009	0.0015	0.5986	0.0008	0.0015	0.5986	0.0008	0.0015	2393
61	$	412.18	29.32	0.4924	146	29	10.008	0.0027	10.009	0.0020	10.010	0.0026	0.5985	0.0002	0.0012	0.5985	0.0002	0.0012	0.5984	0.0002	0.0012	4505
62	$	244.84	30.59	0.8159	155	0	27.828	0.0082	27.824	0.0088	27.824	0.0087	0.5948	0.0001	0.0011	0.5948	0.0002	0.0011	0.5948	0.0002	0.0011	7670
63	$	245.41	30.95	0.8248	153	0	28.428	0.0714	28.412	0.0879	28.408	0.0863	0.5950	0.0008	0.0011	0.5952	0.0009	0.0011	0.5952	0.0009	0.0011	7812
64	$	245.89	30.94	0.8354	156	0	29.188	0.0062	29.181	0.0053	29.181	0.0052	0.5947	0.0001	0.0011	0.5948	0.0001	0.0011	0.5948	0.0001	0.0011	7911

[Test Run Date Codes # - 09/11/85 $ - 09/13/85]

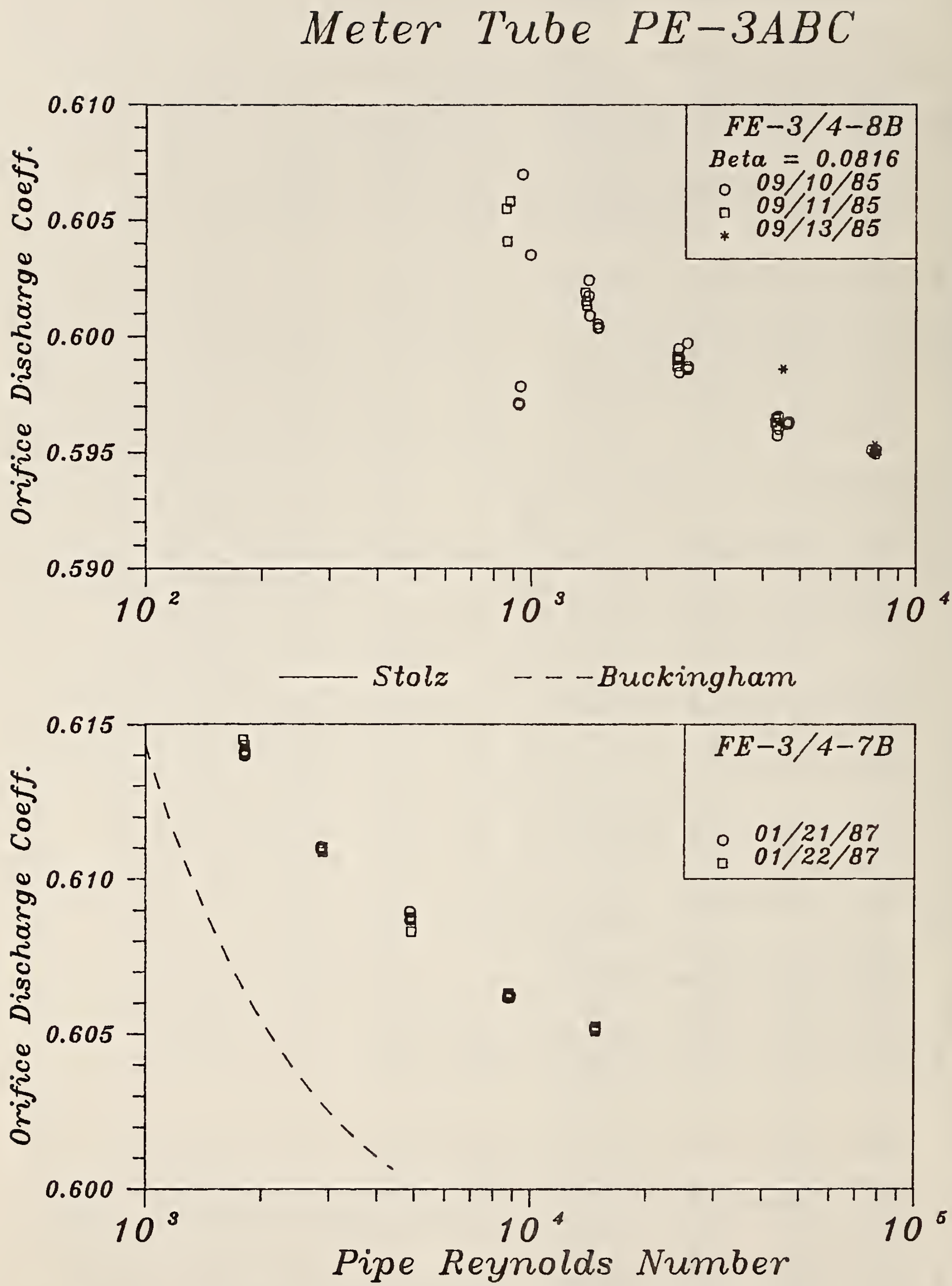
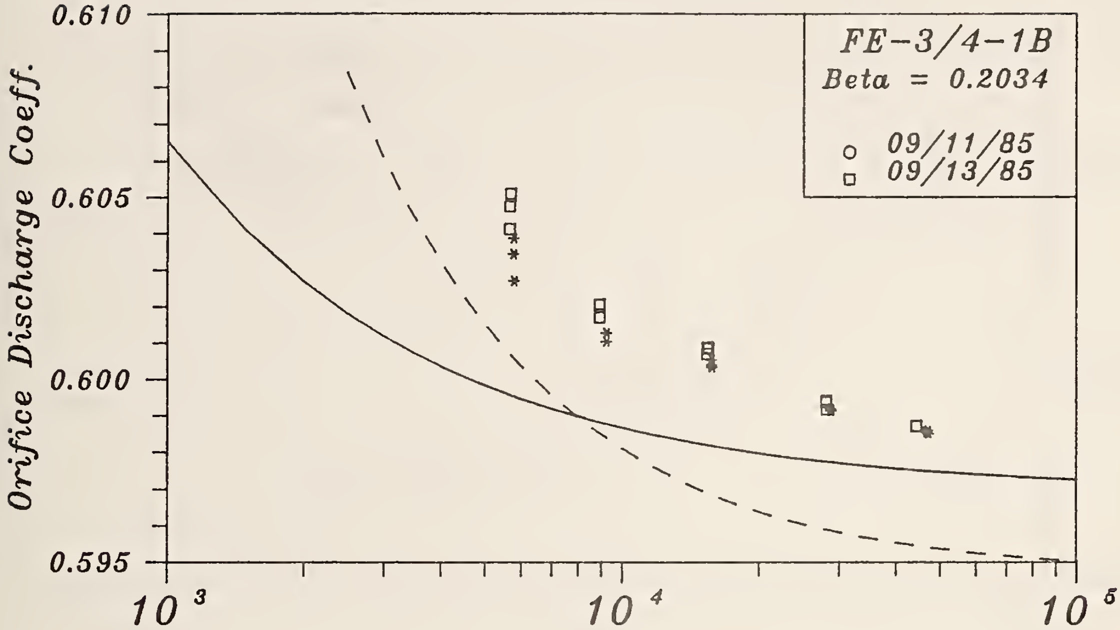


Figure 27A. Discharge Coefficient/Reynolds Number Plots, PE-3ABC 3-Inch Meter Tube, 8 Orifice Plates

Meter Tube PE-3ABC



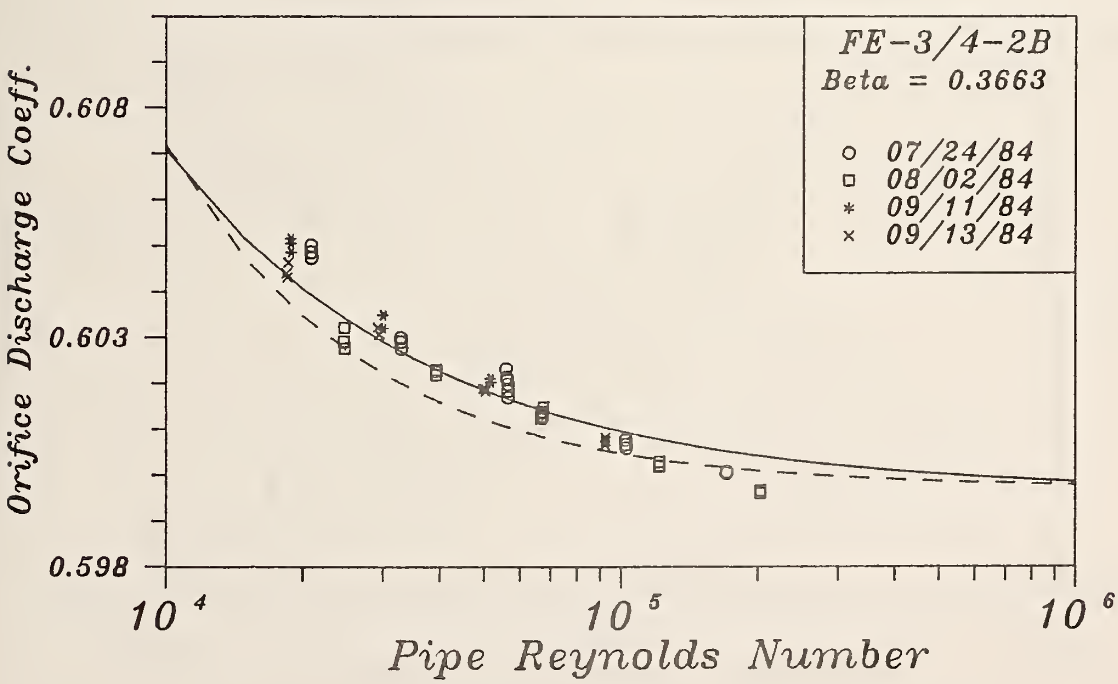


Figure 27B. Discharge Coefficient/Reynolds Number Plots, PE-3ABC 3-Inch Meter Tube, 8 Orifice Plates

Meter Tube PE-3ABC

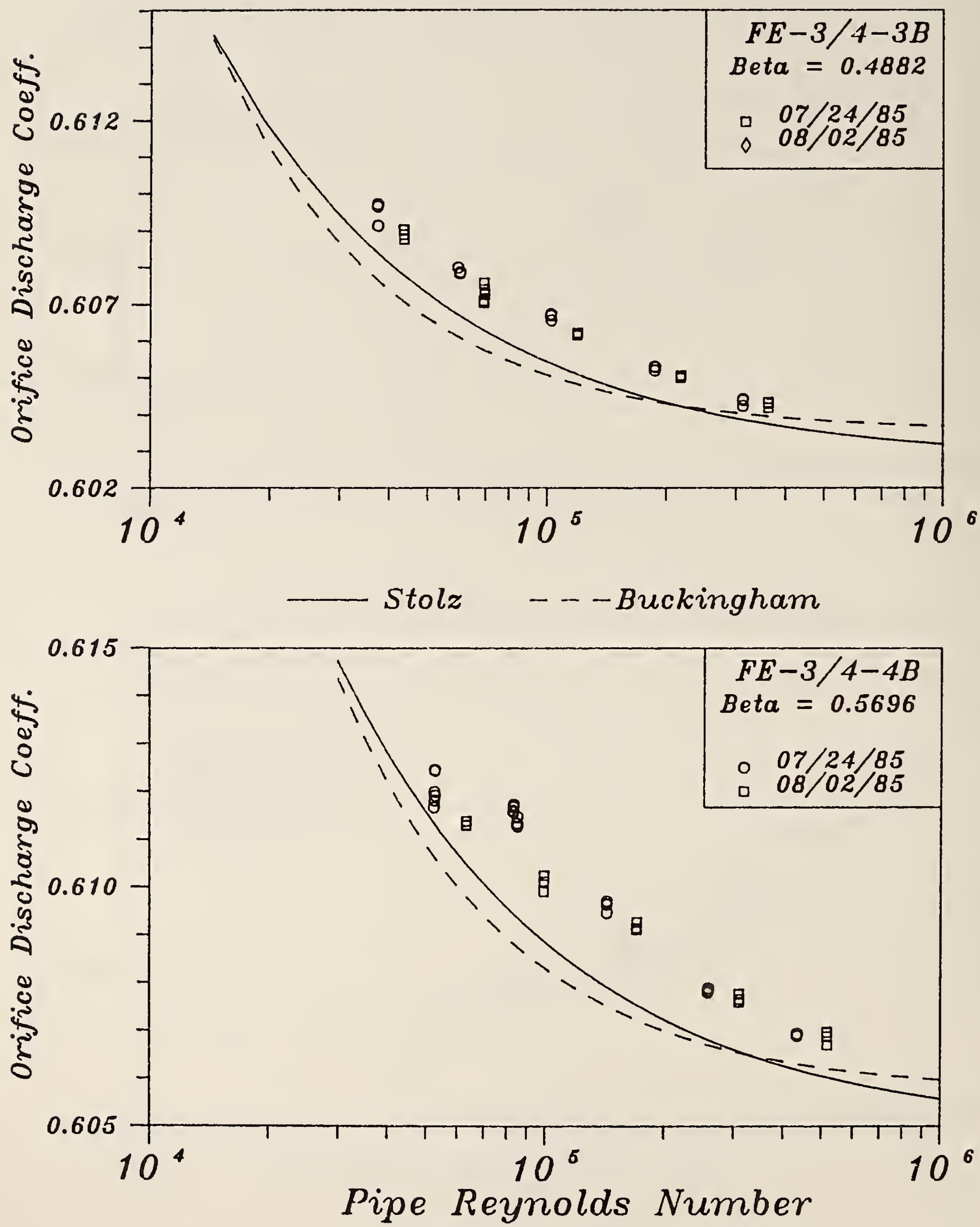


Figure 27C. Discharge Coefficient/Reynolds Number Plots, PE-3ABC 3-Inch Meter Tube, 8 Orifice Plates

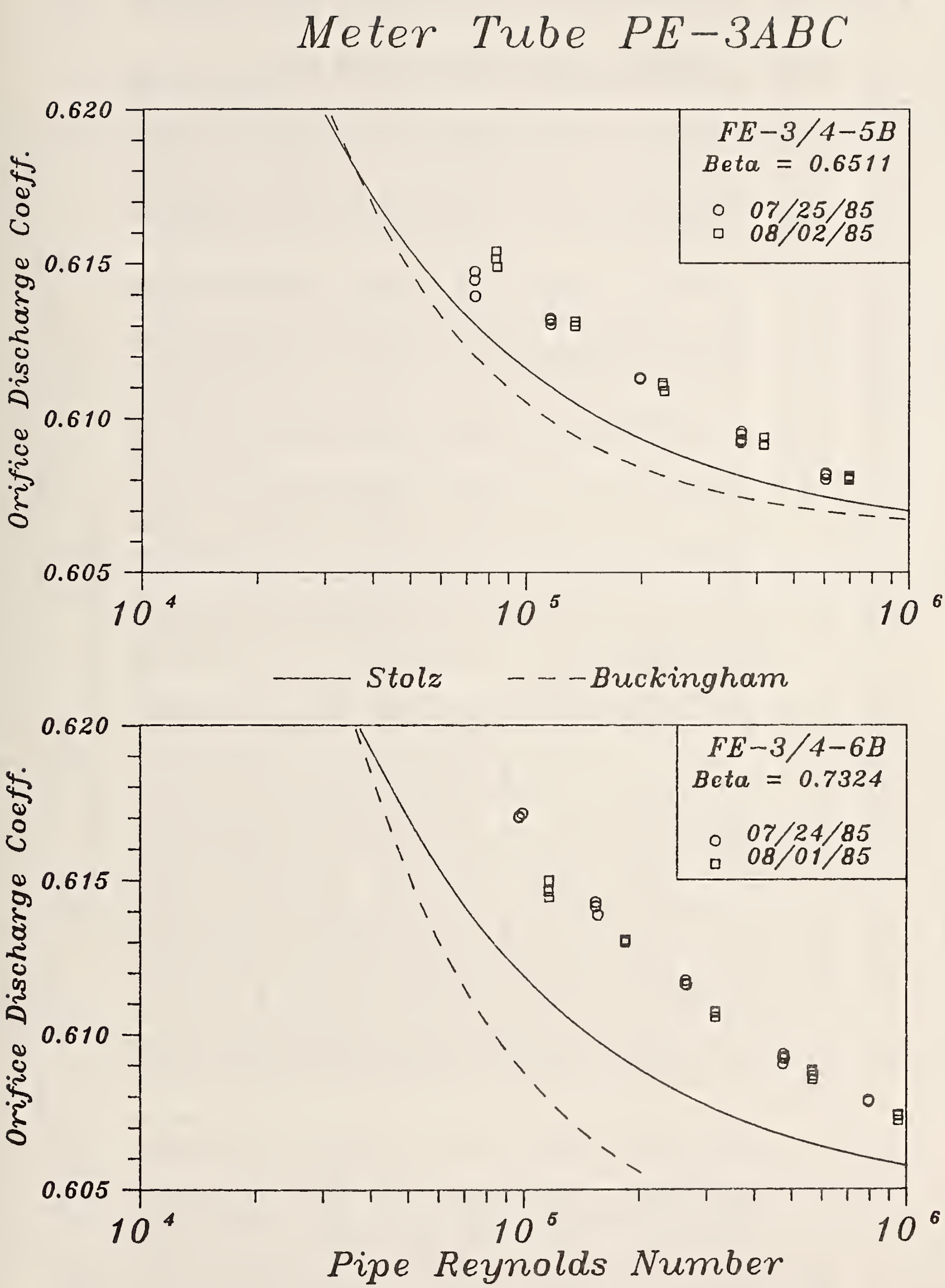


Figure 27D. Discharge Coefficient/Reynolds Number Plots, PE-3ABC 3-Inch Meter Tube, 8 Orifice Plates

Table 41A. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-1A Diameter 0.6248 Inches, Beta Ratio = 0.20321

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
16	#	220.42	32.85	1.6652	182	15	2.9636	0.0012	2.9628	0.0013	2.9639	0.0013	0.5981	0.0004	0.0009	0.5982	0.0004	0.0009	0.5981	0.0004	0.0009	16392
17	#	220.54	32.85	1.6828	182	0	3.0200	0.0009	3.0194	0.0010	3.0203	0.0010	0.5987	0.0004	0.0009	0.5988	0.0003	0.0009	0.5987	0.0003	0.0009	16565
18	#	220.53	32.85	1.6767	182	2	2.9972	0.0008	2.9968	0.0008	2.9972	0.0009	0.5988	0.0004	0.0009	0.5989	0.0003	0.0009	0.5988	0.0003	0.0009	16505
19	#	69.900	33.36	4.7887	97	3	24.587	0.0057	24.587	0.0052	24.585	0.0058	0.5972	0.0002	0.0005	0.5972	0.0002	0.0005	0.5972	0.0002	0.0005	47634
20	#	70.474	33.33	4.7857	98	0	24.561	0.0070	24.560	0.0076	24.563	0.0068	0.5971	0.0002	0.0005	0.5971	0.0003	0.0005	0.5971	0.0002	0.0005	47575
21	#	69.760	33.32	4.7842	97	7	24.542	0.0050	24.540	0.0067	24.539	0.0097	0.5971	0.0002	0.0005	0.5972	0.0002	0.0005	0.5972	0.0003	0.0005	47550
22	#	400.74	32.72	0.6153	153	0	0.4005	0.0005	0.4002	0.0006	0.4014	0.0006	0.6013	0.0025	0.0041	0.6015	0.0024	0.0041	0.6005	0.0023	0.0041	6041
23	#	401.37	32.71	0.6261	158	0	0.4143	0.0003	0.4136	0.0004	0.4151	0.0004	0.6015	0.0024	0.0039	0.6020	0.0023	0.0039	0.6009	0.0022	0.0039	6146
24	#	400.32	32.69	0.6281	151	0	0.4167	0.0002	0.4158	0.0002	0.4173	0.0002	0.6017	0.0024	0.0039	0.6023	0.0023	0.0039	0.6012	0.0022	0.0039	6163
25	#	379.99	32.76	0.9684	157	3	0.9957	0.0009	0.9944	0.0007	0.9955	0.0015	0.6001	0.0010	0.0019	0.6005	0.0010	0.0019	0.6001	0.0010	0.0019	9515
26	#	379.85	32.75	0.9685	157	6	0.9964	0.0002	0.9947	0.0003	0.9965	0.0003	0.5999	0.0010	0.0019	0.6005	0.0010	0.0019	0.5999	0.0009	0.0019	9514
27	#	379.86	32.75	0.9652	157	1	0.9882	0.0003	0.9870	0.0004	0.9888	0.0004	0.6003	0.0010	0.0019	0.6007	0.0010	0.0019	0.6001	0.0009	0.0019	9482
28	#	120.37	32.88	3.0636	166	3	10.048	0.0015	10.047	0.0017	10.048	0.0018	0.5976	0.0002	0.0006	0.5976	0.0002	0.0006	0.5976	0.0002	0.0006	30176
29	#	119.92	32.88	3.0100	167	0	9.696	0.0047	9.696	0.0041	9.696	0.0038	0.5977	0.0002	0.0006	0.5977	0.0002	0.0006	0.5977	0.0002	0.0006	29648
30	#	120.03	32.84	3.0525	167	0	9.974	0.0028	9.973	0.0028	9.975	0.0024	0.5976	0.0002	0.0006	0.5977	0.0002	0.0006	0.5976	0.0002	0.0006	30042
31	$	120.37	31.14	3.0575	164	5	9.998	0.0017	9.999	0.0016	10.000	0.0017	0.5977	0.0002	0.0006	0.5977	0.0002	0.0006	0.5977	0.0002	0.0006	29048
32	$	120.33	31.14	3.0685	167	0	10.070	0.0016	10.070	0.0014	10.070	0.0019	0.5978	0.0002	0.0006	0.5978	0.0002	0.0006	0.5978	0.0002	0.0006	29153
33	$	120.43	31.13	3.0657	161	1	10.050	0.0013	10.050	0.0015	10.050	0.0017	0.5978	0.0002	0.0006	0.5978	0.0002	0.0006	0.5978	0.0002	0.0006	29120
34	$	250.88	31.00	0.6219	156	1	0.4059	0.0001	0.4064	0.0001	0.4064	0.0001	0.6035	0.0028	0.0040	0.6031	0.0029	0.0040	0.6031	0.0025	0.0040	5891
35	$	249.91	31.02	0.6189	155	2	0.4042	0.0001	0.4045	0.0001	0.4046	0.0001	0.6018	0.0028	0.0040	0.6016	0.0029	0.0040	0.6015	0.0025	0.0040	5865
36	$	251.57	31.03	0.6181	156	0	0.4039	0.0001	0.4040	0.0001	0.4042	0.0001	0.6013	0.0028	0.0040	0.6012	0.0029	0.0040	0.6011	0.0025	0.0040	5859
37	$	120.29	31.08	1.6969	167	3	3.0667	0.0006	3.0655	0.0008	3.0661	0.0008	0.5990	0.0004	0.0009	0.5991	0.0004	0.0009	0.5990	0.0004	0.0009	16101
38	$	120.48	31.09	1.6959	167	1	3.0639	0.0005	3.0630	0.0006	3.0637	0.0005	0.5989	0.0004	0.0009	0.5990	0.0004	0.0009	0.5990	0.0004	0.0009	16095
39	$	119.70	31.07	1.6944	166	2	3.0568	0.0009	3.0557	0.0010	3.0566	0.0009	0.5991	0.0004	0.0009	0.5992	0.0004	0.0009	0.5991	0.0004	0.0009	16074
40	$	70.383	31.53	4.9962	98	0	26.754	0.0073	26.753	0.0072	26.752	0.0072	0.5971	0.0002	0.0005	0.5971	0.0002	0.0005	0.5972	0.0002	0.0005	47856
41	$	70.071	31.52	4.9970	97	1	26.759	0.0043	26.755	0.0050	26.758	0.0069	0.5972	0.0002	0.0005	0.5972	0.0002	0.0005	0.5972	0.0002	0.0005	47854
42	$	70.407	31.52	4.9974	98	2	26.768	0.0045	26.765	0.0041	26.763	0.0049	0.5971	0.0002	0.0005	0.5972	0.0002	0.0005	0.5972	0.0002	0.0005	47858
43	$	220.43	31.04	0.9824	182	9	1.0228	0.0003	1.0233	0.0004	1.0231	0.0005	0.6005	0.0011	0.0019	0.6004	0.0012	0.0019	0.6004	0.0010	0.0019	9314
44	$	220.55	31.05	0.9693	182	0	0.9966	0.0003	0.9968	0.0004	0.9968	0.0004	0.6002	0.0011	0.0019	0.6001	0.0012	0.0019	0.6001	0.0010	0.0019	9192
45	$	220.20	31.07	0.9726	182	4	1.0034	0.0002	1.0032	0.0003	1.0036	0.0002	0.6003	0.0011	0.0019	0.6003	0.0012	0.0019	0.6002	0.0010	0.0019	9227

[Test Run Date Codes # - 09/06/85 $ - 09/09/85]

Table 41B. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-2A Diameter 1.1250 Inches, Beta Ratio = 0.36589

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
21	#	164.57	31.48	2.0112	200	0	0.3939	0.0008	0.3947	0.0008	0.3945	0.0008	0.6061	0.0026	0.0040	0.6054	0.0026	0.0040	0.6056	0.0024	0.0040	19244
22	#	117.60	31.56	3.2221	162	0	1.0185	0.0029	1.0183	0.0026	1.0187	0.0027	0.6038	0.0013	0.0017	0.6039	0.0013	0.0017	0.6038	0.0012	0.0017	30882
23	#	118.37	31.58	3.2181	161	0	1.0163	0.0029	1.0162	0.0028	1.0169	0.0031	0.6037	0.0013	0.0017	0.6038	0.0013	0.0017	0.6036	0.0013	0.0017	30857
24	#	118.41	31.60	3.2237	163	0	1.0195	0.0025	1.0193	0.0026	1.0199	0.0024	0.6038	0.0013	0.0017	0.6039	0.0012	0.0017	0.6037	0.0012	0.0017	30923
25	#	67.637	31.72	5.5265	93	0	3.0086	0.0085	3.0080	0.0080	3.0072	0.0078	0.6026	0.0010	0.0008	0.6027	0.0009	0.0008	0.6027	0.0009	0.0008	53146
26	#	68.189	31.73	5.5150	91	0	2.9964	0.0090	2.9946	0.0094	2.9942	0.0095	0.6026	0.0010	0.0008	0.6028	0.0010	0.0008	0.6028	0.0010	0.0008	53046
27	#	68.389	31.74	5.5053	94	0	2.9830	0.0102	2.9812	0.0090	2.9819	0.0112	0.6029	0.0011	0.0008	0.6030	0.0010	0.0008	0.6030	0.0012	0.0008	52964
28	#	161.79	31.83	10.064	200	0	10.019	0.0139	10.020	0.0148	10.016	0.0136	0.6013	0.0004	0.0004	0.6013	0.0005	0.0004	0.6014	0.0004	0.0004	97002
29	#	162.33	31.87	10.083	200	2	10.081	0.0149	10.080	0.0158	10.075	0.0159	0.6006	0.0005	0.0004	0.6007	0.0005	0.0004	0.6008	0.0005	0.0004	97269
30	#	161.82	31.88	10.100	200	0	10.092	0.0122	10.094	0.0141	10.086	0.0152	0.6013	0.0004	0.0004	0.6012	0.0004	0.0004	0.6014	0.0005	0.0004	97446
31	#	107.76	31.94	16.777	148	0	27.905	0.0185	27.906	0.0191	27.888	0.0175	0.6007	0.0003	0.0003	0.6007	0.0003	0.0003	0.6009	0.0002	0.0003	162077
32	#	108.27	31.96	16.709	148	0	27.681	0.0118	27.678	0.0117	27.659	0.0107	0.6006	0.0002	0.0003	0.6007	0.0002	0.0003	0.6009	0.0002	0.0003	161484
33	#	108.28	31.99	16.777	149	0	27.927	0.0122	27.920	0.0109	27.903	0.0088	0.6004	0.0002	0.0003	0.6005	0.0002	0.0003	0.6007	0.0002	0.0003	162247
34	$	117.55	31.12	3.1954	163	0	1.0024	0.0003	1.0025	0.0004	1.0019	0.0003	0.6036	0.0012	0.0017	0.6036	0.0012	0.0017	0.6037	0.0010	0.0017	30346
35	$	118.42	31.11	3.1765	162	26	0.9877	0.0003	0.9875	0.0003	0.9869	0.0003	0.6045	0.0012	0.0018	0.6045	0.0012	0.0018	0.6047	0.0011	0.0018	30160
36	$	118.12	31.11	3.2113	164	0	1.0126	0.0003	1.0122	0.0004	1.0117	0.0003	0.6035	0.0011	0.0017	0.6036	0.0012	0.0017	0.6038	0.0010	0.0017	30490
37	$	164.19	31.09	2.0312	200	1	0.4038	0.0002	0.4031	0.0002	0.4036	0.0002	0.6045	0.0028	0.0039	0.6050	0.0029	0.0039	0.6047	0.0026	0.0039	19277
38	$	167.53	31.10	2.0137	200	0	0.3962	0.0013	0.3957	0.0013	0.3961	0.0013	0.6051	0.0030	0.0040	0.6055	0.0031	0.0040	0.6052	0.0028	0.0040	19115
39	$	168.19	31.10	2.0424	200	1	0.4079	0.0001	0.4075	0.0001	0.4078	0.0001	0.6048	0.0028	0.0038	0.6051	0.0029	0.0039	0.6048	0.0025	0.0038	19388
40	$	67.855	31.12	5.5311	93	0	3.0163	0.0008	3.0150	0.0009	3.0145	0.0015	0.6023	0.0005	0.0008	0.6024	0.0005	0.0008	0.6025	0.0004	0.0008	52527
41	$	68.415	31.11	5.5474	95	0	3.0321	0.0017	3.0308	0.0019	3.0301	0.0018	0.6025	0.0005	0.0008	0.6026	0.0005	0.0008	0.6027	0.0005	0.0008	52671
42	$	68.352	31.12	5.5468	95	0	3.0314	0.0011	3.0301	0.0011	3.0306	0.0007	0.6025	0.0005	0.0008	0.6026	0.0005	0.0008	0.6026	0.0004	0.0008	52676

[Test Run Date Codes # - 09/05/85 $ - 09/09/85]

Table 41C. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-3A Diameter 1.5000 Inches, Beta Ratio = 0.48785

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
4	#	99.97	37.70	3.7155	150	0	0.4056	0.0010	0.4052	0.0011	0.4047	0.0010	0.6088	0.0034	0.0038	0.6091	0.0035	0.0039	0.6095	0.0032	0.0038	40284
5	#	99.325	37.71	3.7101	148	0	0.4046	0.0010	0.4040	0.0014	0.4037	0.0012	0.6087	0.0034	0.0039	0.6091	0.0036	0.0039	0.6094	0.0032	0.0038	40233
6	#	99.97	37.72	3.7080	150	0	0.4040	0.0009	0.4033	0.0011	0.4029	0.0009	0.6088	0.0034	0.0039	0.6093	0.0036	0.0039	0.6096	0.0032	0.0039	40218
7	#	65.450	37.75	5.9106	98	0	1.0295	0.0031	1.0291	0.0030	1.0299	0.0033	0.6079	0.0016	0.0017	0.6080	0.0016	0.0017	0.6078	0.0016	0.0017	64146
8	#	65.100	37.76	5.9533	96	0	1.0454	0.0038	1.0449	0.0041	1.0455	0.0040	0.6076	0.0017	0.0016	0.6078	0.0018	0.0016	0.6076	0.0017	0.0016	64622
9	#	65.412	37.76	5.9716	98	0	1.0493	0.0024	1.0507	0.0027	1.0496	0.0026	0.6084	0.0015	0.0016	0.6079	0.0016	0.0016	0.6083	0.0014	0.0016	64820
10	#	300.49	37.80	5.8914	150	0	1.0248	0.0019	1.0234	0.0028	1.0239	0.0024	0.6073	0.0014	0.0017	0.6077	0.0016	0.0017	0.6076	0.0014	0.0017	63999
11	#	301.04	37.82	5.8882	150	0	1.0225	0.0022	1.0216	0.0023	1.0220	0.0020	0.6077	0.0015	0.0017	0.6079	0.0015	0.0017	0.6078	0.0014	0.0017	63989
12	#	300.16	37.83	5.8995	150	0	1.0269	0.0021	1.0254	0.0023	1.0257	0.0024	0.6076	0.0015	0.0017	0.6080	0.0015	0.0017	0.6079	0.0014	0.0017	64124
13	#	99.92	37.88	18.304	150	0	9.962	0.0129	9.966	0.0152	9.963	0.0149	0.6052	0.0004	0.0004	0.6051	0.0005	0.0004	0.6052	0.0005	0.0004	199150
14	#	101.05	37.90	18.404	151	0	10.072	0.0100	10.073	0.0113	10.073	0.0126	0.6052	0.0004	0.0004	0.6052	0.0004	0.0004	0.6052	0.0004	0.0004	200318
15	#	100.51	37.92	18.356	151	0	10.022	0.0150	10.021	0.0124	10.022	0.0104	0.6051	0.0005	0.0004	0.6051	0.0004	0.0004	0.6051	0.0004	0.0004	199870
16	#	161.72	37.91	10.011	200	0	2.9668	0.0042	2.9667	0.0056	2.9674	0.0054	0.6065	0.0006	0.0007	0.6066	0.0008	0.0007	0.6065	0.0007	0.0007	108985
17	#	162.08	37.93	10.044	200	0	2.9856	0.0068	2.9860	0.0074	2.9868	0.0081	0.6066	0.0008	0.0007	0.6066	0.0009	0.0007	0.6065	0.0009	0.0007	109381
18	#	162.18	37.94	10.086	200	0	3.0138	0.0058	3.0119	0.0072	3.0122	0.0074	0.6063	0.0008	0.0007	0.6065	0.0009	0.0007	0.6064	0.0009	0.0007	109861
19	#	59.900	38.00	30.589	89	0	27.898	0.0134	27.905	0.0128	27.898	0.0093	0.6044	0.0003	0.0003	0.6043	0.0003	0.0003	0.6044	0.0003	0.0003	333582
20	#	60.275	38.01	30.632	87	0	27.975	0.0114	27.986	0.0139	27.982	0.0069	0.6044	0.0003	0.0003	0.6043	0.0003	0.0003	0.6043	0.0003	0.0003	334108
21	#	59.890	38.03	30.642	89	0	27.989	0.0139	28.000	0.0101	27.989	0.0124	0.6044	0.0003	0.0003	0.6043	0.0003	0.0003	0.6044	0.0003	0.0003	334344
22	$	59.519	32.60	30.640	82	0	27.928	0.0124	27.924	0.0134	27.895	0.0235	0.6046	0.0003	0.0003	0.6046	0.0003	0.0003	0.6049	0.0004	0.0003	300074
23	$	60.724	32.61	30.609	83	0	27.861	0.0143	27.857	0.0151	27.838	0.0196	0.6047	0.0003	0.0003	0.6047	0.0003	0.0003	0.6049	0.0003	0.0003	299825
24	$	59.343	32.62	30.596	82	0	27.828	0.0229	27.824	0.0277	27.806	0.0164	0.6048	0.0004	0.0003	0.6049	0.0004	0.0003	0.6051	0.0003	0.0003	299767
25	$	100.01	32.66	18.358	133	0	10.002	0.0162	10.003	0.0173	9.990	0.0159	0.6053	0.0005	0.0004	0.6053	0.0006	0.0004	0.6057	0.0005	0.0004	180014
26	$	100.16	32.68	18.362	136	0	10.008	0.0134	10.008	0.0144	9.995	0.0160	0.6052	0.0005	0.0004	0.6053	0.0005	0.0004	0.6056	0.0005	0.0004	180121
27	$	100.71	32.70	18.327	139	0	9.963	0.0105	9.963	0.0107	9.957	0.0100	0.6055	0.0004	0.0004	0.6055	0.0004	0.0004	0.6057	0.0004	0.0004	179853
28	$	162.19	32.74	10.132	200	0	3.0353	0.0056	3.0345	0.0056	3.0328	0.0054	0.6064	0.0007	0.0007	0.6065	0.0007	0.0007	0.6067	0.0006	0.0007	99510
29	$	161.66	32.77	10.146	200	0	3.0493	0.0054	3.0429	0.0055	3.0420	0.0066	0.6059	0.0006	0.0007	0.6065	0.0007	0.0007	0.6066	0.0007	0.0007	99713
30	$	161.84	32.79	10.151	200	0	3.0481	0.0050	3.0447	0.0059	3.0436	0.0059	0.6063	0.0006	0.0007	0.6066	0.0007	0.0007	0.6067	0.0007	0.0007	99798
31	$	300.50	32.81	5.8289	149	0	1.0031	0.0020	1.0013	0.0024	1.0011	0.0025	0.6069	0.0012	0.0017	0.6075	0.0012	0.0017	0.6075	0.0012	0.0017	57332
32	$	300.32	32.83	5.8168	149	0	0.9985	0.0016	0.9961	0.0017	0.9960	0.0018	0.6070	0.0011	0.0017	0.6078	0.0011	0.0017	0.6078	0.0011	0.0017	57236
33	$	301.63	32.84	5.8247	150	0	1.0012	0.0018	0.9991	0.0018	0.9989	0.0018	0.6070	0.0012	0.0017	0.6077	0.0011	0.0017	0.6077	0.0011	0.0017	57326

[Test Run Date Codes # - 07/26/85 $ - 09/05/85]

Table 41C. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-3A Diameter 1.5000 Inches, Beta Ratio = 0.48785

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34 #	65.040	32.99	5.8729	90	0	1.0165	0.0042	1.0140	0.0038	1.0147	0.0036	0.6075	0.0016	0.0017	0.6082	0.0015	0.0017	0.6080	0.0015	0.0017	57978
35 #	65.008	33.00	5.8822	90	0	1.0187	0.0037	1.0164	0.0038	1.0175	0.0035	0.6078	0.0015	0.0017	0.6084	0.0015	0.0017	0.6081	0.0014	0.0017	58082
36 #	64.901	33.00	5.8801	90	0	1.0182	0.0029	1.0159	0.0028	1.0161	0.0029	0.6077	0.0014	0.0017	0.6084	0.0013	0.0017	0.6083	0.0013	0.0017	58061
37 #	100.12	33.01	3.7150	133	0	0.4056	0.0014	0.4031	0.0015	0.4046	0.0012	0.6083	0.0027	0.0038	0.6102	0.0027	0.0039	0.6091	0.0025	0.0038	36690
38 #	99.72	33.02	3.7134	138	0	0.4057	0.0011	0.4033	0.0013	0.4042	0.0010	0.6080	0.0026	0.0038	0.6098	0.0027	0.0039	0.6091	0.0024	0.0038	36682
39 #	100.11	33.04	3.7241	139	0	0.4077	0.0009	0.4053	0.0008	0.4067	0.0007	0.6082	0.0026	0.0038	0.6100	0.0026	0.0039	0.6090	0.0023	0.0038	36803

[Test Run Date Codes # - 09/05/85]

Table 41D. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-4A Diameter 1.7508 Inches, Beta Ratio = 0.56942

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	42.824	38.05	43.053	64	0	27.980	0.0120	28.000	0.0180	28.005	0.0073	0.6072	0.0004	0.0003	0.6070	0.0004	0.0003	0.6070	0.0004	0.0003	469950
2	#	42.592	38.05	43.062	64	0	28.027	0.0106	28.011	0.0135	28.004	0.0096	0.6068	0.0004	0.0003	0.6070	0.0004	0.0003	0.6071	0.0004	0.0003	470048
3	#	42.585	38.05	43.034	64	0	27.985	0.0101	27.981	0.0086	27.972	0.0154	0.6069	0.0004	0.0003	0.6069	0.0004	0.0003	0.6070	0.0004	0.0003	469741
4	#	162.14	38.02	8.3163	200	0	1.0324	0.0019	1.0337	0.0020	1.0319	0.0023	0.6106	0.0014	0.0017	0.6102	0.0015	0.0016	0.6108	0.0014	0.0016	90726
5	#	161.75	38.03	8.3074	200	0	1.0293	0.0017	1.0306	0.0020	1.0278	0.0021	0.6109	0.0014	0.0017	0.6105	0.0015	0.0017	0.6114	0.0014	0.0017	90646
6	#	161.68	38.05	8.3030	200	0	1.0284	0.0018	1.0291	0.0018	1.0277	0.0020	0.6109	0.0014	0.0017	0.6106	0.0015	0.0017	0.6111	0.0014	0.0017	90633
7	#	130.36	38.09	14.280	187	0	3.0613	0.0066	3.0566	0.0057	3.0551	0.0052	0.6089	0.0008	0.0007	0.6094	0.0007	0.0007	0.6095	0.0007	0.0007	155999
8	#	130.29	38.10	14.228	192	0	3.0349	0.0057	3.0357	0.0060	3.0330	0.0056	0.6094	0.0007	0.0007	0.6093	0.0008	0.0007	0.6095	0.0007	0.0007	155461
9	#	130.48	38.12	14.169	196	0	3.0123	0.0062	3.0112	0.0064	3.0082	0.0068	0.6091	0.0008	0.0007	0.6092	0.0008	0.0007	0.6095	0.0008	0.0007	154868
10	#	69.877	38.16	25.836	105	0	10.060	0.0148	10.060	0.0162	10.049	0.0196	0.6077	0.0005	0.0004	0.6077	0.0006	0.0004	0.6081	0.0007	0.0004	282611
11	#	70.048	38.17	25.811	102	0	10.039	0.0178	10.038	0.0164	10.037	0.0160	0.6078	0.0006	0.0004	0.6078	0.0006	0.0004	0.6078	0.0006	0.0004	282397
12	#	69.915	38.19	25.758	105	0	9.999	0.0097	9.993	0.0145	9.995	0.0126	0.6077	0.0004	0.0004	0.6079	0.0005	0.0004	0.6078	0.0005	0.0004	281920
13	#	350.85	38.14	5.2031	155	0	0.4029	0.0012	0.4035	0.0010	0.4019	0.0009	0.6116	0.0035	0.0039	0.6111	0.0036	0.0039	0.6123	0.0032	0.0039	56894
14	#	351.57	38.15	5.1562	155	0	0.3953	0.0010	0.3957	0.0009	0.3943	0.0009	0.6119	0.0035	0.0039	0.6116	0.0036	0.0039	0.6126	0.0032	0.0039	56392
15	#	352.04	38.15	5.1687	155	0	0.3969	0.0007	0.3973	0.0007	0.3958	0.0006	0.6121	0.0035	0.0039	0.6118	0.0036	0.0039	0.6130	0.0032	0.0039	56528
16	#	351.19	38.18	5.0668	156	0	0.3814	0.0007	0.3814	0.0006	0.3804	0.0006	0.6121	0.0036	0.0041	0.6121	0.0037	0.0041	0.6129	0.0033	0.0041	55446
17	#	351.88	38.19	5.0791	154	0	0.3838	0.0012	0.3834	0.0009	0.3823	0.0008	0.6117	0.0037	0.0041	0.6120	0.0037	0.0041	0.6129	0.0033	0.0040	55591
18	#	351.60	38.21	5.0638	155	0	0.3811	0.0009	0.3811	0.0009	0.3802	0.0008	0.6120	0.0037	0.0041	0.6120	0.0038	0.0041	0.6127	0.0034	0.0041	55445
20	$	230.20	33.07	8.2863	190	0	1.0218	0.0022	1.0216	0.0023	1.0205	0.0022	0.6111	0.0012	0.0017	0.6112	0.0012	0.0017	0.6115	0.0011	0.0017	81938
21	$	229.29	33.10	8.2965	189	0	1.0247	0.0021	1.0244	0.0023	1.0232	0.0024	0.6110	0.0012	0.0017	0.6111	0.0012	0.0017	0.6115	0.0012	0.0017	82089
22	$	230.39	33.13	8.2913	190	0	1.0227	0.0017	1.0228	0.0018	1.0219	0.0018	0.6113	0.0011	0.0017	0.6112	0.0011	0.0017	0.6115	0.0011	0.0017	82088
23	$	339.48	33.15	5.2283	168	0	0.4043	0.0008	0.4049	0.0009	0.4044	0.0007	0.6130	0.0026	0.0039	0.6126	0.0026	0.0039	0.6130	0.0024	0.0039	51784
24	$	341.02	33.17	5.2469	169	0	0.4077	0.0003	0.4080	0.0004	0.4073	0.0003	0.6127	0.0025	0.0038	0.6124	0.0025	0.0038	0.6130	0.0023	0.0038	51989
25	$	341.50	33.20	5.2429	169	0	0.4072	0.0009	0.4071	0.0009	0.4065	0.0009	0.6126	0.0026	0.0038	0.6126	0.0026	0.0038	0.6131	0.0024	0.0038	51982
26	$	69.589	33.26	26.008	96	0	10.159	0.0139	10.159	0.0124	10.154	0.0119	0.6084	0.0005	0.0004	0.6083	0.0005	0.0004	0.6085	0.0004	0.0004	258175
27	$	70.245	33.27	26.083	97	0	10.220	0.0059	10.220	0.0054	10.218	0.0068	0.6083	0.0003	0.0004	0.6083	0.0003	0.0004	0.6084	0.0003	0.0004	258971
28	$	70.025	33.28	25.782	94	0	9.987	0.0087	9.986	0.0108	9.978	0.0085	0.6083	0.0004	0.0004	0.6083	0.0004	0.0004	0.6085	0.0004	0.0004	256038
29	$	130.04	33.31	14.411	179	0	3.1062	0.0043	3.1054	0.0043	3.1033	0.0048	0.6096	0.0006	0.0007	0.6097	0.0006	0.0007	0.6099	0.0006	0.0007	143198
30	$	130.21	33.34	14.449	179	0	3.1248	0.0056	3.1240	0.0061	3.1191	0.0061	0.6094	0.0007	0.0007	0.6095	0.0007	0.0007	0.6100	0.0007	0.0007	143666
31	$	130.14	33.36	14.435	179	0	3.1188	0.0071	3.1180	0.0064	3.1157	0.0062	0.6094	0.0008	0.0007	0.6095	0.0007	0.0007	0.6097	0.0007	0.0007	143586

[Test Run Date Codes # - 07/26/85 $ - 09/05/85]

Table 41D. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-4A Diameter 1.7508 Inches, Beta Ratio = 0.56942

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
32	#	42.799	33.44	43.080	59	0	27.957	0.0201	27.957	0.0219	27.938	0.0105	0.6075	0.0004	0.0003	0.6075	0.0004	0.0003	0.6077	0.0004	0.0003	429220
33	#	42.717	33.46	43.135	58	4	28.082	0.0215	28.080	0.0232	28.073	0.0243	0.6069	0.0004	0.0003	0.6069	0.0005	0.0003	0.6070	0.0005	0.0003	429944
34	#	43.351	33.47	43.088	60	0	27.974	0.0203	27.966	0.0171	27.934	0.0303	0.6074	0.0004	0.0003	0.6075	0.0004	0.0003	0.6078	0.0005	0.0003	429567

[Test Run Date Codes # - 09/05/85]

Table 41E. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-5A Diameter 2.0006 Inches, Beta Ratio = 0.65067

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
4 #	109.67	39.36	58.967	166	0	28.083	0.0110	28.079	0.0066	28.057	0.0063	0.6090	0.0002	0.0003	0.6091	0.0001	0.0003	0.6093	0.0001	0.0003	659977
5 #	109.67	39.35	58.944	160	0	28.056	0.0081	28.051	0.0051	28.022	0.0069	0.6091	0.0001	0.0003	0.6091	0.0001	0.0003	0.6094	0.0001	0.0003	659591
6 #	109.66	39.35	59.427	166	0	28.525	0.0083	28.526	0.0061	28.494	0.0114	0.6090	0.0001	0.0003	0.6090	0.0001	0.0003	0.6093	0.0002	0.0003	665001
8 $	161.60	35.73	11.351	200	0	1.0216	0.0014	1.0206	0.0015	1.0207	0.0012	0.6144	0.0012	0.0017	0.6146	0.0012	0.0017	0.6146	0.0011	0.0017	118420
9 $	161.29	35.76	11.349	200	0	1.0211	0.0019	1.0204	0.0022	1.0201	0.0023	0.6144	0.0013	0.0017	0.6146	0.0013	0.0017	0.6147	0.0012	0.0017	118470
10 $	161.25	35.79	11.320	200	0	1.0152	0.0014	1.0154	0.0018	1.0152	0.0016	0.6146	0.0012	0.0017	0.6145	0.0012	0.0017	0.6146	0.0011	0.0017	118234
11 $	110.19	35.90	58.922	166	0	28.007	0.0095	27.996	0.0048	27.994	0.0053	0.6091	0.0001	0.0003	0.6092	0.0001	0.0003	0.6092	0.0001	0.0003	616766
12 $	109.87	35.91	58.883	166	9	27.967	0.0147	27.946	0.0057	27.934	0.0069	0.6091	0.0002	0.0003	0.6093	0.0001	0.0003	0.6095	0.0001	0.0003	616481
13 $	109.33	35.91	58.851	162	1	27.937	0.0085	27.926	0.0061	27.916	0.0040	0.6091	0.0001	0.0003	0.6092	0.0001	0.0003	0.6093	0.0001	0.0003	616140
14 $	161.76	35.91	35.354	200	1	10.039	0.0037	10.044	0.0049	10.040	0.0053	0.6104	0.0002	0.0004	0.6102	0.0002	0.0004	0.6104	0.0002	0.0004	370137
15 $	161.48	35.94	35.424	200	0	10.082	0.0125	10.084	0.0135	10.080	0.0108	0.6103	0.0004	0.0004	0.6103	0.0004	0.0004	0.6104	0.0004	0.0004	371096
16 $	161.27	35.96	35.319	200	1	10.020	0.0068	10.020	0.0080	10.014	0.0083	0.6104	0.0003	0.0004	0.6104	0.0003	0.0004	0.6105	0.0003	0.0004	370136
17 $	54.786	35.99	35.363	80	1	10.046	0.0101	10.042	0.0094	10.032	0.0039	0.6103	0.0004	0.0004	0.6105	0.0004	0.0004	0.6108	0.0003	0.0004	370816
18 $	53.615	36.01	35.344	81	0	10.030	0.0043	10.034	0.0060	10.034	0.0055	0.6105	0.0004	0.0004	0.6104	0.0004	0.0004	0.6104	0.0004	0.0004	370763
19 $	54.011	36.02	35.229	80	0	9.973	0.0076	9.969	0.0084	9.956	0.0092	0.6102	0.0004	0.0004	0.6104	0.0004	0.0004	0.6108	0.0004	0.0004	369631
20 $	264.46	36.05	7.1616	164	0	0.4053	0.0012	0.4062	0.0016	0.4060	0.0016	0.6154	0.0030	0.0039	0.6147	0.0029	0.0039	0.6149	0.0028	0.0039	75186
21 $	264.65	36.06	7.1635	164	0	0.4048	0.0013	0.4055	0.0011	0.4055	0.0010	0.6159	0.0030	0.0039	0.6154	0.0028	0.0039	0.6154	0.0026	0.0039	75221
22 $	264.77	36.08	7.1150	164	0	0.3995	0.0009	0.3995	0.0008	0.3999	0.0008	0.6158	0.0030	0.0039	0.6158	0.0028	0.0039	0.6155	0.0026	0.0039	74741
23 $	95.901	36.15	19.759	142	0	3.1140	0.0043	3.1159	0.0053	3.1161	0.0054	0.6126	0.0006	0.0007	0.6124	0.0007	0.0007	0.6123	0.0006	0.0007	207848
24 $	96.084	36.16	19.731	145	0	3.1095	0.0045	3.1086	0.0060	3.1074	0.0064	0.6121	0.0006	0.0007	0.6122	0.0007	0.0007	0.6123	0.0007	0.0007	207596
25 $	95.992	36.18	19.737	145	0	3.1120	0.0048	3.1095	0.0053	3.1068	0.0058	0.6121	0.0006	0.0007	0.6123	0.0007	0.0007	0.6126	0.0007	0.0007	207736
26 @	96.119	31.14	19.366	132	0	2.9903	0.0040	2.9911	0.0049	2.9824	0.0053	0.6122	0.0006	0.0007	0.6122	0.0006	0.0007	0.6130	0.0007	0.0007	183986
27 @	95.631	31.15	19.429	131	0	3.0089	0.0039	3.0102	0.0039	3.0024	0.0036	0.6123	0.0006	0.0007	0.6122	0.0006	0.0007	0.6130	0.0005	0.0007	184626
28 @	96.483	31.16	19.361	129	0	2.9907	0.0066	2.9913	0.0065	2.9800	0.0057	0.6120	0.0008	0.0007	0.6120	0.0008	0.0007	0.6131	0.0007	0.0007	184015
29 @	264.76	31.18	7.1355	164	0	0.4191	0.0016	0.4021	0.0010	0.3998	0.0010	0.6026	0.0027	0.0037	0.6152	0.0026	0.0039	0.6169	0.0025	0.0036	67849
30 @	264.80	31.21	7.1314	164	0	0.4230	0.0007	0.4013	0.0009	0.3993	0.0009	0.5995	0.0024	0.0036	0.6155	0.0026	0.0039	0.6170	0.0025	0.0035	67852
31 @	264.70	31.22	7.1280	164	0	0.4240	0.0009	0.4006	0.0011	0.3987	0.0009	0.5985	0.0024	0.0036	0.6157	0.0027	0.0039	0.6172	0.0025	0.0034	67834
32 @	54.213	31.29	35.222	75	0	9.974	0.0051	9.951	0.0053	9.935	0.0095	0.6097	0.0004	0.0004	0.6104	0.0004	0.0004	0.6109	0.0004	0.0004	335683
33 @	54.228	31.31	35.262	75	0	9.994	0.0073	9.970	0.0087	9.957	0.0107	0.6098	0.0004	0.0004	0.6105	0.0004	0.0004	0.6109	0.0005	0.0004	336203
34 @	54.189	31.33	35.254	75	0	9.996	0.0058	9.973	0.0072	9.953	0.0068	0.6096	0.0004	0.0004	0.6103	0.0004	0.0004	0.6109	0.0004	0.0004	336273

[Test Run Date Codes # - 07/26/85 $ - 07/29/85 @ - 09/05/85]

Table 41E. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-5A Diameter 2.0006 Inches, Beta Ratio = 0.65067

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
35	#	161.66	31.34	11.304	200	0	1.0384	0.0017	1.0139	0.0020	1.0092	0.0022	0.6065	0.0011	0.0016	0.6138	0.0012	0.0017	0.6152	0.0012	0.0016	107847
36	#	161.95	31.36	11.312	200	0	1.0389	0.0012	1.0152	0.0017	1.0108	0.0019	0.6068	0.0010	0.0016	0.6138	0.0011	0.0017	0.6151	0.0011	0.0016	107963
37	#	161.74	31.39	11.290	200	0	1.0356	0.0019	1.0105	0.0020	1.0061	0.0024	0.6066	0.0011	0.0016	0.6140	0.0012	0.0017	0.6154	0.0012	0.0016	107826
38	#	109.91	31.48	58.933	152	5	27.969	0.0137	27.941	0.0142	27.920	0.0165	0.6092	0.0002	0.0003	0.6095	0.0002	0.0003	0.6098	0.0002	0.0003	563899
39	#	110.36	31.48	58.854	149	0	27.895	0.0073	27.867	0.0081	27.832	0.0084	0.6092	0.0001	0.0003	0.6095	0.0001	0.0003	0.6099	0.0001	0.0003	563146
40	#	109.58	31.50	58.834	151	0	27.893	0.0124	27.863	0.0105	27.826	0.0132	0.6090	0.0002	0.0003	0.6094	0.0002	0.0003	0.6098	0.0002	0.0003	563191

[Test Run Date Codes # - 09/05/85]

Table 41F. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-6A Diameter 2.2492 Inches, Beta Ratio = 0.73152

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	79.701	37.20	79.343	120	0	27.909	0.0069	27.918	0.0069	27.869	0.0040	0.6062	0.0001	0.0003	0.6061	0.0001	0.0003	0.6067	0.0001	0.0003	851954
2 #	79.881	37.21	79.328	120	0	27.894	0.0088	27.896	0.0086	27.865	0.0121	0.6063	0.0002	0.0003	0.6062	0.0002	0.0003	0.6066	0.0002	0.0003	851953
3 #	79.859	37.21	79.450	120	0	27.989	0.0106	27.988	0.0075	27.938	0.0082	0.6062	0.0002	0.0003	0.6062	0.0001	0.0003	0.6067	0.0001	0.0003	853265
4 #	129.65	37.15	47.577	194	0	9.991	0.0021	9.990	0.0022	9.978	0.0039	0.6075	0.0002	0.0004	0.6076	0.0002	0.0004	0.6079	0.0002	0.0004	510362
5 #	129.68	37.17	47.550	194	0	9.972	0.0030	9.978	0.0038	9.964	0.0039	0.6078	0.0002	0.0004	0.6076	0.0002	0.0004	0.6080	0.0002	0.0004	510278
6 #	129.53	37.19	47.521	194	0	9.965	0.0039	9.965	0.0045	9.953	0.0035	0.6077	0.0002	0.0004	0.6076	0.0002	0.0004	0.6080	0.0002	0.0004	510165
7 #	119.83	37.20	15.266	173	1	1.0135	0.0018	1.0139	0.0020	1.0115	0.0020	0.6121	0.0015	0.0017	0.6120	0.0015	0.0017	0.6127	0.0014	0.0017	163917
8 #	119.97	37.21	15.287	176	0	1.0161	0.0024	1.0166	0.0027	1.0148	0.0022	0.6122	0.0015	0.0017	0.6120	0.0016	0.0017	0.6125	0.0014	0.0017	164173
9 #	120.79	37.21	15.317	179	0	1.0205	0.0016	1.0211	0.0018	1.0180	0.0017	0.6120	0.0014	0.0017	0.6118	0.0015	0.0017	0.6128	0.0013	0.0017	164496
10 #	169.85	37.23	9.709	200	0	0.4069	0.0012	0.4071	0.0013	0.4062	0.0010	0.6144	0.0035	0.0039	0.6142	0.0036	0.0039	0.6149	0.0032	0.0039	104308
11 #	171.55	37.25	9.701	200	0	0.4051	0.0006	0.4059	0.0008	0.4052	0.0008	0.6152	0.0034	0.0039	0.6146	0.0035	0.0039	0.6151	0.0032	0.0039	104263
12 #	170.61	37.27	9.718	200	0	0.4076	0.0008	0.4076	0.0011	0.4067	0.0010	0.6145	0.0034	0.0039	0.6145	0.0035	0.0039	0.6151	0.0032	0.0039	104494
19 #	69.581	37.41	26.184	104	0	3.0042	0.0035	3.0029	0.0046	3.0027	0.0054	0.6098	0.0006	0.0007	0.6099	0.0007	0.0007	0.6100	0.0007	0.0007	282307
20 #	69.654	37.42	26.144	104	1	2.9895	0.0044	2.9920	0.0061	2.9891	0.0066	0.6104	0.0007	0.0007	0.6101	0.0008	0.0007	0.6104	0.0008	0.0007	281928
21 #	69.976	37.43	26.200	103	0	3.0074	0.0060	3.0045	0.0058	3.0027	0.0053	0.6099	0.0008	0.0007	0.6101	0.0008	0.0007	0.6103	0.0007	0.0007	282584
22 $	120.04	32.02	15.330	160	0	1.0192	0.0023	1.0196	0.0022	1.0161	0.0024	0.6125	0.0012	0.0017	0.6124	0.0012	0.0017	0.6134	0.0012	0.0017	148346
23 $	120.15	32.03	15.341	161	0	1.0212	0.0022	1.0210	0.0024	1.0173	0.0025	0.6123	0.0012	0.0017	0.6124	0.0012	0.0017	0.6135	0.0012	0.0017	148479
24 $	120.08	32.05	15.379	158	0	1.0255	0.0014	1.0257	0.0014	1.0226	0.0013	0.6126	0.0011	0.0017	0.6125	0.0011	0.0017	0.6135	0.0010	0.0017	148913
25 $	37.818	32.10	47.601	52	0	9.977	0.0089	9.977	0.0061	9.966	0.0058	0.6079	0.0005	0.0004	0.6079	0.0005	0.0004	0.6082	0.0005	0.0004	461386
26 $	38.520	32.11	47.638	53	1	9.993	0.0047	9.995	0.0066	9.981	0.0055	0.6078	0.0005	0.0004	0.6078	0.0005	0.0004	0.6082	0.0005	0.0004	461835
27 $	38.558	32.12	47.612	53	0	9.983	0.0050	9.982	0.0049	9.967	0.0084	0.6078	0.0005	0.0004	0.6079	0.0005	0.0004	0.6083	0.0005	0.0004	461685
28 $	69.758	32.14	26.326	96	0	3.0320	0.0035	3.0323	0.0039	3.0260	0.0026	0.6098	0.0005	0.0007	0.6098	0.0006	0.0007	0.6104	0.0005	0.0007	255383
29 $	70.180	32.16	26.119	93	1	2.9837	0.0050	2.9832	0.0049	2.9769	0.0038	0.6099	0.0007	0.0007	0.6100	0.0007	0.0007	0.6106	0.0006	0.0007	253481
30 $	69.872	32.18	26.451	96	0	3.0608	0.0052	3.0596	0.0047	3.0507	0.0054	0.6098	0.0007	0.0007	0.6100	0.0006	0.0007	0.6109	0.0007	0.0007	256807
31 $	178.38	32.23	9.892	200	0	0.4207	0.0013	0.4218	0.0014	0.4189	0.0011	0.6152	0.0026	0.0038	0.6144	0.0026	0.0037	0.6166	0.0024	0.0037	96141
32 $	187.76	32.27	10.024	200	8	0.4341	0.0009	0.4355	0.0008	0.4316	0.0009	0.6137	0.0025	0.0036	0.6127	0.0024	0.0036	0.6154	0.0023	0.0036	97499
33 $	175.97	32.30	9.652	200	0	0.4006	0.0007	0.4006	0.0007	0.3993	0.0007	0.6152	0.0026	0.0039	0.6152	0.0026	0.0039	0.6162	0.0024	0.0039	93946
34 $	80.241	32.44	79.326	108	0	27.846	0.0054	27.845	0.0061	27.798	0.0040	0.6064	0.0001	0.0003	0.6064	0.0001	0.0003	0.6069	0.0001	0.0003	774317
35 $	79.855	32.44	79.391	110	0	27.889	0.0052	27.885	0.0064	27.850	0.0071	0.6064	0.0001	0.0003	0.6065	0.0001	0.0003	0.6068	0.0001	0.0003	774945
36 $	79.731	32.45	79.369	110	1	27.871	0.0071	27.867	0.0083	27.830	0.0071	0.6064	0.0001	0.0003	0.6065	0.0001	0.0003	0.6069	0.0001	0.0003	774892

[Test Run Date Codes # - 07/25/85 $ - 09/05/85]

Table 41G. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-7A Diameter 0.3757 Inches, Beta Ratio = 0.12219

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
67	#	1206.5	22.55	0.2299	136	0	0.0000	0.0000	0.4086	0.0001	0.4088	0.0001	0.0000	0.0000	0.0000	0.6150	0.0028	0.0043	0.6148	0.0030	0.0043	1804
68	#	1200.0	22.56	0.2303	135	0	0.0000	0.0000	0.4096	0.0001	0.4096	0.0001	0.0000	0.0000	0.0000	0.6151	0.0028	0.0043	0.6151	0.0030	0.0043	1808
69	#	1206.6	22.57	0.2303	136	1	0.0000	0.0000	0.4096	0.0001	0.4095	0.0000	0.0000	0.0000	0.0000	0.6153	0.0028	0.0043	0.6153	0.0030	0.0043	1808
70	#	700.91	22.55	0.3620	143	1	0.0000	0.0000	1.0220	0.0001	1.0223	0.0001	0.0000	0.0000	0.0000	0.6122	0.0011	0.0022	0.6121	0.0012	0.0022	2841
71	#	701.57	22.56	0.3622	143	1	0.0000	0.0000	1.0229	0.0000	1.0233	0.0001	0.0000	0.0000	0.0000	0.6123	0.0011	0.0022	0.6121	0.0012	0.0022	2843
72	#	703.22	22.56	0.3623	145	2	0.0000	0.0000	1.0231	0.0001	1.0235	0.0001	0.0000	0.0000	0.0000	0.6123	0.0011	0.0022	0.6122	0.0012	0.0022	2844
73	#	572.68	22.54	0.6250	142	2	0.0000	0.0000	3.0749	0.0006	3.0754	0.0006	0.0000	0.0000	0.0000	0.6093	0.0004	0.0012	0.6093	0.0004	0.0012	4904
74	#	572.79	22.53	0.6254	142	2	0.0000	0.0000	3.0770	0.0012	3.0777	0.0011	0.0000	0.0000	0.0000	0.6095	0.0004	0.0012	0.6094	0.0004	0.0012	4906
75	#	569.72	22.54	0.6255	141	5	0.0000	0.0000	3.0763	0.0009	3.0766	0.0012	0.0000	0.0000	0.0000	0.6097	0.0004	0.0012	0.6097	0.0004	0.0012	4907
76	#	311.01	22.56	1.1248	154	0	0.0000	0.0000	10.026	0.0015	10.026	0.0015	0.0000	0.0000	0.0000	0.6072	0.0001	0.0009	0.6072	0.0002	0.0009	8829
77	#	310.12	22.56	1.1248	153	0	0.0000	0.0000	10.027	0.0021	10.026	0.0025	0.0000	0.0000	0.0000	0.6072	0.0002	0.0009	0.6072	0.0002	0.0009	8829
78	#	310.82	22.55	1.1249	154	0	0.0000	0.0000	10.028	0.0022	10.027	0.0024	0.0000	0.0000	0.0000	0.6072	0.0002	0.0009	0.6073	0.0002	0.0009	8828
79	#	311.02	22.12	1.1234	154	1	0.0000	0.0000	9.999	0.0024	9.999	0.0024	0.0000	0.0000	0.0000	0.6073	0.0002	0.0009	0.6073	0.0002	0.0009	8726
80	#	310.99	22.12	1.1249	154	0	0.0000	0.0000	10.026	0.0038	10.026	0.0041	0.0000	0.0000	0.0000	0.6073	0.0002	0.0009	0.6073	0.0002	0.0009	8738
81	#	309.19	22.13	1.1244	152	0	0.0000	0.0000	10.018	0.0032	10.017	0.0033	0.0000	0.0000	0.0000	0.6073	0.0002	0.0009	0.6073	0.0002	0.0009	8736
82	#	185.19	22.73	1.8782	169	0	0.0000	0.0000	28.058	0.0095	28.057	0.0114	0.0000	0.0000	0.0000	0.6061	0.0002	0.0008	0.6062	0.0002	0.0008	14802
83	#	185.40	22.70	1.8817	164	0	0.0000	0.0000	28.153	0.0053	28.153	0.0057	0.0000	0.0000	0.0000	0.6062	0.0001	0.0008	0.6062	0.0001	0.0008	14819
84	#	184.99	22.70	1.8807	169	0	0.0000	0.0000	28.126	0.0091	28.124	0.0097	0.0000	0.0000	0.0000	0.6062	0.0001	0.0008	0.6062	0.0002	0.0008	14811
92	$	311.00	22.13	1.1281	154	0	0.0000	0.0000	10.085	0.0022	10.085	0.0021	0.0000	0.0000	0.0000	0.6072	0.0002	0.0009	0.6072	0.0002	0.0009	8765
93	$	310.73	22.09	1.1283	154	0	0.0000	0.0000	10.087	0.0020	10.087	0.0023	0.0000	0.0000	0.0000	0.6073	0.0002	0.0009	0.6073	0.0002	0.0009	8758
94	$	310.84	22.11	1.1284	154	0	0.0000	0.0000	10.089	0.0033	10.091	0.0030	0.0000	0.0000	0.0000	0.6073	0.0002	0.0009	0.6072	0.0002	0.0009	8763
95	$	1206.5	22.12	0.2297	136	0	0.0000	0.0000	0.4065	0.0002	0.4065	0.0002	0.0000	0.0000	0.0000	0.6159	0.0031	0.0044	0.6158	0.0033	0.0044	1784
96	$	1206.7	22.12	0.2301	136	0	0.0000	0.0000	0.4077	0.0001	0.4078	0.0002	0.0000	0.0000	0.0000	0.6162	0.0031	0.0043	0.6161	0.0033	0.0043	1787
97	$	1206.6	22.12	0.2304	136	0	0.0000	0.0000	0.4085	0.0002	0.4087	0.0001	0.0000	0.0000	0.0000	0.6164	0.0031	0.0043	0.6163	0.0032	0.0043	1790
98	$	703.32	22.04	0.3611	145	1	0.0000	0.0000	1.0139	0.0001	1.0152	0.0001	0.0000	0.0000	0.0000	0.6130	0.0013	0.0022	0.6126	0.0013	0.0022	2800
99	$	699.35	22.08	0.3610	144	0	0.0000	0.0000	1.0140	0.0001	1.0156	0.0001	0.0000	0.0000	0.0000	0.6129	0.0013	0.0022	0.6124	0.0013	0.0022	2802
100	$	702.53	22.09	0.3611	145	1	0.0000	0.0000	1.0145	0.0001	1.0163	0.0002	0.0000	0.0000	0.0000	0.6128	0.0013	0.0022	0.6123	0.0013	0.0022	2803
101	$	572.95	22.09	0.6244	142	2	0.0000	0.0000	3.0662	0.0017	3.0687	0.0016	0.0000	0.0000	0.0000	0.6096	0.0005	0.0012	0.6093	0.0005	0.0012	4847
102	$	572.75	22.09	0.6233	142	2	0.0000	0.0000	3.0549	0.0012	3.0577	0.0014	0.0000	0.0000	0.0000	0.6096	0.0004	0.0012	0.6093	0.0005	0.0012	4838
103	$	572.80	22.09	0.6250	142	2	0.0000	0.0000	3.0710	0.0012	3.0736	0.0012	0.0000	0.0000	0.0000	0.6096	0.0004	0.0012	0.6094	0.0005	0.0012	4851

[Test Run Date Codes # - 01/23/87 $ - 01/27/87]

Table 41G. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-7A Diameter 0.3757 Inches, Beta Ratio = 0.12219

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
104 #	310.99	21.68	1.1243	154	0	0.0000	0.0000	10.012	0.0036	10.013	0.0030	0.0000	0.0000	0.0000	0.6073	0.0002	0.0009	0.6073	0.0002	0.0009	8642
105 #	310.77	21.70	1.1249	154	0	0.0000	0.0000	10.025	0.0032	10.027	0.0034	0.0000	0.0000	0.0000	0.6073	0.0002	0.0009	0.6072	0.0002	0.0009	8651
106 #	310.94	21.71	1.1249	154	0	0.0000	0.0000	10.026	0.0031	10.027	0.0032	0.0000	0.0000	0.0000	0.6073	0.0002	0.0009	0.6072	0.0002	0.0009	8653
107 #	185.03	22.35	1.8760	166	0	0.0000	0.0000	27.984	0.0082	27.982	0.0068	0.0000	0.0000	0.0000	0.6062	0.0001	0.0008	0.6062	0.0001	0.0008	14652
108 #	185.20	22.35	1.8754	166	0	0.0000	0.0000	27.962	0.0056	27.961	0.0052	0.0000	0.0000	0.0000	0.6062	0.0001	0.0008	0.6062	0.0001	0.0008	14648
109 #	185.07	22.35	1.8760	166	0	0.0000	0.0000	27.980	0.0070	27.980	0.0080	0.0000	0.0000	0.0000	0.6062	0.0001	0.0008	0.6062	0.0001	0.0008	14652

[Test Run Date Codes # - 01/30/87]

Table 41H. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-8A Diameter 0.2510 Inches, Beta Ratio = 0.08163

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
78	#	1206.5	22.00	0.1001	136	3	0.0000	0.0000	0.3984	0.0002	0.4004	0.0002	0.0000	0.0000	0.0000	0.6075	0.0027	0.0047	0.6060	0.0029	0.0047	775
79	#	1206.5	22.02	0.1006	136	1	0.0000	0.0000	0.4031	0.0002	0.4050	0.0002	0.0000	0.0000	0.0000	0.6074	0.0027	0.0046	0.6060	0.0029	0.0046	780
80	#	1206.5	22.02	0.1008	136	0	0.0000	0.0000	0.4046	0.0001	0.4065	0.0001	0.0000	0.0000	0.0000	0.6074	0.0027	0.0046	0.6060	0.0029	0.0046	781
81	#	1206.6	22.02	0.1008	136	0	0.0000	0.0000	0.4041	0.0004	0.4062	0.0004	0.0000	0.0000	0.0000	0.6074	0.0027	0.0046	0.6058	0.0029	0.0046	781
82	#	1206.7	22.03	0.1005	136	0	0.0000	0.0000	0.4021	0.0001	0.4040	0.0001	0.0000	0.0000	0.0000	0.6075	0.0027	0.0047	0.6061	0.0029	0.0047	779
83	#	1206.4	22.04	0.1006	136	1	0.0000	0.0000	0.4027	0.0001	0.4046	0.0001	0.0000	0.0000	0.0000	0.6076	0.0027	0.0047	0.6062	0.0029	0.0047	780
84	#	1206.5	22.07	0.1595	136	0	0.0000	0.0000	1.0256	0.0004	1.0274	0.0004	0.0000	0.0000	0.0000	0.6033	0.0011	0.0024	0.6027	0.0011	0.0024	1238
85	#	1206.7	22.07	0.1598	136	0	0.0000	0.0000	1.0296	0.0005	1.0314	0.0005	0.0000	0.0000	0.0000	0.6032	0.0011	0.0024	0.6027	0.0011	0.0024	1240
86	#	1206.7	22.07	0.1597	136	0	0.0000	0.0000	1.0282	0.0006	1.0302	0.0006	0.0000	0.0000	0.0000	0.6033	0.0011	0.0024	0.6027	0.0011	0.0024	1239
90	#	703.32	22.03	0.2751	145	3	0.0000	0.0000	3.0863	0.0007	3.0886	0.0009	0.0000	0.0000	0.0000	0.5998	0.0004	0.0015	0.5996	0.0004	0.0015	2132
91	#	704.19	22.04	0.2752	145	2	0.0000	0.0000	3.0893	0.0004	3.0913	0.0003	0.0000	0.0000	0.0000	0.5998	0.0004	0.0015	0.5996	0.0004	0.0015	2134
92	#	704.44	22.04	0.2755	145	2	0.0000	0.0000	3.0946	0.0003	3.0966	0.0004	0.0000	0.0000	0.0000	0.5999	0.0004	0.0015	0.5997	0.0004	0.0015	2136
93	#	773.60	22.05	0.4934	137	0	0.0000	0.0000	10.009	0.0020	10.010	0.0018	0.0000	0.0000	0.0000	0.5974	0.0001	0.0012	0.5973	0.0001	0.0012	3826
94	#	773.32	22.05	0.4933	137	0	0.0000	0.0000	10.007	0.0030	10.007	0.0025	0.0000	0.0000	0.0000	0.5973	0.0002	0.0012	0.5973	0.0002	0.0012	3826
95	#	773.25	22.05	0.4933	137	0	0.0000	0.0000	10.004	0.0019	10.005	0.0018	0.0000	0.0000	0.0000	0.5974	0.0001	0.0012	0.5973	0.0001	0.0012	3826
96	$	1206.5	22.10	0.1019	136	0	0.0000	0.0000	0.4138	0.0007	0.4142	0.0007	0.0000	0.0000	0.0000	0.6068	0.0027	0.0046	0.6065	0.0029	0.0046	791
97	$	1206.6	22.09	0.1021	136	0	0.0000	0.0000	0.4163	0.0007	0.4165	0.0006	0.0000	0.0000	0.0000	0.6066	0.0027	0.0045	0.6064	0.0029	0.0045	793
98	$	1206.5	22.08	0.1022	136	0	0.0000	0.0000	0.4167	0.0007	0.4170	0.0006	0.0000	0.0000	0.0000	0.6069	0.0027	0.0045	0.6066	0.0029	0.0045	793
99	$	1206.5	22.05	0.1599	136	0	0.0000	0.0000	1.0320	0.0007	1.0331	0.0006	0.0000	0.0000	0.0000	0.6031	0.0011	0.0024	0.6028	0.0012	0.0024	1240
100	$	1206.4	22.05	0.1600	136	0	0.0000	0.0000	1.0324	0.0007	1.0330	0.0006	0.0000	0.0000	0.0000	0.6031	0.0011	0.0024	0.6030	0.0012	0.0024	1241
101	$	1206.6	22.05	0.1599	136	0	0.0000	0.0000	1.0309	0.0008	1.0317	0.0007	0.0000	0.0000	0.0000	0.6033	0.0011	0.0024	0.6031	0.0012	0.0024	1240
102	$	704.25	22.02	0.2732	145	1	0.0000	0.0000	3.0431	0.0010	3.0442	0.0016	0.0000	0.0000	0.0000	0.6000	0.0004	0.0015	0.5999	0.0004	0.0015	2117
103	$	700.12	22.02	0.2732	144	0	0.0000	0.0000	3.0417	0.0007	3.0425	0.0006	0.0000	0.0000	0.0000	0.6001	0.0004	0.0015	0.6000	0.0004	0.0015	2117
104	$	703.93	22.02	0.2731	145	0	0.0000	0.0000	3.0408	0.0005	3.0418	0.0006	0.0000	0.0000	0.0000	0.6000	0.0004	0.0015	0.5999	0.0004	0.0015	2116
105	$	773.60	22.02	0.4928	137	0	0.0000	0.0000	9.976	0.0021	9.976	0.0019	0.0000	0.0000	0.0000	0.5977	0.0001	0.0012	0.5977	0.0001	0.0012	3819
106	$	773.59	22.02	0.4928	137	0	0.0000	0.0000	9.975	0.0024	9.977	0.0024	0.0000	0.0000	0.0000	0.5976	0.0001	0.0012	0.5976	0.0002	0.0012	3819
107	$	773.50	22.02	0.4928	137	0	0.0000	0.0000	9.973	0.0024	9.976	0.0028	0.0000	0.0000	0.0000	0.5977	0.0001	0.0012	0.5976	0.0002	0.0012	3819
108	$	773.53	21.62	0.4928	137	0	0.0000	0.0000	9.975	0.0041	9.976	0.0041	0.0000	0.0000	0.0000	0.5977	0.0002	0.0012	0.5976	0.0002	0.0012	3783
109	$	773.32	21.62	0.4935	137	0	0.0000	0.0000	10.007	0.0008	10.007	0.0009	0.0000	0.0000	0.0000	0.5975	0.0001	0.0012	0.5975	0.0001	0.0012	3788
110	$	773.56	21.61	0.4936	137	0	0.0000	0.0000	10.006	0.0021	10.006	0.0018	0.0000	0.0000	0.0000	0.5976	0.0001	0.0012	0.5976	0.0001	0.0012	3788

[Test Run Date Codes # - 01/28/87 $ - 01/29/87]

Table 41H. Orifice Discharge Coefficient Values - Meter Tube PE-4

Meter Tube PE-4ABC Diameter 3.0747 Inches -- Orifice Plate FE-3/4-8A Diameter 0.2510 Inches, Beta Ratio = 0.08163

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
114	#	461.68	22.23	0.8231	143	0	0.0000	0.0000	27.877	0.0072	27.874	0.0079	0.0000	0.0000	0.0000	0.5971	0.0001	0.0011	0.5971	0.0001	0.0011	6411
115	#	461.70	22.23	0.8230	143	0	0.0000	0.0000	27.870	0.0112	27.867	0.0098	0.0000	0.0000	0.0000	0.5971	0.0001	0.0011	0.5972	0.0001	0.0011	6410
116	#	461.49	22.24	0.8231	143	0	0.0000	0.0000	27.874	0.0073	27.871	0.0070	0.0000	0.0000	0.0000	0.5971	0.0001	0.0011	0.5971	0.0001	0.0011	6412
117	$	773.58	21.62	0.4937	137	0	0.0000	0.0000	10.011	0.0021	10.010	0.0019	0.0000	0.0000	0.0000	0.5977	0.0001	0.0012	0.5977	0.0001	0.0012	3790
118	$	773.37	21.62	0.4939	137	0	0.0000	0.0000	10.021	0.0037	10.020	0.0034	0.0000	0.0000	0.0000	0.5976	0.0002	0.0012	0.5976	0.0002	0.0012	3791
119	$	773.51	21.64	0.4940	137	0	0.0000	0.0000	10.024	0.0024	10.023	0.0021	0.0000	0.0000	0.0000	0.5976	0.0001	0.0012	0.5976	0.0001	0.0012	3794
120	$	461.61	22.20	0.8259	143	0	0.0000	0.0000	28.069	0.0037	28.067	0.0033	0.0000	0.0000	0.0000	0.5971	0.0001	0.0011	0.5971	0.0001	0.0011	6428
121	$	461.44	22.22	0.8264	143	0	0.0000	0.0000	28.094	0.0044	28.092	0.0038	0.0000	0.0000	0.0000	0.5972	0.0001	0.0011	0.5972	0.0001	0.0011	6435
122	$	461.67	22.23	0.8266	143	0	0.0000	0.0000	28.103	0.0045	28.103	0.0039	0.0000	0.0000	0.0000	0.5972	0.0001	0.0011	0.5972	0.0001	0.0011	6438

[Test Run Date Codes # - 01/29/87 $ - 01/30/87]

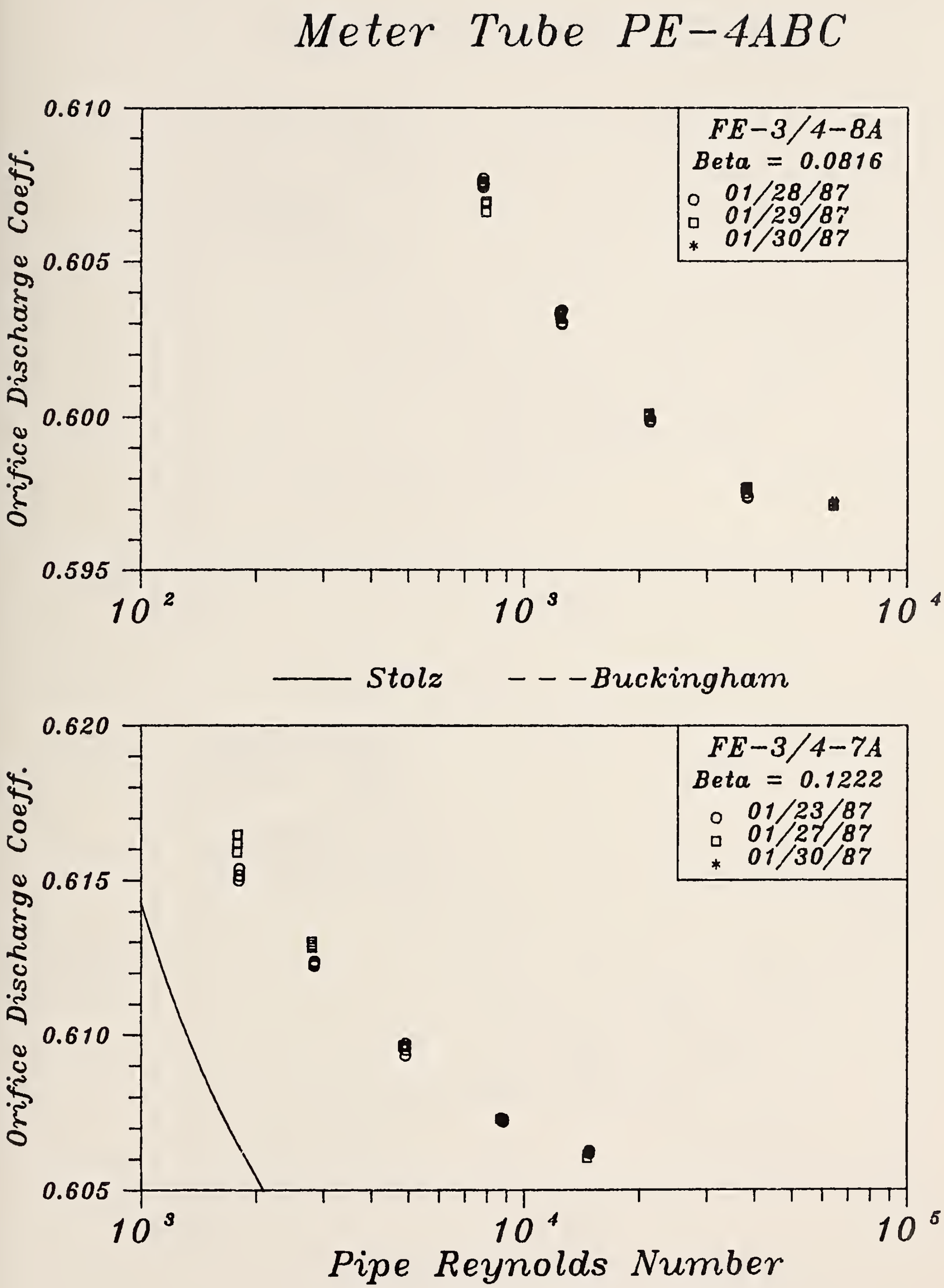


Figure 28A. Discharge Coefficient/Reynolds Number Plots, PE-4ABC 3-Inch Meter Tube, 8 Orifice Plates, Final Data Base

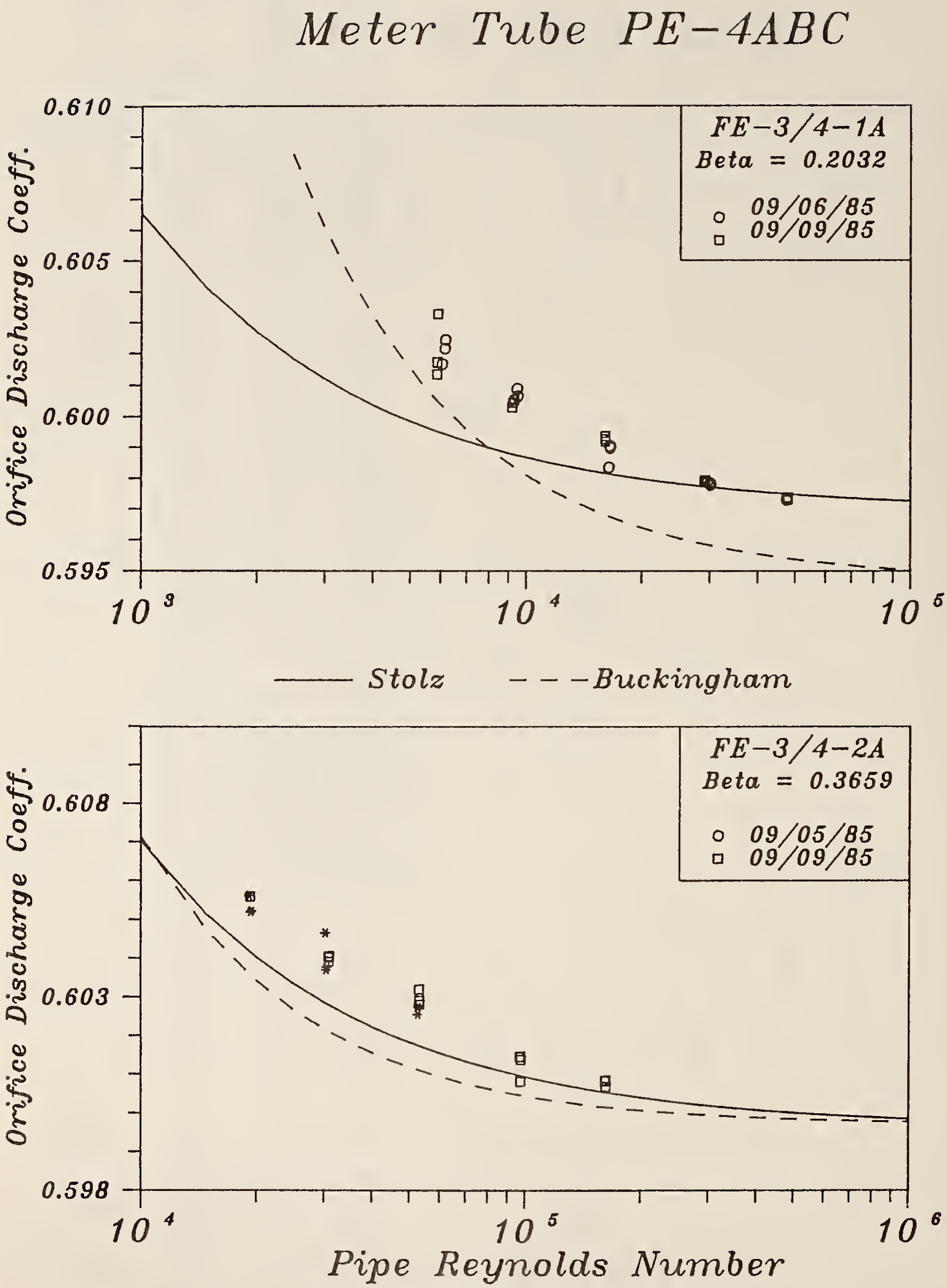


Figure 28B. Discharge Coefficient/Reynolds Number Plots, PE-4ABC 3-Inch Meter Tube, 8 Orifice Plates, Final Data Base

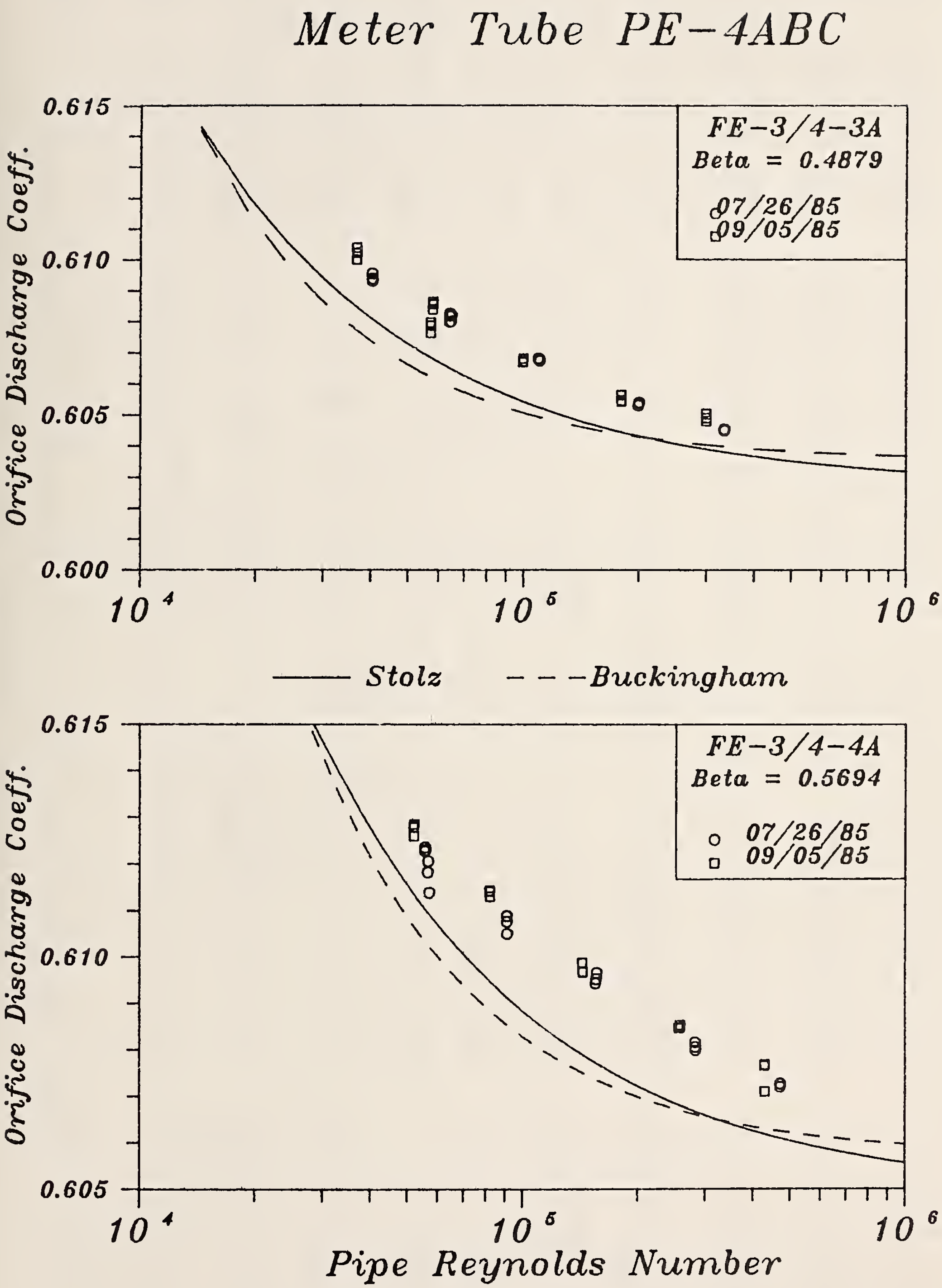


Figure 28C. Discharge Coefficient/Reynolds Number Plots, PE-4ABC 3-Inch Meter Tube, 8 Orifice Plates, Final Data Base

Meter Tube PE-4ABC

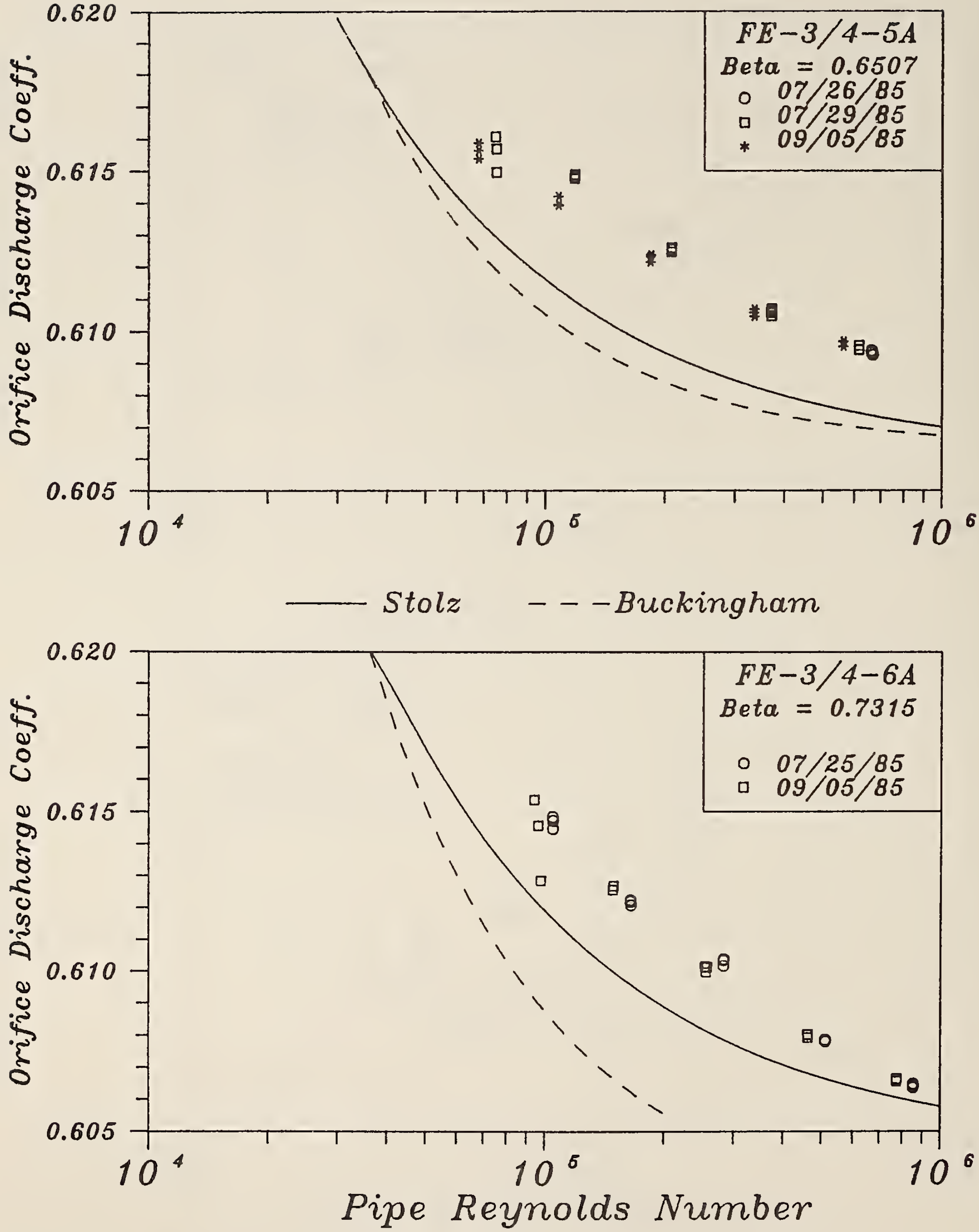


Figure 28D. Discharge Coefficient/Reynolds Number Plots, PE-4ABC 3-Inch Meter Tube, 8 Orifice Plates, Final Data Base

Table 42A. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-1B Diameter 0.8752 Inches, Beta Ratio = 0.21653

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	301.71	28.18	5.9985	151	0	9.977	0.0170	9.982	0.0164	9.984	0.0162	0.5980	0.0005	0.0005	0.5978	0.0005	0.0005	0.5977	0.0005	0.0005	40690
2	#	300.00	28.21	6.0111	149	0	10.015	0.0114	10.023	0.0124	10.023	0.0132	0.5981	0.0004	0.0005	0.5978	0.0004	0.0005	0.5978	0.0004	0.0005	40802
3	#	300.36	28.25	6.0030	149	0	10.014	0.0191	10.001	0.0186	10.002	0.0205	0.5973	0.0006	0.0005	0.5977	0.0006	0.0005	0.5976	0.0006	0.0005	40783
4	#	162.19	28.33	9.989	200	0	27.730	0.0203	27.723	0.0193	27.721	0.0215	0.5972	0.0003	0.0004	0.5973	0.0002	0.0004	0.5974	0.0003	0.0004	67980
5	#	162.00	28.37	10.006	200	1	27.831	0.0147	27.827	0.0153	27.825	0.0162	0.5972	0.0002	0.0004	0.5972	0.0002	0.0004	0.5973	0.0002	0.0004	68155
6	#	163.25	28.41	10.005	200	1	27.822	0.0153	27.814	0.0229	27.811	0.0239	0.5973	0.0002	0.0004	0.5973	0.0003	0.0004	0.5974	0.0003	0.0004	68212
7	#	114.52	28.95	3.2900	154	0	2.9921	0.0065	2.9920	0.0072	2.9933	0.0069	0.5989	0.0009	0.0008	0.5989	0.0008	0.0008	0.5988	0.0008	0.0008	22694
8	#	115.41	28.97	3.2872	155	0	2.9877	0.0071	2.9867	0.0106	2.9886	0.0116	0.5989	0.0009	0.0008	0.5990	0.0011	0.0008	0.5988	0.0012	0.0008	22684
9	#	114.62	28.99	3.2869	154	0	2.9873	0.0082	2.9847	0.0088	2.9868	0.0090	0.5988	0.0010	0.0008	0.5991	0.0010	0.0008	0.5989	0.0010	0.0008	22692
10	#	60.055	29.05	6.0452	81	0	10.131	0.0242	10.125	0.0369	10.124	0.0392	0.5981	0.0008	0.0005	0.5982	0.0011	0.0005	0.5983	0.0012	0.0005	41789
11	#	59.213	29.06	6.0226	80	0	10.057	0.0247	10.049	0.0374	10.048	0.0388	0.5980	0.0008	0.0005	0.5983	0.0012	0.0005	0.5983	0.0012	0.0005	41641
12	#	59.963	29.07	6.0221	81	0	10.054	0.0289	10.050	0.0364	10.047	0.0375	0.5980	0.0009	0.0005	0.5982	0.0011	0.0005	0.5983	0.0012	0.0005	41647
13	#	310.62	28.99	1.2131	154	0	0.4033	0.0010	0.4025	0.0008	0.4033	0.0008	0.6015	0.0045	0.0039	0.6022	0.0027	0.0039	0.6015	0.0024	0.0039	8375
14	#	310.32	28.99	1.2128	154	0	0.4028	0.0013	0.4017	0.0014	0.4026	0.0013	0.6018	0.0045	0.0039	0.6026	0.0028	0.0039	0.6019	0.0026	0.0039	8373
15	#	310.51	29.00	1.2110	154	0	0.4018	0.0013	0.4005	0.0012	0.4016	0.0010	0.6016	0.0045	0.0039	0.6026	0.0028	0.0040	0.6018	0.0025	0.0039	8362
16	#	199.75	29.05	1.9247	165	0	1.0196	0.0031	1.0175	0.0032	1.0193	0.0033	0.6003	0.0020	0.0018	0.6008	0.0014	0.0018	0.6003	0.0013	0.0018	13305
17	#	200.76	29.07	1.9260	166	0	1.0232	0.0030	1.0196	0.0028	1.0214	0.0028	0.5996	0.0019	0.0017	0.6006	0.0013	0.0018	0.6001	0.0013	0.0017	13320
18	#	199.57	29.10	1.9189	165	0	1.0129	0.0025	1.0119	0.0029	1.0140	0.0028	0.6004	0.0019	0.0018	0.6007	0.0014	0.0018	0.6001	0.0013	0.0018	13279
19	$	199.74	26.85	1.9367	165	3	1.0320	0.0004	1.0308	0.0004	1.0317	0.0006	0.6002	0.0009	0.0017	0.6005	0.0009	0.0017	0.6003	0.0010	0.0017	12758
20	$	200.60	26.86	1.9216	166	1	1.0158	0.0005	1.0144	0.0004	1.0155	0.0004	0.6002	0.0009	0.0018	0.6006	0.0010	0.0018	0.6003	0.0010	0.0018	12661
21	$	200.95	26.86	1.9165	166	4	1.0100	0.0005	1.0086	0.0004	1.0097	0.0004	0.6004	0.0009	0.0018	0.6008	0.0010	0.0018	0.6005	0.0010	0.0018	12628
22	$	115.44	26.87	3.3146	155	1	3.0356	0.0007	3.0338	0.0010	3.0348	0.0008	0.5989	0.0004	0.0008	0.5991	0.0004	0.0008	0.5990	0.0004	0.0008	21845
23	$	115.44	26.88	3.3129	155	0	3.0299	0.0010	3.0274	0.0013	3.0291	0.0011	0.5992	0.0004	0.0008	0.5994	0.0004	0.0008	0.5993	0.0004	0.0008	21839
24	$	115.22	26.87	3.3111	151	4	3.0279	0.0008	3.0257	0.0009	3.0272	0.0008	0.5990	0.0004	0.0008	0.5993	0.0004	0.0008	0.5991	0.0004	0.0008	21822
25	$	310.61	26.85	1.2154	154	0	0.4048	0.0003	0.4037	0.0002	0.4042	0.0002	0.6014	0.0023	0.0039	0.6022	0.0024	0.0039	0.6019	0.0025	0.0039	8007
26	$	310.52	26.86	1.2155	154	0	0.4043	0.0002	0.4035	0.0001	0.4040	0.0002	0.6019	0.0023	0.0039	0.6024	0.0024	0.0039	0.6020	0.0025	0.0039	8009
27	$	310.44	26.86	1.2158	154	0	0.4050	0.0003	0.4037	0.0002	0.4042	0.0002	0.6014	0.0023	0.0039	0.6024	0.0024	0.0039	0.6020	0.0025	0.0039	8011
28	$	60.174	26.94	6.0296	81	0	10.068	0.0021	10.070	0.0022	10.070	0.0036	0.5982	0.0003	0.0005	0.5982	0.0003	0.0005	0.5982	0.0003	0.0005	39800
29	$	60.143	26.91	6.0250	81	2	10.054	0.0027	10.052	0.0033	10.053	0.0029	0.5982	0.0003	0.0005	0.5983	0.0003	0.0005	0.5982	0.0003	0.0005	39743
30	$	59.794	26.90	6.0205	81	6	10.043	0.0068	10.038	0.0091	10.041	0.0036	0.5981	0.0004	0.0005	0.5982	0.0004	0.0005	0.5981	0.0003	0.0005	39705

[Test Run Date Codes # - 10/11/85 $ - 10/15/85]

Table 42A. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-1B Diameter 0.8752 Inches, Beta Ratio = 0.21653

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	300.10	26.94	6.0276	149	0	10.075	0.0031	10.073	0.0033	10.073	0.0032	0.5978	0.0002	0.0005	0.5979	0.0002	0.0005	0.5979	0.0002	0.0005	39787
32	#	299.73	26.93	6.0251	149	0	10.067	0.0033	10.063	0.0044	10.062	0.0045	0.5978	0.0002	0.0005	0.5979	0.0002	0.0005	0.5980	0.0002	0.0005	39761
33	#	300.42	26.95	6.0267	149	0	10.073	0.0054	10.071	0.0055	10.071	0.0060	0.5978	0.0002	0.0005	0.5979	0.0002	0.0005	0.5979	0.0002	0.0005	39790
34	#	220.49	27.09	8.8088	182	2	21.542	0.0039	21.542	0.0030	21.543	0.0034	0.5975	0.0001	0.0004	0.5975	0.0001	0.0004	0.5975	0.0001	0.0004	58338
35	#	220.35	27.09	8.8100	182	3	21.562	0.0044	21.554	0.0025	21.551	0.0033	0.5973	0.0001	0.0004	0.5974	0.0001	0.0004	0.5974	0.0001	0.0004	58346
36	#	220.51	27.09	8.8101	182	7	21.549	0.0054	21.544	0.0033	21.540	0.0039	0.5975	0.0001	0.0004	0.5976	0.0001	0.0004	0.5976	0.0001	0.0004	58347
37	#	300.50	26.97	5.9883	149	0	9.955	0.0180	9.947	0.0184	9.946	0.0186	0.5975	0.0006	0.0005	0.5977	0.0006	0.0005	0.5978	0.0006	0.0005	39554
38	#	300.42	27.02	5.9971	149	0	9.980	0.0186	9.974	0.0209	9.974	0.0209	0.5976	0.0006	0.0005	0.5978	0.0006	0.0005	0.5978	0.0006	0.0005	39656
39	#	300.06	27.06	5.9952	149	0	9.965	0.0108	9.968	0.0155	9.968	0.0165	0.5979	0.0003	0.0005	0.5978	0.0005	0.0005	0.5978	0.0005	0.0005	39678
40	#	161.78	27.17	10.063	200	0	28.134	0.0151	28.131	0.0179	28.133	0.0176	0.5973	0.0002	0.0004	0.5973	0.0002	0.0004	0.5973	0.0002	0.0004	66763
41	#	161.76	27.21	10.072	200	9	28.162	0.0117	28.153	0.0117	28.149	0.0137	0.5975	0.0002	0.0004	0.5976	0.0002	0.0004	0.5977	0.0002	0.0004	66881
42	#	162.28	27.25	10.055	200	0	28.092	0.0131	28.082	0.0144	28.080	0.0164	0.5973	0.0002	0.0004	0.5974	0.0002	0.0004	0.5974	0.0002	0.0004	66830

[Test Run Date Codes # - 10/15/85]

Table 42B. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-2B Diameter 1.5002 Inches, Beta Ratio = 0.37115

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
19 #	105.40	25.43	3.6434	142	1	0.4072	0.0002	0.4066	0.0002	0.4070	0.0002	0.6065	0.0023	0.0038	0.6069	0.0026	0.0038	0.6066	0.0023	0.0038	23248
20 #	106.10	25.42	3.6299	143	1	0.4042	0.0001	0.4034	0.0002	0.4042	0.0002	0.6065	0.0023	0.0038	0.6071	0.0026	0.0038	0.6064	0.0023	0.0038	23157
21 #	106.11	25.44	3.6348	143	1	0.4052	0.0003	0.4040	0.0003	0.4049	0.0002	0.6066	0.0023	0.0038	0.6075	0.0026	0.0038	0.6068	0.0023	0.0038	23199
22 #	64.635	25.47	5.7834	87	0	1.0319	0.0006	1.0306	0.0008	1.0299	0.0005	0.6048	0.0010	0.0016	0.6052	0.0011	0.0016	0.6054	0.0009	0.0016	36937
23 #	65.205	25.47	5.7877	86	0	1.0329	0.0003	1.0316	0.0003	1.0315	0.0004	0.6049	0.0009	0.0016	0.6053	0.0011	0.0016	0.6053	0.0009	0.0016	36964
24 #	64.955	25.47	5.7876	85	0	1.0325	0.0008	1.0314	0.0006	1.0315	0.0003	0.6050	0.0010	0.0016	0.6054	0.0011	0.0016	0.6053	0.0009	0.0016	36964
25 #	324.82	25.48	5.8247	161	1	1.0469	0.0003	1.0459	0.0002	1.0459	0.0002	0.6047	0.0009	0.0016	0.6050	0.0010	0.0016	0.6050	0.0009	0.0016	37209
26 #	324.93	25.49	5.8141	161	0	1.0429	0.0004	1.0421	0.0003	1.0422	0.0003	0.6048	0.0009	0.0016	0.6050	0.0010	0.0016	0.6050	0.0009	0.0016	37150
27 #	325.06	25.49	5.8153	161	0	1.0443	0.0004	1.0428	0.0002	1.0426	0.0002	0.6045	0.0009	0.0016	0.6049	0.0010	0.0016	0.6050	0.0009	0.0016	37157
28 #	170.37	25.50	9.940	200	2	3.0590	0.0009	3.0564	0.0010	3.0556	0.0010	0.6037	0.0003	0.0007	0.6040	0.0004	0.0007	0.6040	0.0003	0.0007	63528
29 #	179.89	25.50	9.936	200	0	3.0538	0.0008	3.0525	0.0005	3.0531	0.0005	0.6040	0.0003	0.0007	0.6041	0.0004	0.0007	0.6040	0.0003	0.0007	63499
30 #	179.82	25.50	9.938	200	1	3.0569	0.0006	3.0547	0.0007	3.0552	0.0007	0.6038	0.0003	0.0007	0.6040	0.0004	0.0007	0.6040	0.0003	0.0007	63514
31 #	104.58	25.60	18.124	141	0	10.191	0.0195	10.192	0.0176	10.189	0.0204	0.6031	0.0006	0.0004	0.6030	0.0006	0.0004	0.6031	0.0006	0.0004	116091
32 #	104.59	25.76	17.983	140	0	10.042	0.0139	10.042	0.0148	10.040	0.0164	0.6028	0.0005	0.0004	0.6028	0.0005	0.0004	0.6029	0.0005	0.0004	115605
33 #	105.53	25.81	18.001	142	0	10.063	0.0126	10.059	0.0137	10.060	0.0124	0.6028	0.0004	0.0004	0.6029	0.0005	0.0004	0.6029	0.0004	0.0004	115856
34 #	61.513	25.86	30.006	83	0	28.027	0.0068	28.023	0.0071	28.010	0.0084	0.6021	0.0003	0.0003	0.6021	0.0003	0.0003	0.6023	0.0003	0.0003	193332
35 #	61.425	25.88	30.115	83	0	28.211	0.0108	28.209	0.0128	28.197	0.0104	0.6023	0.0003	0.0003	0.6023	0.0003	0.0003	0.6024	0.0003	0.0003	194122
36 #	62.184	25.92	30.011	83	0	28.032	0.0087	28.028	0.0146	28.013	0.0147	0.6021	0.0003	0.0003	0.6022	0.0003	0.0003	0.6023	0.0003	0.0003	193627
37 $	65.182	27.19	5.7345	88	1	1.0151	0.0030	1.0147	0.0034	1.0144	0.0024	0.6047	0.0013	0.0017	0.6048	0.0014	0.0017	0.6049	0.0013	0.0017	38062
38 $	64.980	27.21	5.7001	87	0	1.0020	0.0027	1.0009	0.0036	1.0013	0.0036	0.6050	0.0013	0.0017	0.6053	0.0015	0.0017	0.6052	0.0015	0.0017	37851
39 $	65.204	27.21	5.7219	88	0	1.0112	0.0030	1.0099	0.0034	1.0091	0.0036	0.6046	0.0013	0.0017	0.6049	0.0014	0.0017	0.6052	0.0015	0.0017	37995
40 $	105.58	27.24	3.6135	143	0	0.4009	0.0010	0.4003	0.0012	0.4006	0.0011	0.6063	0.0025	0.0039	0.6068	0.0026	0.0039	0.6066	0.0027	0.0039	24011
41 $	106.64	27.27	3.6214	145	0	0.4025	0.0015	0.4015	0.0015	0.4019	0.0013	0.6065	0.0026	0.0038	0.6073	0.0026	0.0039	0.6069	0.0027	0.0038	24079
42 $	106.30	27.30	3.6255	144	0	0.4041	0.0010	0.4030	0.0012	0.4032	0.0010	0.6060	0.0024	0.0038	0.6068	0.0025	0.0038	0.6067	0.0026	0.0038	24123
43 $	324.87	27.39	5.6024	161	0	0.9702	0.0024	0.9676	0.0030	0.9693	0.0027	0.6043	0.0012	0.0017	0.6051	0.0014	0.0017	0.6046	0.0014	0.0017	37350
44 $	324.91	27.44	5.5809	161	0	0.9614	0.0017	0.9590	0.0015	0.9610	0.0015	0.6048	0.0011	0.0017	0.6055	0.0011	0.0017	0.6049	0.0012	0.0017	37248
45 $	324.82	27.46	5.6669	161	0	0.9920	0.0039	0.9886	0.0035	0.9899	0.0037	0.6045	0.0015	0.0017	0.6056	0.0015	0.0017	0.6052	0.0015	0.0017	37839
46 $	61.880	27.59	30.013	81	0	28.038	0.0168	28.032	0.0162	28.033	0.0118	0.6022	0.0003	0.0003	0.6023	0.0003	0.0003	0.6023	0.0003	0.0003	200977
47 $	61.800	27.60	30.002	84	0	28.014	0.0100	28.010	0.0087	28.002	0.0084	0.6023	0.0003	0.0003	0.6023	0.0003	0.0003	0.6024	0.0003	0.0003	200945
48 $	62.430	27.61	29.990	85	0	28.005	0.0117	27.996	0.0159	27.987	0.0150	0.6021	0.0003	0.0003	0.6022	0.0003	0.0003	0.6023	0.0003	0.0003	200907

[Test Run Date Codes # - 10/09/85 $ - 10/15/85]

Table 42B. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-2B Diameter 1.5002 Inches, Beta Ratio = 0.37115

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
49	#	189.81	27.76	9.927	185	0	3.0522	0.0060	3.0513	0.0056	3.0514	0.0057	0.6037	0.0007	0.0007	0.6038	0.0006	0.0007	0.6038	0.0007	0.0007	66723
50	#	174.36	27.78	9.911	200	0	3.0431	0.0084	3.0397	0.0079	3.0404	0.0084	0.6037	0.0009	0.0007	0.6040	0.0009	0.0007	0.6039	0.0009	0.0007	66645
51	#	183.54	27.81	9.925	200	0	3.0526	0.0073	3.0500	0.0075	3.0501	0.0073	0.6036	0.0008	0.0007	0.6038	0.0008	0.0007	0.6038	0.0008	0.0007	66783
52	#	105.04	27.85	17.943	143	0	10.005	0.0105	10.002	0.0115	9.999	0.0135	0.6027	0.0004	0.0004	0.6028	0.0004	0.0004	0.6029	0.0005	0.0004	120840
53	#	105.04	27.86	17.803	143	0	9.843	0.0159	9.848	0.0195	9.844	0.0170	0.6029	0.0005	0.0004	0.6028	0.0006	0.0004	0.6029	0.0006	0.0004	119920
54	#	105.75	27.87	17.942	144	1	10.005	0.0144	10.000	0.0156	10.003	0.0147	0.6027	0.0005	0.0004	0.6028	0.0005	0.0004	0.6027	0.0005	0.0004	120883

[Test Run Date Codes # - 10/15/85]

Table 42C. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37140

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	64.964	21.59	5.6764	58	0	0.0000	0.0000	0.9946	0.0004	0.9946	0.0004	0.0000	0.0000	0.0000	0.6036	0.0012	0.0017	0.6036	0.0011	0.0017	33120
2 #	64.916	21.60	5.6949	58	0	0.0000	0.0000	1.0015	0.0005	1.0012	0.0005	0.0000	0.0000	0.0000	0.6035	0.0012	0.0017	0.6035	0.0011	0.0017	33236
3 #	64.916	21.60	5.6960	58	0	0.0000	0.0000	1.0017	0.0003	1.0011	0.0003	0.0000	0.0000	0.0000	0.6035	0.0012	0.0017	0.6037	0.0011	0.0017	33242
4 #	103.91	21.61	3.6407	93	0	0.0000	0.0000	0.4080	0.0002	0.4071	0.0003	0.0000	0.0000	0.0000	0.6045	0.0029	0.0038	0.6051	0.0027	0.0038	21253
5 #	103.93	21.61	3.6364	93	0	0.0000	0.0000	0.4066	0.0002	0.4060	0.0001	0.0000	0.0000	0.0000	0.6047	0.0029	0.0038	0.6052	0.0027	0.0038	21227
6 #	103.89	21.61	3.6352	93	0	0.0000	0.0000	0.4067	0.0002	0.4058	0.0001	0.0000	0.0000	0.0000	0.6045	0.0029	0.0038	0.6051	0.0027	0.0038	21220
7 #	104.56	21.62	17.869	94	0	0.0000	0.0000	9.947	0.0031	9.946	0.0022	0.0000	0.0000	0.0000	0.6008	0.0002	0.0004	0.6008	0.0002	0.0004	104332
8 #	105.62	21.62	17.870	95	0	0.0000	0.0000	9.944	0.0041	9.942	0.0031	0.0000	0.0000	0.0000	0.6009	0.0002	0.0004	0.6010	0.0002	0.0004	104339
9 #	105.58	21.62	17.866	95	0	0.0000	0.0000	9.940	0.0013	9.944	0.0017	0.0000	0.0000	0.0000	0.6009	0.0002	0.0004	0.6008	0.0002	0.0004	104321
10 #	189.87	21.61	9.912	170	0	0.0000	0.0000	3.0486	0.0007	3.0475	0.0006	0.0000	0.0000	0.0000	0.6020	0.0004	0.0007	0.6021	0.0004	0.0007	57862
11 #	189.90	21.61	9.910	170	1	0.0000	0.0000	3.0469	0.0008	3.0456	0.0006	0.0000	0.0000	0.0000	0.6021	0.0004	0.0007	0.6022	0.0004	0.0007	57851
12 #	190.00	21.61	9.908	169	0	0.0000	0.0000	3.0461	0.0007	3.0454	0.0006	0.0000	0.0000	0.0000	0.6020	0.0004	0.0007	0.6021	0.0004	0.0007	57838
13 #	224.53	21.63	5.8499	185	0	0.0000	0.0000	1.0582	0.0003	1.0573	0.0003	0.0000	0.0000	0.0000	0.6030	0.0011	0.0016	0.6033	0.0010	0.0016	34165
14 #	224.50	21.64	5.8508	185	0	0.0000	0.0000	1.0587	0.0003	1.0578	0.0003	0.0000	0.0000	0.0000	0.6030	0.0011	0.0016	0.6032	0.0010	0.0016	34179
15 #	224.71	21.66	5.8413	185	0	0.0000	0.0000	1.0552	0.0004	1.0539	0.0004	0.0000	0.0000	0.0000	0.6030	0.0011	0.0016	0.6034	0.0010	0.0016	34139
16 #	105.79	21.72	17.925	95	2	0.0000	0.0000	10.018	0.0152	10.007	0.0207	0.0000	0.0000	0.0000	0.6006	0.0005	0.0004	0.6009	0.0007	0.0004	104914
17 #	104.59	21.74	17.931	94	1	0.0000	0.0000	10.013	0.0233	10.020	0.0212	0.0000	0.0000	0.0000	0.6009	0.0007	0.0004	0.6007	0.0007	0.0004	104996
18 #	105.69	21.76	17.942	95	3	0.0000	0.0000	10.033	0.0144	10.036	0.0094	0.0000	0.0000	0.0000	0.6007	0.0005	0.0004	0.6006	0.0003	0.0004	105110
19 #	60.156	21.82	29.854	54	0	0.0000	0.0000	27.832	0.0228	27.831	0.0243	0.0000	0.0000	0.0000	0.6001	0.0004	0.0003	0.6001	0.0004	0.0003	175147
20 #	60.116	21.83	29.858	54	0	0.0000	0.0000	27.833	0.0078	27.840	0.0068	0.0000	0.0000	0.0000	0.6002	0.0003	0.0003	0.6001	0.0003	0.0003	175218
21 #	60.172	21.84	29.777	54	0	0.0000	0.0000	27.687	0.0062	27.675	0.0099	0.0000	0.0000	0.0000	0.6001	0.0003	0.0003	0.6002	0.0003	0.0003	174783
22 $	60.608	22.30	29.805	56	0	0.0000	0.0000	27.742	0.0124	27.733	0.0152	0.0000	0.0000	0.0000	0.6001	0.0003	0.0003	0.6002	0.0003	0.0003	176870
23 $	60.614	22.31	29.837	56	0	0.0000	0.0000	27.803	0.0076	27.810	0.0076	0.0000	0.0000	0.0000	0.6001	0.0003	0.0003	0.6000	0.0003	0.0003	177100
24 $	60.626	22.33	29.825	56	0	0.0000	0.0000	27.775	0.0164	27.780	0.0162	0.0000	0.0000	0.0000	0.6002	0.0003	0.0003	0.6001	0.0003	0.0003	177118
25 $	106.09	22.38	17.915	98	0	0.0000	0.0000	9.997	0.0166	9.997	0.0133	0.0000	0.0000	0.0000	0.6009	0.0005	0.0004	0.6009	0.0004	0.0004	106511
26 $	104.99	22.39	17.872	97	0	0.0000	0.0000	9.948	0.0285	9.950	0.0289	0.0000	0.0000	0.0000	0.6009	0.0009	0.0004	0.6009	0.0009	0.0004	106286
27 $	104.92	22.41	17.879	97	0	0.0000	0.0000	9.958	0.0152	9.963	0.0142	0.0000	0.0000	0.0000	0.6008	0.0005	0.0004	0.6007	0.0005	0.0004	106373
28 $	105.02	22.41	17.905	97	0	0.0000	0.0000	9.985	0.0011	9.988	0.0013	0.0000	0.0000	0.0000	0.6009	0.0002	0.0004	0.6008	0.0002	0.0004	106530
29 $	105.92	22.40	17.899	98	1	0.0000	0.0000	9.981	0.0017	9.979	0.0017	0.0000	0.0000	0.0000	0.6008	0.0002	0.0004	0.6009	0.0002	0.0004	106470
30 $	104.84	22.40	17.895	97	0	0.0000	0.0000	9.978	0.0021	9.978	0.0026	0.0000	0.0000	0.0000	0.6008	0.0002	0.0004	0.6008	0.0002	0.0004	106449

[Test Run Date Codes # - 01/07/87 $ - 01/09/87]

Table 42C. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37140

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	225.71	22.39	5.7118	186	0	0.0000	0.0000	1.0107	0.0005	1.0104	0.0003	0.0000	0.0000	0.0000	0.6025	0.0010	0.0017	0.6026	0.0010	0.0017	33968
32	#	225.69	22.39	5.7108	186	0	0.0000	0.0000	1.0102	0.0005	1.0100	0.0004	0.0000	0.0000	0.0000	0.6026	0.0010	0.0017	0.6026	0.0010	0.0017	33962
33	#	225.95	22.40	5.7091	186	0	0.0000	0.0000	1.0090	0.0004	1.0089	0.0004	0.0000	0.0000	0.0000	0.6027	0.0010	0.0017	0.6028	0.0010	0.0017	33960
34	#	190.47	22.40	9.873	174	1	0.0000	0.0000	3.0262	0.0006	3.0264	0.0009	0.0000	0.0000	0.0000	0.6019	0.0004	0.0007	0.6019	0.0004	0.0007	58731
35	#	190.21	22.40	9.882	174	0	0.0000	0.0000	3.0309	0.0005	3.0319	0.0006	0.0000	0.0000	0.0000	0.6020	0.0004	0.0007	0.6019	0.0003	0.0007	58782
36	#	190.28	22.40	9.862	174	0	0.0000	0.0000	3.0182	0.0006	3.0186	0.0006	0.0000	0.0000	0.0000	0.6020	0.0004	0.0007	0.6020	0.0003	0.0007	58661
37	#	65.009	22.40	5.7025	60	0	0.0000	0.0000	1.0052	0.0003	1.0057	0.0004	0.0000	0.0000	0.0000	0.6032	0.0011	0.0017	0.6030	0.0010	0.0017	33920
38	#	64.925	22.40	5.6377	60	0	0.0000	0.0000	0.9827	0.0007	0.9829	0.0005	0.0000	0.0000	0.0000	0.6031	0.0011	0.0017	0.6031	0.0010	0.0017	33535
39	#	64.951	22.40	5.6445	60	1	0.0000	0.0000	0.9840	0.0008	0.9842	0.0004	0.0000	0.0000	0.0000	0.6035	0.0011	0.0017	0.6034	0.0010	0.0017	33575
40	#	104.02	22.40	3.6067	96	0	0.0000	0.0000	0.4011	0.0002	0.4005	0.0002	0.0000	0.0000	0.0000	0.6040	0.0025	0.0038	0.6044	0.0024	0.0038	21454
41	#	103.94	22.39	3.6043	96	0	0.0000	0.0000	0.4000	0.0003	0.3999	0.0002	0.0000	0.0000	0.0000	0.6044	0.0026	0.0039	0.6045	0.0024	0.0039	21435
42	#	103.93	22.39	3.6058	96	0	0.0000	0.0000	0.4003	0.0003	0.3999	0.0002	0.0000	0.0000	0.0000	0.6044	0.0026	0.0039	0.6047	0.0024	0.0039	21443

[Test Run Date Codes # - 01/09/87]

Table 42D. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-3B Diameter 1.9995 Inches, Beta Ratio = 0.49468

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	55.856	26.62	32.640	76	0	9.975	0.0230	9.978	0.0211	9.975	0.0243	0.6050	0.0008	0.0003	0.6049	0.0007	0.0003	0.6050	0.0008	0.0003	213921
2	#	56.680	26.64	32.702	77	0	10.012	0.0108	10.013	0.0089	10.015	0.0100	0.6051	0.0004	0.0003	0.6050	0.0004	0.0003	0.6050	0.0004	0.0003	214423
3	#	56.199	26.65	32.676	76	0	9.995	0.0096	9.997	0.0102	9.991	0.0101	0.6051	0.0004	0.0003	0.6050	0.0004	0.0003	0.6052	0.0004	0.0003	214299
4	#	164.25	26.70	10.570	200	0	1.0390	0.0012	1.0405	0.0016	1.0369	0.0017	0.6071	0.0010	0.0016	0.6066	0.0011	0.0016	0.6077	0.0010	0.0016	69397
5	#	169.34	26.75	10.566	200	0	1.0385	0.0019	1.0395	0.0021	1.0365	0.0023	0.6071	0.0011	0.0016	0.6068	0.0012	0.0016	0.6076	0.0011	0.0016	69453
6	#	169.51	26.79	10.571	200	0	1.0391	0.0017	1.0402	0.0022	1.0375	0.0018	0.6071	0.0010	0.0016	0.6068	0.0012	0.0016	0.6076	0.0011	0.0016	69546
7	#	100.10	26.85	18.160	135	0	3.0789	0.0041	3.0775	0.0054	3.0748	0.0056	0.6059	0.0005	0.0007	0.6061	0.0007	0.0007	0.6063	0.0007	0.0007	119633
8	#	100.16	26.87	18.153	135	0	3.0739	0.0062	3.0739	0.0074	3.0739	0.0072	0.6062	0.0007	0.0007	0.6062	0.0008	0.0007	0.6062	0.0008	0.0007	119635
9	#	100.09	26.90	18.175	135	0	3.0816	0.0051	3.0816	0.0053	3.0784	0.0052	0.6061	0.0006	0.0007	0.6061	0.0006	0.0007	0.6065	0.0006	0.0007	119860
10	#	281.01	26.95	6.5963	174	0	0.4033	0.0010	0.4040	0.0011	0.4019	0.0008	0.6081	0.0024	0.0038	0.6076	0.0027	0.0038	0.6092	0.0024	0.0038	43550
11	#	281.15	26.98	6.6238	174	0	0.4066	0.0008	0.4071	0.0009	0.4051	0.0008	0.6082	0.0024	0.0038	0.6078	0.0027	0.0038	0.6093	0.0024	0.0038	43761
12	#	281.20	27.00	6.6296	174	0	0.4069	0.0008	0.4077	0.0009	0.4058	0.0010	0.6085	0.0024	0.0038	0.6079	0.0027	0.0038	0.6093	0.0024	0.0038	43819
13	#	167.13	27.23	32.663	200	0	9.988	0.0101	9.987	0.0115	9.988	0.0095	0.6051	0.0003	0.0003	0.6051	0.0004	0.0003	0.6051	0.0003	0.0003	216987
14	#	168.92	27.24	32.888	200	0	10.130	0.0082	10.127	0.0102	10.125	0.0084	0.6050	0.0003	0.0003	0.6051	0.0003	0.0003	0.6051	0.0003	0.0003	218536
15	#	166.85	27.26	32.858	200	0	10.113	0.0129	10.113	0.0132	10.107	0.0140	0.6049	0.0004	0.0003	0.6049	0.0004	0.0003	0.6051	0.0004	0.0003	218432
16	#	110.99	27.28	54.366	151	1	27.755	0.0249	27.754	0.0258	27.739	0.0235	0.6042	0.0003	0.0002	0.6042	0.0003	0.0002	0.6044	0.0003	0.0002	361566
17	#	110.39	27.30	54.213	143	0	27.587	0.0085	27.586	0.0100	27.583	0.0096	0.6043	0.0001	0.0003	0.6043	0.0002	0.0003	0.6044	0.0001	0.0003	360711
18	#	110.99	27.32	54.205	145	0	27.578	0.0062	27.576	0.0075	27.570	0.0049	0.6043	0.0001	0.0003	0.6043	0.0001	0.0003	0.6044	0.0001	0.0003	360815
22	$	100.07	28.38	17.977	131	0	3.0161	0.0048	3.0143	0.0056	3.0158	0.0068	0.6061	0.0007	0.0007	0.6063	0.0007	0.0007	0.6061	0.0008	0.0007	122476
23	$	100.44	28.41	17.987	137	0	3.0227	0.0050	3.0179	0.0049	3.0189	0.0049	0.6058	0.0007	0.0007	0.6063	0.0006	0.0007	0.6062	0.0006	0.0007	122628
24	$	99.68	28.43	17.995	136	0	3.0225	0.0061	3.0222	0.0065	3.0222	0.0069	0.6061	0.0008	0.0007	0.6061	0.0008	0.0007	0.6061	0.0008	0.0007	122733
25	$	280.98	28.73	6.6048	174	0	0.4047	0.0010	0.4030	0.0008	0.4038	0.0008	0.6080	0.0030	0.0038	0.6092	0.0024	0.0038	0.6086	0.0024	0.0038	45342
26	$	282.75	28.76	6.6387	175	0	0.4087	0.0010	0.4072	0.0009	0.4078	0.0009	0.6081	0.0030	0.0038	0.6092	0.0024	0.0038	0.6087	0.0024	0.0038	45604
27	$	280.95	28.79	6.6427	174	0	0.4094	0.0008	0.4073	0.0009	0.4081	0.0009	0.6080	0.0030	0.0038	0.6095	0.0024	0.0038	0.6089	0.0024	0.0038	45662
28	$	164.70	28.83	10.453	200	0	1.0160	0.0024	1.0138	0.0029	1.0158	0.0029	0.6073	0.0014	0.0016	0.6079	0.0013	0.0016	0.6073	0.0013	0.0016	71915
29	$	169.19	28.85	10.442	200	0	1.0130	0.0022	1.0108	0.0028	1.0131	0.0028	0.6076	0.0014	0.0016	0.6082	0.0013	0.0016	0.6075	0.0013	0.0016	71874
30	$	169.29	28.88	10.470	200	0	1.0192	0.0017	1.0167	0.0021	1.0183	0.0020	0.6073	0.0013	0.0016	0.6080	0.0011	0.0016	0.6075	0.0011	0.0016	72108
31	$	55.894	28.93	32.731	76	0	10.040	0.0115	10.044	0.0135	10.045	0.0142	0.6049	0.0005	0.0003	0.6048	0.0005	0.0003	0.6048	0.0005	0.0003	225674
32	$	55.861	28.93	32.713	76	0	10.029	0.0127	10.030	0.0123	10.028	0.0163	0.6049	0.0005	0.0003	0.6048	0.0005	0.0003	0.6049	0.0006	0.0003	225549
33	$	56.215	28.95	32.699	76	0	10.018	0.0114	10.021	0.0139	10.018	0.0140	0.6050	0.0005	0.0003	0.6049	0.0005	0.0003	0.6050	0.0005	0.0003	225549

[Test Run Date Codes # - 10/10/85 $ - 10/16/85]

Table 42D. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-3B Diameter 1.9995 Inches, Beta Ratio = 0.49468

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34	#	111.07	29.00	54.431	151	0	27.839	0.0106	27.835	0.0100	27.817	0.0093	0.6041	0.0002	0.0002	0.6041	0.0001	0.0002	0.6043	0.0001	0.0002	375859
35	#	110.72	29.00	54.456	151	0	27.847	0.0105	27.847	0.0110	27.833	0.0126	0.6043	0.0002	0.0002	0.6043	0.0002	0.0002	0.6044	0.0002	0.0002	376030
36	#	110.72	28.99	54.647	151	0	28.053	0.0131	28.047	0.0132	28.042	0.0142	0.6042	0.0002	0.0002	0.6043	0.0002	0.0002	0.6043	0.0002	0.0002	377271

[Test Run Date Codes # - 10/16/85]

Table 42E. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-4B Diameter 2.2496 Inches, Beta Ratio = 0.55656

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	80.207	27.42	23.278	104	0	3.0134	0.0047	3.0132	0.0056	3.0061	0.0049	0.6082	0.0006	0.0007	0.6082	0.0007	0.0007	0.6090	0.0006	0.0007	155290
2	#	80.406	27.44	23.241	108	0	3.0035	0.0052	3.0034	0.0074	2.9964	0.0062	0.6083	0.0007	0.0007	0.6083	0.0009	0.0007	0.6090	0.0007	0.0007	155116
3	#	80.308	27.46	23.305	108	0	3.0188	0.0037	3.0177	0.0045	3.0137	0.0044	0.6084	0.0005	0.0007	0.6085	0.0006	0.0007	0.6089	0.0006	0.0007	155610
4	#	220.48	27.51	8.6249	182	0	0.4092	0.0007	0.4096	0.0009	0.4086	0.0009	0.6116	0.0024	0.0038	0.6113	0.0027	0.0038	0.6121	0.0024	0.0038	57653
5	#	220.37	27.55	8.6325	182	0	0.4104	0.0006	0.4103	0.0006	0.4091	0.0006	0.6112	0.0023	0.0038	0.6113	0.0026	0.0038	0.6122	0.0023	0.0038	57755
6	#	220.49	27.59	8.6163	182	0	0.4085	0.0009	0.4084	0.0009	0.4074	0.0010	0.6115	0.0024	0.0038	0.6116	0.0027	0.0038	0.6123	0.0024	0.0038	57697
7	#	134.80	27.63	13.564	181	0	1.0170	0.0013	1.0170	0.0014	1.0150	0.0017	0.6101	0.0010	0.0016	0.6101	0.0011	0.0016	0.6107	0.0011	0.0016	90906
8	#	135.71	27.65	13.512	182	0	1.0096	0.0022	1.0095	0.0025	1.0076	0.0026	0.6100	0.0011	0.0016	0.6100	0.0013	0.0016	0.6106	0.0012	0.0016	90597
9	#	135.51	27.68	13.557	179	0	1.0161	0.0014	1.0156	0.0019	1.0138	0.0021	0.6101	0.0010	0.0016	0.6102	0.0012	0.0016	0.6108	0.0011	0.0016	90962
10	#	43.016	27.73	42.313	58	0	10.003	0.0109	9.999	0.0147	9.995	0.0142	0.6069	0.0005	0.0003	0.6070	0.0006	0.0003	0.6071	0.0006	0.0003	284215
11	#	43.055	27.74	42.321	58	0	10.014	0.0094	10.003	0.0169	9.983	0.0140	0.6066	0.0005	0.0003	0.6070	0.0006	0.0003	0.6076	0.0006	0.0003	284330
12	#	43.001	27.75	42.384	58	0	10.019	0.0065	10.030	0.0137	10.023	0.0139	0.6074	0.0004	0.0003	0.6071	0.0006	0.0003	0.6072	0.0006	0.0003	284817
13	#	150.11	27.79	42.270	186	0	9.975	0.0061	9.974	0.0073	9.961	0.0064	0.6071	0.0002	0.0003	0.6071	0.0003	0.0003	0.6075	0.0002	0.0003	284298
14	#	149.77	27.80	42.910	186	0	10.283	0.0064	10.282	0.0071	10.267	0.0075	0.6070	0.0002	0.0003	0.6070	0.0003	0.0003	0.6075	0.0003	0.0003	288667
15	#	149.92	27.81	42.634	186	0	10.151	0.0054	10.151	0.0058	10.134	0.0060	0.6070	0.0002	0.0003	0.6070	0.0002	0.0003	0.6075	0.0002	0.0003	286872
16	#	89.163	27.83	70.488	121	0	27.819	0.0075	27.815	0.0072	27.782	0.0113	0.6062	0.0001	0.0002	0.6063	0.0001	0.0002	0.6066	0.0002	0.0002	474502
17	#	89.252	27.81	70.597	121	0	27.916	0.0062	27.916	0.0047	27.872	0.0092	0.6061	0.0001	0.0002	0.6061	0.0001	0.0002	0.6066	0.0001	0.0002	475029
18	#	89.316	27.81	70.637	121	0	27.945	0.0084	27.942	0.0085	27.903	0.0079	0.6061	0.0001	0.0002	0.6061	0.0001	0.0002	0.6066	0.0001	0.0002	475295
19	$	149.05	28.88	42.228	185	0	9.959	0.0055	9.961	0.0056	9.956	0.0068	0.6070	0.0002	0.0003	0.6070	0.0002	0.0003	0.6071	0.0002	0.0003	290842
20	$	149.70	28.92	42.173	186	0	9.937	0.0066	9.939	0.0082	9.928	0.0086	0.6069	0.0003	0.0003	0.6069	0.0003	0.0003	0.6072	0.0003	0.0003	290713
21	$	149.81	28.96	42.395	186	0	10.043	0.0063	10.044	0.0076	10.034	0.0089	0.6069	0.0002	0.0003	0.6069	0.0003	0.0003	0.6072	0.0003	0.0003	292494
22	$	89.906	29.00	70.180	123	0	27.604	0.0167	27.612	0.0170	27.571	0.0235	0.6060	0.0002	0.0002	0.6059	0.0002	0.0002	0.6063	0.0003	0.0002	484611
23	$	90.058	29.01	70.532	123	0	27.866	0.0069	27.865	0.0072	27.852	0.0068	0.6062	0.0001	0.0002	0.6062	0.0001	0.0002	0.6063	0.0001	0.0002	487144
24	$	89.875	29.02	70.532	122	0	27.858	0.0095	27.861	0.0073	27.846	0.0094	0.6062	0.0002	0.0002	0.6062	0.0001	0.0002	0.6064	0.0001	0.0002	487251
28	$	80.401	29.15	23.276	110	0	3.0138	0.0053	3.0171	0.0057	3.0137	0.0046	0.6083	0.0007	0.0007	0.6079	0.0007	0.0007	0.6083	0.0006	0.0007	161244
29	$	79.981	29.16	23.313	109	0	3.0218	0.0056	3.0255	0.0072	3.0229	0.0069	0.6084	0.0007	0.0007	0.6081	0.0008	0.0007	0.6083	0.0008	0.0007	161541
30	$	80.636	29.17	23.300	110	0	3.0223	0.0057	3.0216	0.0063	3.0160	0.0055	0.6080	0.0007	0.0007	0.6081	0.0007	0.0007	0.6087	0.0007	0.0007	161481
31	$	134.59	29.19	13.451	182	0	1.0021	0.0019	1.0038	0.0020	1.0007	0.0023	0.6096	0.0013	0.0017	0.6091	0.0011	0.0016	0.6100	0.0012	0.0016	93261
32	$	135.29	29.23	13.446	183	0	1.0023	0.0024	1.0034	0.0025	0.9997	0.0028	0.6093	0.0014	0.0017	0.6090	0.0012	0.0016	0.6101	0.0013	0.0016	93311
33	$	135.49	29.25	13.416	183	0	0.9968	0.0014	0.9985	0.0019	0.9956	0.0020	0.6096	0.0013	0.0017	0.6091	0.0011	0.0017	0.6100	0.0011	0.0017	93139

[Test Run Date Codes # - 10/10/85 $ - 10/16/85]

Table 42E. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-4B Diameter 2.2496 Inches, Beta Ratio = 0.55656

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34	#	220.50	29.30	8.6561	182	0	0.4133	0.0008	0.4157	0.0009	0.4126	0.0008	0.6108	0.0030	0.0037	0.6091	0.0024	0.0037	0.6114	0.0023	0.0037	60160
35	#	220.47	29.32	8.5489	182	0	0.4036	0.0009	0.4048	0.0010	0.4024	0.0011	0.6105	0.0030	0.0038	0.6096	0.0025	0.0038	0.6114	0.0025	0.0038	59440
36	#	220.65	29.34	8.5883	182	0	0.4072	0.0006	0.4089	0.0008	0.4062	0.0008	0.6106	0.0030	0.0038	0.6093	0.0024	0.0038	0.6113	0.0024	0.0038	59740
37	$	220.49	32.58	8.6686	182	0	0.4154	0.0006	0.4146	0.0005	0.4146	0.0004	0.6104	0.0027	0.0037	0.6110	0.0024	0.0037	0.6110	0.0023	0.0037	64552
38	$	220.46	32.63	8.6437	182	0	0.4125	0.0007	0.4121	0.0008	0.4122	0.0009	0.6108	0.0028	0.0037	0.6111	0.0024	0.0038	0.6110	0.0024	0.0037	64433
39	$	220.35	32.67	8.6413	182	0	0.4121	0.0005	0.4115	0.0005	0.4118	0.0005	0.6109	0.0028	0.0037	0.6114	0.0024	0.0038	0.6112	0.0023	0.0037	64468
40	$	80.596	32.82	23.290	112	0	3.0231	0.0036	3.0230	0.0047	3.0205	0.0042	0.6080	0.0006	0.0007	0.6080	0.0006	0.0007	0.6082	0.0006	0.0007	174287
41	$	80.534	32.84	23.300	107	2	3.0250	0.0041	3.0215	0.0041	3.0250	0.0029	0.6080	0.0006	0.0007	0.6084	0.0006	0.0007	0.6080	0.0005	0.0007	174434
42	$	80.648	32.86	23.298	112	0	3.0223	0.0042	3.0245	0.0046	3.0249	0.0036	0.6083	0.0006	0.0007	0.6080	0.0006	0.0007	0.6080	0.0005	0.0007	174495
43	$	134.52	32.88	13.597	186	1	1.0253	0.0014	1.0249	0.0016	1.0248	0.0015	0.6095	0.0012	0.0016	0.6096	0.0011	0.0016	0.6096	0.0010	0.0016	101879
44	$	135.16	32.91	13.528	186	0	1.0147	0.0016	1.0141	0.0022	1.0151	0.0017	0.6095	0.0012	0.0016	0.6097	0.0012	0.0016	0.6094	0.0011	0.0016	101422
45	$	134.95	32.94	13.690	181	0	1.0395	0.0021	1.0392	0.0024	1.0390	0.0024	0.6095	0.0013	0.0016	0.6095	0.0012	0.0016	0.6096	0.0012	0.0016	102702

[Test Run Date Codes # - 10/16/85 $ - 11/19/85]

Table 42F. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-5B Diameter 2.6249 Inches, Beta Ratio = 0.64941

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	55.187	27.60	33.834	74	0	3.1043	0.0045	3.0998	0.0050	3.1006	0.0076	0.6101	0.0008	0.0007	0.6105	0.0007	0.0007	0.6105	0.0009	0.0007	226614
2 #	54.314	27.62	33.879	73	0	3.1053	0.0017	3.1063	0.0057	3.1076	0.0026	0.6108	0.0007	0.0007	0.6107	0.0007	0.0007	0.6106	0.0005	0.0007	227011
3 #	55.163	27.63	33.859	74	0	3.1095	0.0054	3.1054	0.0064	3.0999	0.0066	0.6100	0.0008	0.0007	0.6104	0.0008	0.0007	0.6110	0.0008	0.0007	226927
4 #	155.12	27.68	12.528	192	0	0.4204	0.0012	0.4202	0.0016	0.4192	0.0017	0.6139	0.0044	0.0037	0.6141	0.0028	0.0037	0.6148	0.0026	0.0037	84059
5 #	155.12	27.72	12.487	192	0	0.4179	0.0006	0.4175	0.0007	0.4168	0.0005	0.6137	0.0044	0.0037	0.6140	0.0026	0.0037	0.6145	0.0024	0.0037	83855
6 #	155.15	27.76	12.473	192	0	0.4173	0.0008	0.4166	0.0010	0.4156	0.0008	0.6135	0.0044	0.0037	0.6140	0.0027	0.0037	0.6147	0.0024	0.0037	83836
7 #	97.235	27.81	20.289	131	0	1.1082	0.0016	1.1069	0.0020	1.1069	0.0023	0.6123	0.0017	0.0015	0.6127	0.0011	0.0015	0.6127	0.0011	0.0015	136517
8 #	97.131	27.83	20.289	130	0	1.1090	0.0026	1.1071	0.0030	1.1085	0.0019	0.6121	0.0018	0.0015	0.6126	0.0013	0.0015	0.6122	0.0010	0.0015	136577
9 #	97.234	27.85	20.308	126	0	1.1114	0.0021	1.1096	0.0028	1.1085	0.0014	0.6120	0.0017	0.0015	0.6125	0.0013	0.0015	0.6128	0.0010	0.0015	136769
10 #	161.51	27.91	33.927	200	0	3.1180	0.0033	3.1158	0.0036	3.1161	0.0035	0.6105	0.0007	0.0007	0.6107	0.0005	0.0007	0.6106	0.0005	0.0007	228788
11 #	161.62	27.93	33.956	200	0	3.1223	0.0026	3.1210	0.0028	3.1198	0.0033	0.6106	0.0006	0.0007	0.6107	0.0005	0.0007	0.6108	0.0005	0.0007	229084
12 #	161.59	27.94	33.997	200	0	3.1339	0.0031	3.1298	0.0035	3.1260	0.0028	0.6102	0.0007	0.0007	0.6106	0.0005	0.0007	0.6109	0.0004	0.0007	229407
13 #	64.782	27.99	101.33	88	0	28.071	0.0072	28.074	0.0101	28.046	0.0093	0.6077	0.0002	0.0002	0.6076	0.0002	0.0002	0.6079	0.0002	0.0002	684525
14 #	65.296	27.98	101.24	88	0	28.041	0.0120	28.030	0.0149	27.995	0.0154	0.6074	0.0002	0.0002	0.6076	0.0002	0.0002	0.6079	0.0002	0.0002	683758
15 #	64.196	27.98	101.26	87	0	28.034	0.0125	28.033	0.0115	28.006	0.0113	0.6077	0.0002	0.0002	0.6077	0.0002	0.0002	0.6080	0.0002	0.0002	683923
16 #	105.12	27.96	61.045	140	0	10.153	0.0111	10.148	0.0148	10.134	0.0145	0.6087	0.0004	0.0003	0.6089	0.0005	0.0003	0.6093	0.0005	0.0003	412108
17 #	104.71	27.98	60.792	142	0	10.065	0.0060	10.073	0.0063	10.057	0.0065	0.6088	0.0003	0.0003	0.6086	0.0002	0.0003	0.6091	0.0002	0.0003	410578
18 #	104.34	28.00	60.770	140	0	10.068	0.0044	10.067	0.0055	10.048	0.0053	0.6085	0.0002	0.0003	0.6085	0.0002	0.0003	0.6091	0.0002	0.0003	410610
19 $	104.51	28.80	60.999	143	0	10.146	0.0124	10.142	0.0112	10.124	0.0095	0.6085	0.0004	0.0003	0.6086	0.0004	0.0003	0.6092	0.0003	0.0003	419396
20 $	104.72	28.86	60.803	143	0	10.078	0.0075	10.078	0.0075	10.059	0.0075	0.6086	0.0003	0.0003	0.6086	0.0003	0.0003	0.6092	0.0003	0.0003	418590
21 $	104.72	28.92	60.779	143	1	10.073	0.0089	10.072	0.0091	10.059	0.0079	0.6085	0.0003	0.0003	0.6085	0.0003	0.0003	0.6089	0.0003	0.0003	418969
22 $	64.222	29.08	101.24	88	0	28.039	0.0090	28.031	0.0134	27.992	0.0134	0.6075	0.0002	0.0002	0.6076	0.0002	0.0002	0.6080	0.0002	0.0002	700271
23 $	64.835	29.13	101.29	86	0	28.056	0.0120	28.063	0.0070	28.014	0.0059	0.6077	0.0002	0.0002	0.6076	0.0001	0.0002	0.6081	0.0001	0.0002	701426
24 $	65.109	29.16	101.29	89	0	28.092	0.0106	28.079	0.0116	28.004	0.0097	0.6073	0.0002	0.0002	0.6074	0.0002	0.0002	0.6082	0.0002	0.0002	701832
25 $	161.79	29.16	33.183	200	0	2.9880	0.0042	2.9846	0.0047	2.9816	0.0039	0.6100	0.0005	0.0007	0.6103	0.0006	0.0007	0.6106	0.0005	0.0007	229927
26 $	161.78	29.19	33.460	200	1	3.0339	0.0034	3.0335	0.0045	3.0297	0.0042	0.6104	0.0005	0.0007	0.6105	0.0006	0.0007	0.6108	0.0005	0.0007	231997
27 $	161.45	29.20	34.242	200	8	3.1857	0.0086	3.1901	0.0084	3.1856	0.0118	0.6096	0.0009	0.0006	0.6092	0.0009	0.0006	0.6096	0.0012	0.0006	237471
29 $	97.199	29.30	20.091	132	0	1.0882	0.0043	1.0882	0.0056	1.0828	0.0058	0.6120	0.0015	0.0015	0.6120	0.0018	0.0015	0.6135	0.0019	0.0015	139630
30 $	97.123	29.32	20.114	132	0	1.0903	0.0058	1.0899	0.0058	1.0862	0.0050	0.6121	0.0019	0.0015	0.6123	0.0018	0.0015	0.6133	0.0017	0.0015	139850
31 $	97.285	29.35	19.780	132	0	1.0542	0.0035	1.0519	0.0052	1.0495	0.0050	0.6122	0.0014	0.0016	0.6129	0.0018	0.0016	0.6136	0.0017	0.0016	137617

[Test Run Date Codes # - 10/11/85 $ - 10/17/85]

Table 42F. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-5B Diameter 2.6249 Inches, Beta Ratio = 0.64941

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
32 #	155.12	29.40	12.387	192	0	0.4106	0.0014	0.4096	0.0017	0.4088	0.0015	0.6144	0.0025	0.0038	0.6151	0.0026	0.0038	0.6157	0.0025	0.0038	86277
33 #	155.08	29.43	12.418	192	0	0.4122	0.0010	0.4117	0.0013	0.4110	0.0011	0.6146	0.0024	0.0038	0.6150	0.0025	0.0038	0.6155	0.0024	0.0038	86544
34 #	155.64	29.47	12.528	193	0	0.4193	0.0007	0.4188	0.0007	0.4180	0.0007	0.6148	0.0023	0.0037	0.6152	0.0023	0.0037	0.6158	0.0022	0.0037	87391
35 $	155.11	32.34	12.414	192	0	0.4132	0.0008	0.4127	0.0009	0.4126	0.0010	0.6139	0.0026	0.0038	0.6143	0.0025	0.0038	0.6143	0.0025	0.0038	91984
36 $	155.62	32.38	12.254	193	0	0.4022	0.0008	0.4012	0.0010	0.4024	0.0010	0.6142	0.0027	0.0039	0.6150	0.0027	0.0039	0.6141	0.0026	0.0039	90877
37 $	155.11	32.42	12.393	192	0	0.4117	0.0007	0.4110	0.0008	0.4117	0.0006	0.6140	0.0026	0.0038	0.6146	0.0025	0.0038	0.6140	0.0025	0.0038	91986
38 $	96.575	32.49	19.589	134	0	1.0344	0.0020	1.0326	0.0021	1.0355	0.0020	0.6123	0.0012	0.0016	0.6128	0.0012	0.0016	0.6119	0.0011	0.0016	145599
39 $	97.206	32.51	19.619	135	0	1.0392	0.0014	1.0362	0.0016	1.0383	0.0019	0.6118	0.0011	0.0016	0.6127	0.0011	0.0016	0.6121	0.0011	0.0016	145885
40 $	97.282	32.53	19.529	135	0	1.0279	0.0018	1.0269	0.0026	1.0294	0.0026	0.6123	0.0012	0.0016	0.6126	0.0013	0.0016	0.6119	0.0013	0.0016	145273
41 $	97.452	32.58	19.573	129	0	1.0324	0.0010	1.0302	0.0015	1.0331	0.0020	0.6124	0.0011	0.0016	0.6130	0.0011	0.0016	0.6121	0.0011	0.0016	145750
42 $	97.206	32.60	19.577	135	0	1.0335	0.0014	1.0318	0.0015	1.0346	0.0015	0.6122	0.0011	0.0016	0.6127	0.0011	0.0016	0.6118	0.0011	0.0016	145842
43 $	97.773	32.62	19.553	131	0	1.0320	0.0015	1.0302	0.0020	1.0303	0.0027	0.6119	0.0011	0.0016	0.6124	0.0012	0.0016	0.6124	0.0013	0.0016	145724
44 $	54.724	32.45	33.251	76	0	3.0009	0.0057	3.0050	0.0074	3.0021	0.0072	0.6102	0.0007	0.0007	0.6098	0.0009	0.0007	0.6101	0.0009	0.0007	246947
45 $	55.440	32.47	33.235	77	0	2.9991	0.0044	2.9992	0.0059	2.9983	0.0056	0.6101	0.0006	0.0007	0.6101	0.0008	0.0007	0.6101	0.0007	0.0007	246929
46 $	54.764	32.50	33.287	76	0	3.0034	0.0043	3.0071	0.0059	3.0088	0.0067	0.6106	0.0006	0.0007	0.6102	0.0008	0.0007	0.6100	0.0008	0.0007	247471

[Test Run Date Codes # - 10/17/85 $ - 11/20/85]

Table 42G. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-6B Diameter 3.0000 Inches, Beta Ratio = 0.74221

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
22	#	74.496	25.69	85.545	98	0	9.991	0.0039	9.994	0.0032	9.958	0.0047	0.6058	0.0002	0.0004	0.6057	0.0002	0.0004	0.6068	0.0002	0.0004	549073
23	#	74.725	25.70	85.650	99	0	10.014	0.0037	10.019	0.0040	9.981	0.0041	0.6058	0.0002	0.0004	0.6057	0.0002	0.0004	0.6068	0.0002	0.0004	549874
24	#	74.601	25.70	85.706	101	0	10.024	0.0042	10.030	0.0040	10.000	0.0041	0.6059	0.0002	0.0004	0.6057	0.0002	0.0004	0.6066	0.0002	0.0004	550229
25	#	44.956	25.82	142.82	61	0	28.002	0.0165	27.987	0.0212	27.900	0.0110	0.6041	0.0002	0.0003	0.6043	0.0003	0.0003	0.6052	0.0002	0.0003	919369
26	#	44.950	25.86	142.75	61	0	27.977	0.0210	27.966	0.0201	27.869	0.0226	0.6041	0.0003	0.0003	0.6042	0.0003	0.0003	0.6053	0.0003	0.0003	919782
27	#	44.964	25.94	142.72	61	0	27.931	0.0150	27.954	0.0201	27.857	0.0131	0.6045	0.0002	0.0003	0.6042	0.0003	0.0003	0.6053	0.0002	0.0003	921241
28	#	44.032	26.07	142.88	60	0	28.038	0.0177	28.035	0.0100	27.926	0.0202	0.6040	0.0003	0.0003	0.6040	0.0002	0.0003	0.6052	0.0003	0.0003	924940
29	#	109.14	26.20	17.446	143	0	0.4070	0.0008	0.4109	0.0009	0.4056	0.0011	0.6122	0.0024	0.0038	0.6092	0.0027	0.0038	0.6132	0.0025	0.0038	113271
30	#	109.31	26.22	17.693	144	0	0.4183	0.0039	0.4216	0.0043	0.4160	0.0039	0.6126	0.0036	0.0037	0.6102	0.0040	0.0037	0.6142	0.0037	0.0037	114929
31	#	108.97	26.25	17.627	147	0	0.4158	0.0005	0.4191	0.0007	0.4135	0.0009	0.6119	0.0023	0.0037	0.6095	0.0026	0.0037	0.6136	0.0024	0.0037	114577
32	#	40.257	26.32	47.571	54	0	3.0728	0.0037	3.0728	0.0055	3.0635	0.0029	0.6075	0.0006	0.0007	0.6075	0.0008	0.0007	0.6084	0.0006	0.0007	309691
33	#	40.299	26.33	47.807	54	0	3.0977	0.0044	3.0996	0.0051	3.0913	0.0052	0.6080	0.0007	0.0007	0.6078	0.0007	0.0007	0.6087	0.0007	0.0007	311297
34	#	40.614	26.35	48.000	53	0	3.1239	0.0034	3.1264	0.0045	3.1163	0.0040	0.6079	0.0006	0.0007	0.6077	0.0007	0.0007	0.6087	0.0006	0.0007	312694
35	#	69.825	26.42	27.570	94	0	1.0228	0.0019	1.0240	0.0021	1.0203	0.0022	0.6102	0.0011	0.0016	0.6099	0.0012	0.0016	0.6110	0.0012	0.0016	179888
36	#	70.728	26.45	27.660	95	0	1.0289	0.0017	1.0309	0.0012	1.0267	0.0016	0.6104	0.0011	0.0016	0.6098	0.0011	0.0016	0.6111	0.0011	0.0016	180594
37	#	70.627	26.47	27.682	95	0	1.0315	0.0015	1.0323	0.0014	1.0278	0.0015	0.6101	0.0010	0.0016	0.6099	0.0011	0.0016	0.6112	0.0010	0.0016	180822
41	$	39.889	27.45	47.701	54	0	3.0827	0.0073	3.0860	0.0060	3.0839	0.0071	0.6082	0.0009	0.0007	0.6079	0.0008	0.0007	0.6081	0.0009	0.0007	318438
42	$	39.922	27.45	47.787	54	0	3.0994	0.0051	3.0988	0.0066	3.0914	0.0069	0.6077	0.0008	0.0007	0.6077	0.0008	0.0007	0.6085	0.0008	0.0007	319011
43	$	40.849	27.47	48.009	53	0	3.1285	0.0042	3.1277	0.0048	3.1205	0.0031	0.6077	0.0007	0.0007	0.6077	0.0007	0.0007	0.6084	0.0006	0.0007	320632
44	$	109.55	27.51	17.440	149	2	0.4043	0.0006	0.4048	0.0006	0.4047	0.0005	0.6141	0.0030	0.0039	0.6137	0.0024	0.0038	0.6138	0.0023	0.0039	116580
45	$	109.55	27.55	17.451	149	0	0.4053	0.0007	0.4052	0.0010	0.4054	0.0011	0.6137	0.0030	0.0038	0.6138	0.0025	0.0038	0.6136	0.0024	0.0038	116754
46	$	109.58	27.58	17.434	149	0	0.4048	0.0009	0.4044	0.0010	0.4043	0.0008	0.6135	0.0031	0.0038	0.6137	0.0025	0.0039	0.6138	0.0024	0.0038	116717
47	$	70.470	27.63	27.717	95	0	1.0320	0.0010	1.0314	0.0009	1.0303	0.0014	0.6108	0.0012	0.0016	0.6110	0.0010	0.0016	0.6114	0.0010	0.0016	185766
48	$	70.198	27.64	27.765	93	0	1.0353	0.0013	1.0364	0.0015	1.0351	0.0011	0.6109	0.0012	0.0016	0.6106	0.0011	0.0016	0.6110	0.0010	0.0016	186128
49	$	70.840	27.65	27.672	96	0	1.0292	0.0018	1.0292	0.0024	1.0281	0.0019	0.6107	0.0013	0.0016	0.6107	0.0012	0.0016	0.6110	0.0011	0.0016	185542
50	$	135.52	27.71	47.697	184	0	3.0850	0.0029	3.0854	0.0027	3.0789	0.0029	0.6080	0.0005	0.0007	0.6079	0.0004	0.0007	0.6086	0.0004	0.0007	320233
51	$	134.62	27.76	47.528	183	0	3.0623	0.0025	3.0611	0.0031	3.0563	0.0027	0.6081	0.0005	0.0007	0.6082	0.0005	0.0007	0.6086	0.0004	0.0007	319452
52	$	135.08	27.77	47.523	175	0	3.0623	0.0020	3.0617	0.0025	3.0560	0.0019	0.6080	0.0005	0.0007	0.6080	0.0004	0.0007	0.6086	0.0004	0.0007	319484

[Test Run Date Codes # - 10/10/85 $ - 10/16/85]

Table 42G. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-6B Diameter 3.0000 Inches, Beta Ratio = 0.74221

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
53	#	44.883	27.87	142.94	61	0	28.025	0.0108	28.031	0.0142	27.961	0.0183	0.6045	0.0002	0.0003	0.6044	0.0002	0.0003	0.6052	0.0003	0.0003	963081
54	#	45.236	27.93	142.84	62	0	27.982	0.0165	27.998	0.0130	27.902	0.0219	0.6046	0.0002	0.0003	0.6044	0.0002	0.0003	0.6054	0.0003	0.0003	963668
55	#	44.589	27.99	142.77	61	0	27.974	0.0215	27.966	0.0342	27.897	0.0277	0.6044	0.0003	0.0003	0.6045	0.0004	0.0003	0.6052	0.0003	0.0003	964476
56	#	73.733	28.15	85.805	101	0	10.061	0.0052	10.064	0.0040	10.034	0.0043	0.6056	0.0002	0.0004	0.6056	0.0002	0.0004	0.6065	0.0002	0.0004	581667
57	#	74.781	28.16	86.583	102	0	10.242	0.0057	10.244	0.0039	10.214	0.0025	0.6057	0.0002	0.0003	0.6057	0.0002	0.0003	0.6065	0.0002	0.0003	587070
58	#	74.487	28.17	86.750	102	0	10.278	0.0036	10.281	0.0025	10.258	0.0061	0.6058	0.0002	0.0003	0.6057	0.0002	0.0003	0.6064	0.0002	0.0003	588329
59	$	108.71	32.81	17.382	151	0	0.4046	0.0006	0.4040	0.0007	0.4040	0.0006	0.6122	0.0028	0.0038	0.6126	0.0025	0.0039	0.6126	0.0024	0.0038	130054
60	$	109.03	32.84	17.367	152	0	0.4037	0.0006	0.4031	0.0006	0.4029	0.0008	0.6123	0.0028	0.0039	0.6128	0.0024	0.0039	0.6130	0.0024	0.0038	130022
61	$	109.01	32.86	17.392	148	0	0.4050	0.0006	0.4044	0.0007	0.4044	0.0005	0.6122	0.0028	0.0038	0.6127	0.0025	0.0038	0.6126	0.0023	0.0038	130262
64	$	70.558	33.04	27.325	98	0	1.0073	0.0019	1.0074	0.0024	1.0064	0.0028	0.6099	0.0013	0.0017	0.6099	0.0012	0.0017	0.6102	0.0013	0.0017	205414
65	$	70.644	33.06	27.297	98	0	1.0061	0.0012	1.0048	0.0012	1.0039	0.0016	0.6097	0.0012	0.0017	0.6100	0.0011	0.0017	0.6103	0.0011	0.0017	205281
66	$	69.834	33.07	27.191	97	0	0.9986	0.0025	0.9983	0.0023	0.9961	0.0020	0.6096	0.0014	0.0017	0.6097	0.0012	0.0017	0.6103	0.0011	0.0017	204532
67	$	39.642	33.11	47.274	55	0	3.0425	0.0070	3.0398	0.0072	3.0340	0.0085	0.6072	0.0009	0.0007	0.6074	0.0009	0.0007	0.6080	0.0010	0.0007	355885
68	$	40.382	33.12	47.582	56	0	3.0871	0.0078	3.0836	0.0061	3.0768	0.0091	0.6067	0.0009	0.0007	0.6070	0.0008	0.0007	0.6077	0.0010	0.0007	358274
69	$	39.718	33.12	47.861	55	0	3.1228	0.0018	3.1197	0.0026	3.1115	0.0038	0.6067	0.0006	0.0007	0.6070	0.0006	0.0007	0.6078	0.0006	0.0007	360376
70	$	134.74	33.18	47.513	187	0	3.0732	0.0021	3.0742	0.0026	3.0693	0.0022	0.6072	0.0004	0.0007	0.6071	0.0004	0.0007	0.6076	0.0004	0.0007	358197
71	$	134.51	33.18	47.707	186	0	3.0980	0.0029	3.0965	0.0042	3.0929	0.0025	0.6072	0.0005	0.0007	0.6074	0.0005	0.0007	0.6077	0.0004	0.0007	359660
72	$	134.75	33.18	47.673	186	0	3.0963	0.0024	3.0944	0.0031	3.0901	0.0029	0.6070	0.0004	0.0007	0.6071	0.0005	0.0007	0.6076	0.0004	0.0007	359400
73	$	74.825	33.20	85.904	101	0	10.108	0.0078	10.112	0.0099	10.101	0.0138	0.6053	0.0003	0.0004	0.6052	0.0003	0.0004	0.6055	0.0004	0.0004	647888
74	$	74.586	33.20	85.395	104	0	9.996	0.0040	9.993	0.0065	9.977	0.0073	0.6051	0.0002	0.0004	0.6052	0.0003	0.0004	0.6057	0.0003	0.0004	644045
75	$	74.660	33.19	85.777	104	0	10.076	0.0079	10.078	0.0068	10.074	0.0071	0.6054	0.0003	0.0004	0.6053	0.0003	0.0004	0.6055	0.0003	0.0004	646797
76	$	44.225	33.27	142.63	62	0	27.982	0.0097	27.983	0.0108	27.933	0.0061	0.6040	0.0002	0.0003	0.6040	0.0002	0.0003	0.6046	0.0002	0.0003	1077221
77	$	44.397	33.30	142.75	62	0	28.044	0.0112	28.046	0.0144	27.978	0.0128	0.6039	0.0002	0.0003	0.6039	0.0002	0.0003	0.6046	0.0002	0.0003	1078804
78	$	44.246	33.37	142.65	62	0	28.012	0.0264	27.998	0.0223	27.937	0.0111	0.6038	0.0003	0.0003	0.6040	0.0003	0.0003	0.6046	0.0002	0.0003	1079603

[Test Run Date Codes # - 10/16/85 $ - 11/19/85]

Table 42H. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-7B Diameter 0.3737 Inches, Beta Ratio = 0.09245

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
40	#	124.90	21.72	1.5433	115	0	0.0000	0.0000	19.815	0.0148	19.812	0.0176	0.0000	0.0000	0.0000	0.5990	0.0003	0.0008	0.5991	0.0003	0.0008	9033
41	#	124.93	21.74	1.5393	115	0	0.0000	0.0000	19.714	0.0187	19.714	0.0190	0.0000	0.0000	0.0000	0.5990	0.0003	0.0008	0.5990	0.0003	0.0008	9014
42	#	125.01	21.76	1.5349	115	0	0.0000	0.0000	19.593	0.0214	19.591	0.0226	0.0000	0.0000	0.0000	0.5991	0.0004	0.0008	0.5992	0.0004	0.0008	8992
64	$	125.19	22.27	1.5561	112	0	0.0000	0.0000	20.137	0.0444	20.133	0.0361	0.0000	0.0000	0.0000	0.5992	0.0007	0.0008	0.5992	0.0006	0.0008	9228
65	$	125.85	22.28	1.5251	113	0	0.0000	0.0000	19.342	0.0428	19.344	0.0466	0.0000	0.0000	0.0000	0.5992	0.0007	0.0008	0.5991	0.0007	0.0008	9046
66	$	124.54	22.31	1.5516	112	0	0.0000	0.0000	20.023	0.0268	20.024	0.0248	0.0000	0.0000	0.0000	0.5991	0.0004	0.0008	0.5991	0.0004	0.0008	9210
67	$	124.59	22.33	1.5310	112	1	0.0000	0.0000	19.500	0.0431	19.494	0.0361	0.0000	0.0000	0.0000	0.5991	0.0007	0.0008	0.5991	0.0006	0.0008	9092
68	$	124.50	22.35	1.5291	112	0	0.0000	0.0000	19.450	0.0080	19.446	0.0086	0.0000	0.0000	0.0000	0.5991	0.0002	0.0008	0.5992	0.0002	0.0008	9085
89	@	1206.5	23.45	0.2185	136	1	0.0000	0.0000	0.3858	0.0001	0.3864	0.0001	0.0000	0.0000	0.0000	0.6079	0.0033	0.0045	0.6074	0.0040	0.0045	1332
90	@	1206.6	23.44	0.2183	136	0	0.0000	0.0000	0.3854	0.0001	0.3860	0.0000	0.0000	0.0000	0.0000	0.6079	0.0033	0.0045	0.6074	0.0040	0.0045	1331
91	@	1206.4	23.44	0.2183	136	0	0.0000	0.0000	0.3851	0.0001	0.3856	0.0001	0.0000	0.0000	0.0000	0.6079	0.0033	0.0045	0.6075	0.0040	0.0045	1331
92	@	581.13	23.43	0.3516	144	1	0.0000	0.0000	1.0093	0.0001	1.0101	0.0001	0.0000	0.0000	0.0000	0.6049	0.0012	0.0022	0.6047	0.0015	0.0022	2143
93	@	581.19	23.43	0.3515	144	1	0.0000	0.0000	1.0079	0.0002	1.0086	0.0002	0.0000	0.0000	0.0000	0.6051	0.0013	0.0022	0.6048	0.0015	0.0022	2142
94	@	580.83	23.43	0.3516	144	10	0.0000	0.0000	1.0099	0.0005	1.0107	0.0005	0.0000	0.0000	0.0000	0.6046	0.0013	0.0021	0.6044	0.0015	0.0021	2143
95	@	325.24	23.43	0.6125	161	0	0.0000	0.0000	3.0909	0.0137	3.0922	0.0141	0.0000	0.0000	0.0000	0.6021	0.0014	0.0012	0.6020	0.0015	0.0012	3733
96	@	325.02	23.43	0.6069	161	0	0.0000	0.0000	3.0343	0.0104	3.0360	0.0113	0.0000	0.0000	0.0000	0.6021	0.0011	0.0012	0.6019	0.0012	0.0012	3698
97	@	325.08	23.42	0.6075	161	0	0.0000	0.0000	3.0388	0.0104	3.0404	0.0116	0.0000	0.0000	0.0000	0.6022	0.0011	0.0012	0.6021	0.0013	0.0012	3701
98	@	165.92	23.44	1.0999	150	0	0.0000	0.0000	10.034	0.0033	10.035	0.0033	0.0000	0.0000	0.0000	0.6000	0.0002	0.0008	0.6000	0.0002	0.0008	6704
99	@	164.76	23.44	1.0986	149	0	0.0000	0.0000	10.008	0.0027	10.010	0.0029	0.0000	0.0000	0.0000	0.6001	0.0002	0.0009	0.6000	0.0002	0.0009	6697
100	@	164.79	23.45	1.0988	149	0	0.0000	0.0000	10.010	0.0028	10.011	0.0031	0.0000	0.0000	0.0000	0.6001	0.0002	0.0009	0.6001	0.0002	0.0009	6699
101	&	1206.5	22.86	0.2253	136	1	0.0000	0.0000	0.4105	0.0001	0.4111	0.0001	0.0000	0.0000	0.0000	0.6076	0.0027	0.0043	0.6072	0.0028	0.0043	1355
102	&	1206.6	22.86	0.2254	136	0	0.0000	0.0000	0.4109	0.0001	0.4116	0.0001	0.0000	0.0000	0.0000	0.6076	0.0027	0.0043	0.6071	0.0028	0.0043	1355
103	&	1206.4	22.87	0.2255	136	3	0.0000	0.0000	0.4111	0.0001	0.4119	0.0001	0.0000	0.0000	0.0000	0.6077	0.0027	0.0043	0.6071	0.0028	0.0043	1356
104	&	581.06	22.85	0.3588	144	2	0.0000	0.0000	1.0514	0.0002	1.0524	0.0002	0.0000	0.0000	0.0000	0.6047	0.0011	0.0021	0.6044	0.0011	0.0021	2157
105	&	581.17	22.85	0.3590	144	0	0.0000	0.0000	1.0518	0.0002	1.0529	0.0002	0.0000	0.0000	0.0000	0.6049	0.0011	0.0021	0.6046	0.0011	0.0021	2158
106	&	581.14	22.85	0.3591	144	1	0.0000	0.0000	1.0526	0.0001	1.0536	0.0001	0.0000	0.0000	0.0000	0.6049	0.0011	0.0021	0.6046	0.0011	0.0021	2159
107	&	325.24	22.84	0.6037	161	9	0.0000	0.0000	3.0082	0.0005	3.0097	0.0006	0.0000	0.0000	0.0000	0.6015	0.0004	0.0012	0.6013	0.0004	0.0012	3629
108	&	325.40	22.84	0.6043	161	3	0.0000	0.0000	3.0072	0.0009	3.0087	0.0008	0.0000	0.0000	0.0000	0.6022	0.0004	0.0012	0.6020	0.0004	0.0012	3632
109	&	325.13	22.84	0.6031	161	20	0.0000	0.0000	3.0127	0.0012	3.0133	0.0016	0.0000	0.0000	0.0000	0.6004	0.0004	0.0012	0.6003	0.0004	0.0012	3625

[Test Run Date Codes # - 01/08/87 $ - 01/12/87 @ - 02/06/87 & - 02/09/87]

Table 42H. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-7B Diameter 0.3737 Inches, Beta Ratio = 0.09245

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
110	#	165.16	22.85	1.0977	150	0	0.0000	0.0000	9.992	0.0028	9.992	0.0029	0.0000	0.0000	0.0000	0.6001	0.0002	0.0009	0.6001	0.0002	0.0009	6599
111	#	164.85	22.86	1.0983	150	0	0.0000	0.0000	9.998	0.0031	9.998	0.0036	0.0000	0.0000	0.0000	0.6002	0.0002	0.0009	0.6002	0.0002	0.0009	6604
112	#	165.00	22.85	1.0980	150	0	0.0000	0.0000	9.995	0.0028	9.997	0.0029	0.0000	0.0000	0.0000	0.6001	0.0002	0.0009	0.6001	0.0002	0.0009	6601

[Test Run Date Codes # - 02/09/87]

Table 42I. Orifice Discharge Coefficient Values - Meter Tube PE-5

Meter Tube PE-5ABC Diameter 4.0420 Inches -- Orifice Plate FE-5/6-8B Diameter 0.2476 Inches, Beta Ratio = 0.06126

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	1206.1	25.15	0.0995	136	2	0.3904	0.0007	0.3912	0.0007	0.3902	0.0007	0.6271	0.0026	0.0049	0.6265	0.0026	0.0049	0.6273	0.0027	0.0049	631
2	#	1197.2	25.24	0.0991	135	1	0.3861	0.0006	0.3868	0.0006	0.3857	0.0006	0.6283	0.0026	0.0050	0.6278	0.0026	0.0050	0.6287	0.0028	0.0050	630
3	#	1206.3	24.93	0.1003	136	2	0.3957	0.0005	0.3958	0.0006	0.3951	0.0006	0.6281	0.0025	0.0049	0.6281	0.0026	0.0049	0.6287	0.0027	0.0049	633
7	#	499.88	21.13	0.4985	151	0	10.055	0.0085	10.055	0.0076	10.055	0.0070	0.6187	0.0003	0.0012	0.6187	0.0003	0.0012	0.6187	0.0003	0.0012	2877
8	#	500.79	21.04	0.4975	147	5	10.016	0.0088	10.012	0.0095	10.014	0.0088	0.6187	0.0003	0.0012	0.6189	0.0003	0.0012	0.6188	0.0003	0.0012	2865
9	#	502.45	21.11	0.4964	148	0	9.972	0.0100	9.969	0.0104	9.969	0.0104	0.6187	0.0003	0.0012	0.6188	0.0004	0.0012	0.6188	0.0004	0.0012	2863
10	#	802.02	21.12	0.2745	142	12	3.0278	0.0041	3.0265	0.0030	3.0252	0.0028	0.6209	0.0005	0.0016	0.6210	0.0005	0.0016	0.6212	0.0005	0.0016	1584
11	#	802.27	21.10	0.2749	142	0	3.0259	0.0026	3.0248	0.0027	3.0244	0.0027	0.6220	0.0004	0.0016	0.6221	0.0004	0.0016	0.6222	0.0005	0.0016	1585
12	#	801.93	21.12	0.2749	142	0	3.0253	0.0032	3.0237	0.0037	3.0231	0.0035	0.6221	0.0005	0.0016	0.6222	0.0005	0.0016	0.6223	0.0005	0.0016	1586
13	#	1206.1	21.35	0.1598	136	0	1.0115	0.0016	1.0115	0.0015	1.0095	0.0014	0.6257	0.0011	0.0026	0.6257	0.0011	0.0026	0.6263	0.0011	0.0026	927
14	#	1206.2	21.46	0.1599	136	2	1.0126	0.0010	1.0126	0.0011	1.0107	0.0011	0.6256	0.0010	0.0026	0.6256	0.0010	0.0026	0.6262	0.0011	0.0026	930
15	#	1206.2	21.54	0.1602	136	0	1.0155	0.0013	1.0154	0.0015	1.0134	0.0014	0.6257	0.0011	0.0026	0.6257	0.0011	0.0026	0.6263	0.0011	0.0026	934
17	$	1206.2	24.77	0.1014	136	1	0.4033	0.0009	0.4022	0.0008	0.4026	0.0007	0.6286	0.0031	0.0048	0.6295	0.0025	0.0048	0.6291	0.0024	0.0048	637
18	$	1206.3	23.67	0.1012	136	3	0.4015	0.0006	0.4007	0.0005	0.4009	0.0005	0.6288	0.0031	0.0048	0.6294	0.0025	0.0049	0.6292	0.0024	0.0048	620
19	$	1206.2	22.39	0.1594	136	2	1.0092	0.0013	1.0089	0.0013	1.0085	0.0013	0.6247	0.0013	0.0026	0.6248	0.0011	0.0026	0.6249	0.0010	0.0026	948
20	$	1206.2	22.28	0.1592	136	2	1.0071	0.0012	1.0062	0.0010	1.0063	0.0010	0.6246	0.0013	0.0026	0.6249	0.0010	0.0026	0.6249	0.0010	0.0026	944
21	$	1206.1	22.22	0.1591	136	0	1.0024	0.0023	1.0025	0.0022	1.0029	0.0022	0.6257	0.0014	0.0026	0.6257	0.0012	0.0026	0.6256	0.0012	0.0026	942
22	$	802.84	22.04	0.2743	142	0	3.0171	0.0048	3.0164	0.0047	3.0165	0.0050	0.6217	0.0007	0.0016	0.6218	0.0006	0.0016	0.6217	0.0006	0.0016	1618
23	$	802.75	21.94	0.2741	142	0	3.0123	0.0130	3.0123	0.0132	3.0132	0.0142	0.6218	0.0014	0.0016	0.6218	0.0014	0.0016	0.6217	0.0015	0.0016	1613
24	$	802.63	21.70	0.2703	142	0	2.9253	0.0037	2.9246	0.0036	2.9253	0.0037	0.6221	0.0006	0.0016	0.6222	0.0005	0.0016	0.6221	0.0005	0.0016	1581
25	$	501.42	21.34	0.4933	147	0	9.853	0.0098	9.854	0.0103	9.855	0.0107	0.6185	0.0003	0.0012	0.6185	0.0004	0.0012	0.6185	0.0004	0.0012	2861
26	$	502.20	21.22	0.4973	148	0	10.015	0.0078	10.015	0.0086	10.017	0.0092	0.6185	0.0003	0.0012	0.6185	0.0003	0.0012	0.6184	0.0003	0.0012	2876
27	$	501.65	21.12	0.4949	148	0	9.918	0.0129	9.916	0.0130	9.916	0.0136	0.6186	0.0004	0.0012	0.6186	0.0004	0.0012	0.6186	0.0004	0.0012	2855

[Test Run Date Codes # - 10/15/85 $ - 10/16/85]

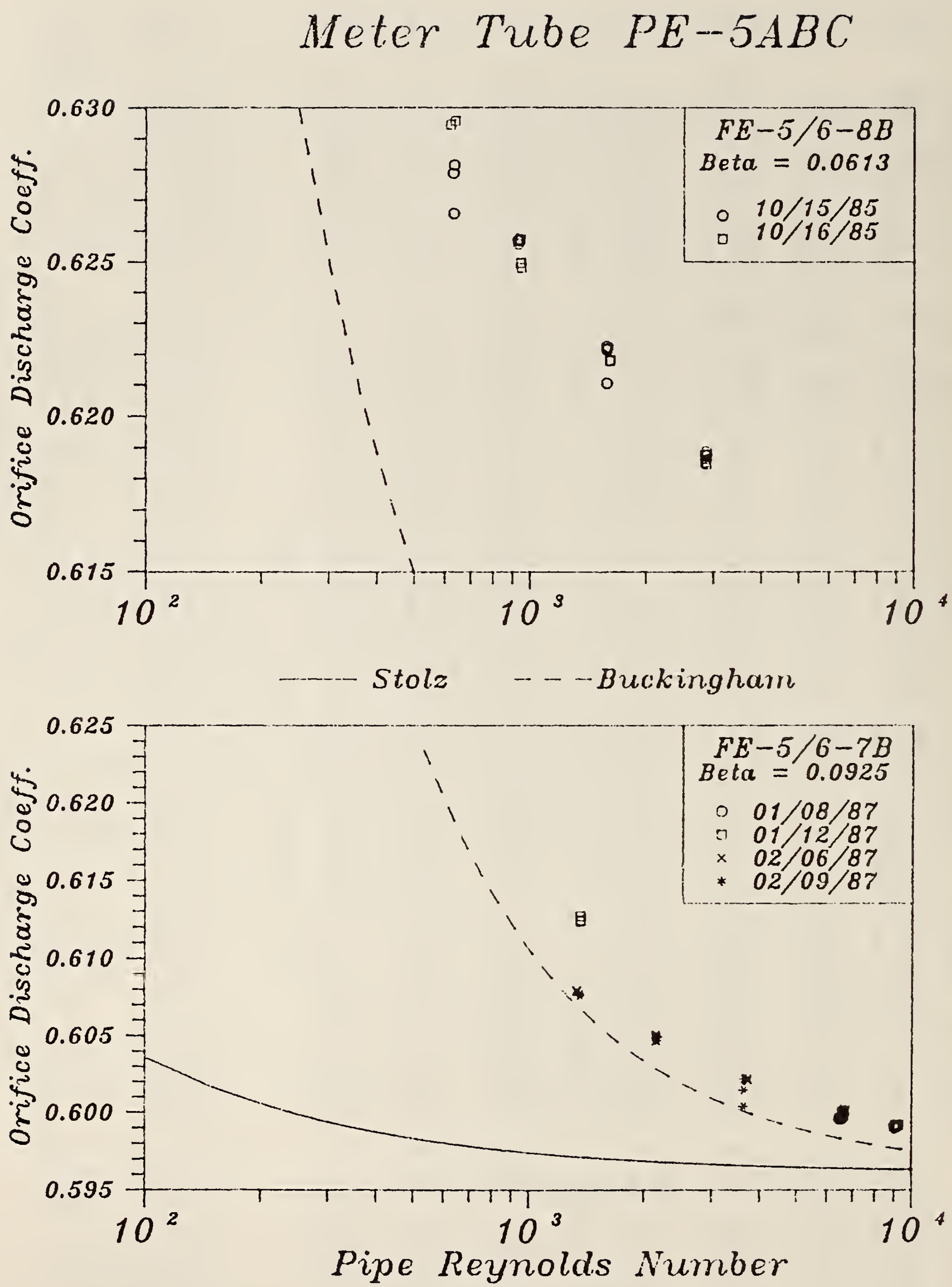


Figure 29A. Discharge Coefficient/Reynolds Number Plots, PE-5ABC 4-Inch Meter Tube, 8 Orifice Plates, Final Data Base

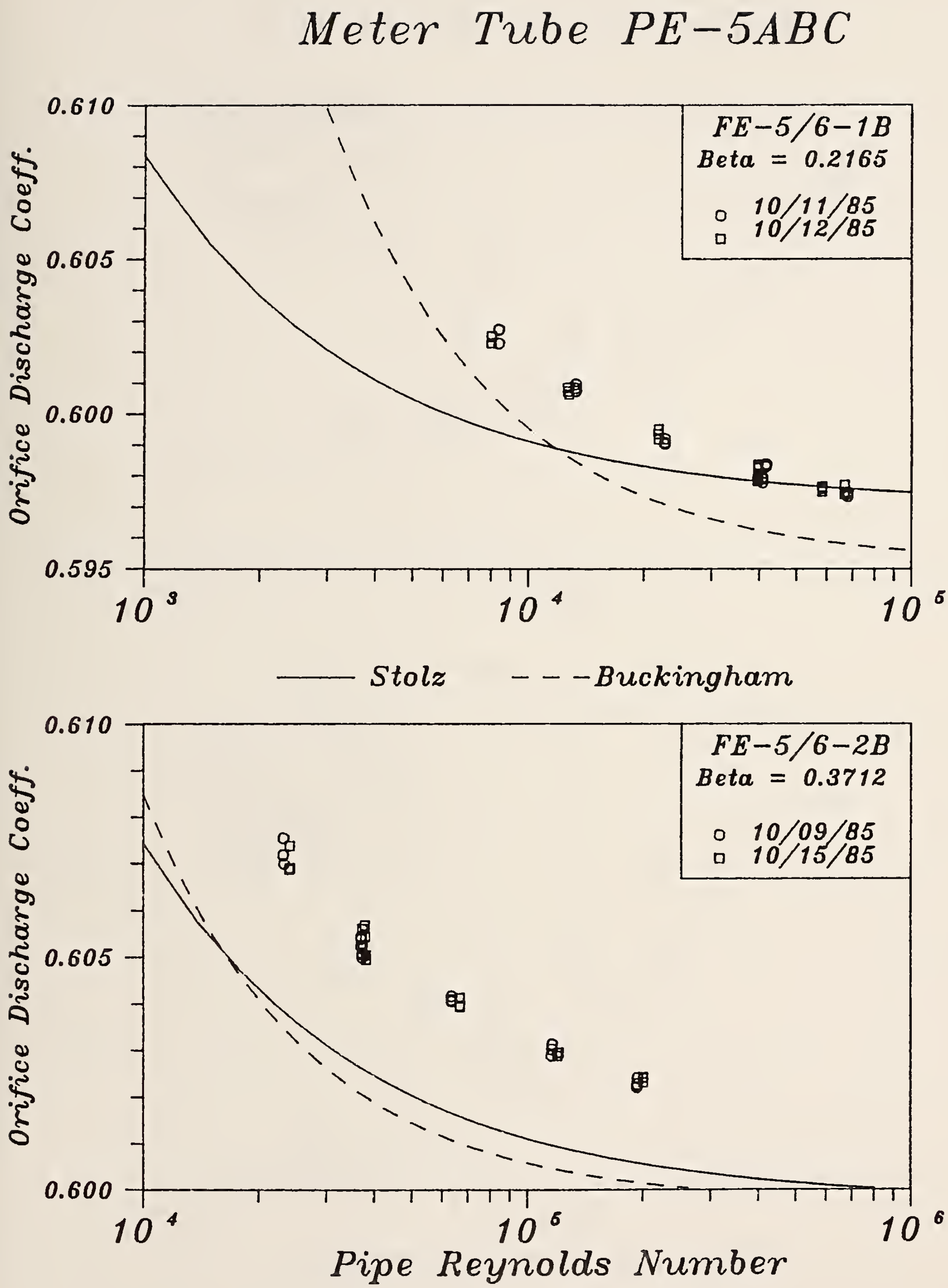


Figure 29B. Discharge Coefficient/Reynolds Number Plots, PE-5ABC 4-Inch Meter Tube, 8 Orifice Plates, Final Data Base

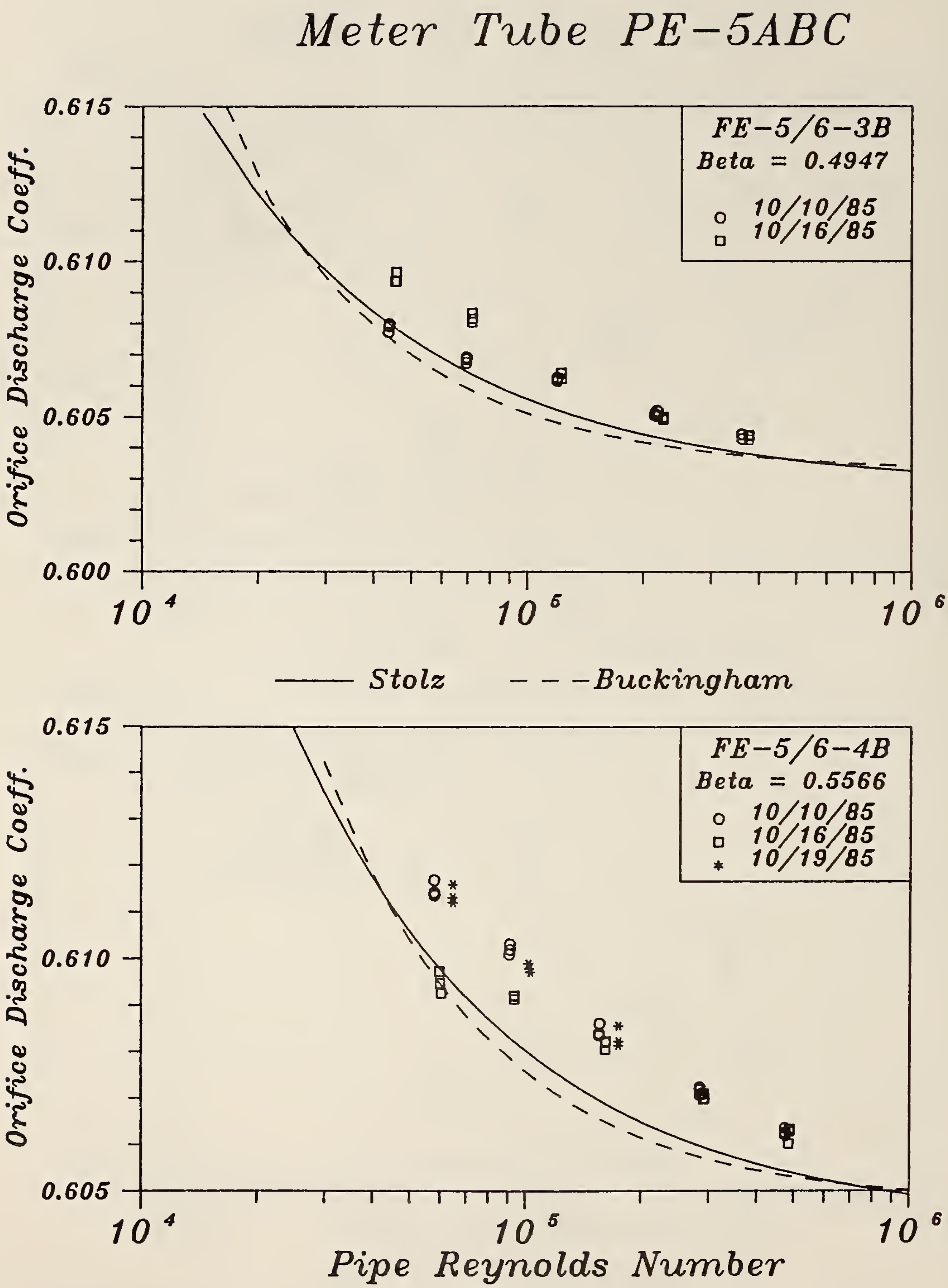


Figure 29C. Discharge Coefficient/Reynolds Number Plots, PE-5ABC 4-Inch Meter Tube, 8 Orifice Plates, Final Data Base

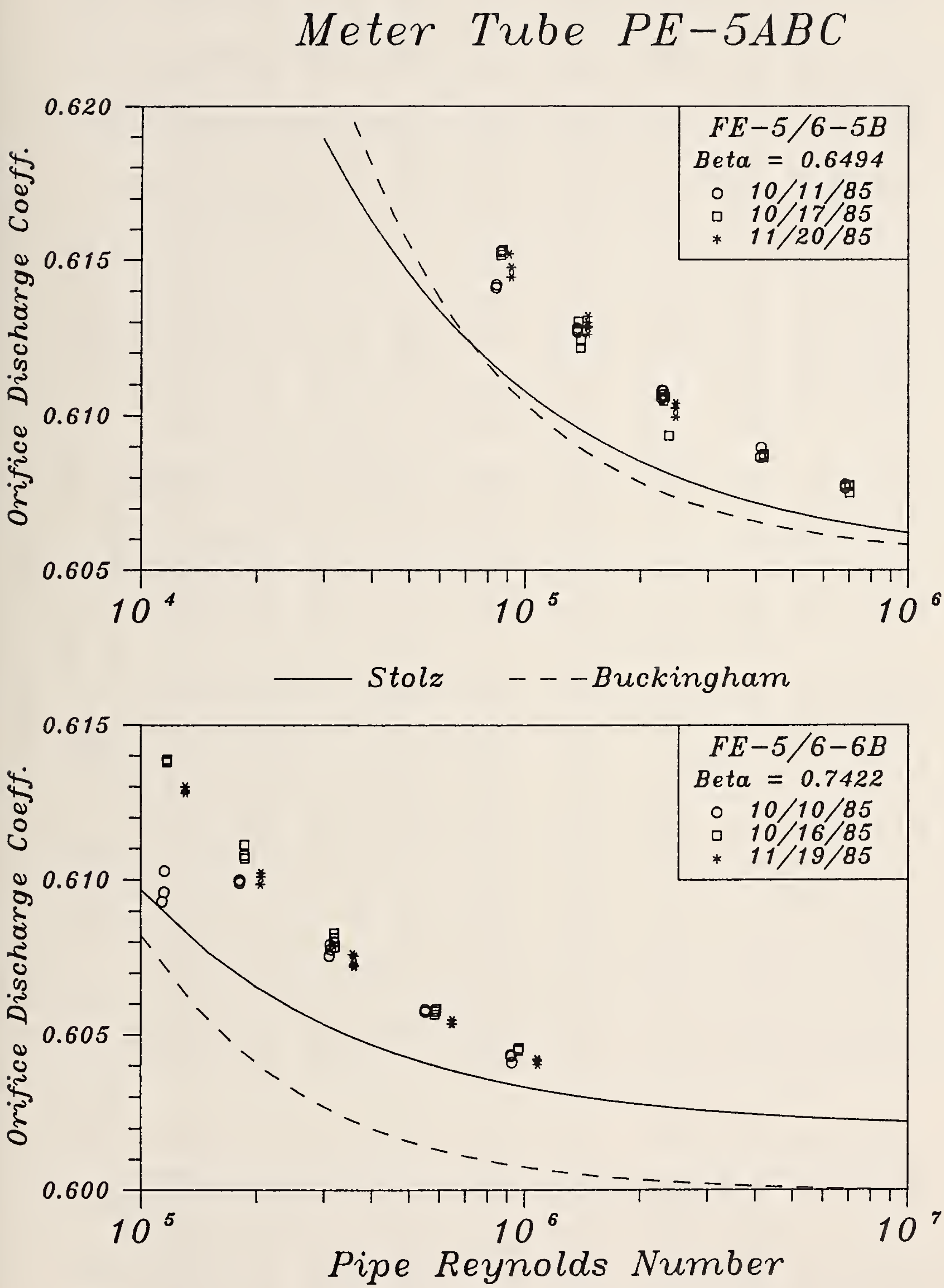


Figure 29D. Discharge Coefficient/Reynolds Number Plots, PE-5ABC 4-Inch Meter Tube, 8 Orifice Plates, Final Data Base

Table 43A. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-1C Diameter 0.8747 Inches, Beta Ratio = 0.21688

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	310.57	33.57	1.2080	154	0	0.4033	0.0011	0.4027	0.0012	0.4028	0.0011	0.6000	0.0027	0.0039	0.6004	0.0033	0.0039	0.6004	0.0027	0.0039	9200
2	#	310.36	33.59	1.2003	154	0	0.3976	0.0007	0.3977	0.0006	0.3974	0.0005	0.6005	0.0027	0.0040	0.6004	0.0033	0.0040	0.6006	0.0027	0.0040	9145
3	#	310.41	33.61	1.1987	154	0	0.3969	0.0010	0.3969	0.0007	0.3966	0.0006	0.6002	0.0027	0.0040	0.6001	0.0033	0.0040	0.6004	0.0027	0.0040	9137
4	#	199.70	33.71	1.8988	165	1	0.9980	0.0023	0.9984	0.0024	0.9989	0.0024	0.5996	0.0013	0.0018	0.5994	0.0015	0.0018	0.5993	0.0013	0.0018	14502
5	#	199.54	33.73	1.9044	165	0	1.0047	0.0024	1.0038	0.0023	1.0038	0.0023	0.5994	0.0013	0.0018	0.5996	0.0015	0.0018	0.5996	0.0013	0.0018	14551
6	#	200.81	33.75	1.8986	166	0	0.9994	0.0023	0.9988	0.0025	0.9991	0.0029	0.5991	0.0013	0.0018	0.5993	0.0015	0.0018	0.5992	0.0014	0.0018	14512
7	#	114.73	33.84	3.3094	182	0	3.0449	0.0071	3.0440	0.0078	3.0434	0.0078	0.5983	0.0008	0.0008	0.5983	0.0009	0.0008	0.5984	0.0009	0.0008	25342
8	#	114.73	33.86	3.3017	182	0	3.0301	0.0061	3.0303	0.0071	3.0310	0.0069	0.5983	0.0007	0.0008	0.5983	0.0008	0.0008	0.5982	0.0008	0.0008	25294
9	#	114.35	33.87	3.3004	180	0	3.0304	0.0061	3.0287	0.0073	3.0288	0.0076	0.5981	0.0007	0.0008	0.5982	0.0009	0.0008	0.5982	0.0008	0.0008	25289
10	#	59.738	33.96	5.9943	95	0	10.033	0.0217	10.023	0.0251	10.023	0.0250	0.5970	0.0007	0.0005	0.5973	0.0008	0.0005	0.5972	0.0008	0.0005	46014
11	#	59.754	33.97	5.9787	95	0	9.973	0.0198	9.968	0.0201	9.971	0.0223	0.5972	0.0007	0.0005	0.5973	0.0007	0.0005	0.5973	0.0007	0.0005	45904
12	#	60.356	33.97	6.0047	96	0	10.056	0.0204	10.054	0.0290	10.053	0.0268	0.5973	0.0007	0.0005	0.5974	0.0009	0.0005	0.5974	0.0008	0.0005	46104
13	#	300.03	34.03	5.9924	149	0	10.015	0.0147	10.022	0.0180	10.020	0.0180	0.5973	0.0005	0.0005	0.5971	0.0006	0.0005	0.5971	0.0006	0.0005	46065
14	#	300.45	34.05	5.9892	149	0	9.996	0.0135	10.004	0.0132	10.004	0.0130	0.5975	0.0004	0.0005	0.5973	0.0004	0.0005	0.5973	0.0004	0.0005	46059
15	#	300.10	34.07	5.9935	149	0	10.030	0.0161	10.024	0.0152	10.024	0.0160	0.5970	0.0005	0.0005	0.5971	0.0005	0.0005	0.5972	0.0005	0.0005	46111
16	#	183.45	34.15	10.008	192	0	28.020	0.0201	28.006	0.0186	28.004	0.0186	0.5964	0.0002	0.0004	0.5965	0.0002	0.0004	0.5965	0.0002	0.0004	77117
17	#	183.57	34.17	10.013	189	1	28.050	0.0143	28.037	0.0166	28.039	0.0163	0.5964	0.0002	0.0004	0.5965	0.0002	0.0004	0.5965	0.0002	0.0004	77193
18	#	182.74	34.19	10.025	177	0	28.136	0.0139	28.112	0.0105	28.108	0.0112	0.5962	0.0002	0.0004	0.5965	0.0002	0.0004	0.5965	0.0002	0.0004	77315
19	$	114.88	34.13	3.2669	177	0	2.9681	0.0064	2.9681	0.0080	2.9698	0.0079	0.5982	0.0008	0.0008	0.5982	0.0009	0.0008	0.5980	0.0009	0.0008	25164
20	$	114.51	34.14	3.2597	180	0	2.9578	0.0066	2.9562	0.0087	2.9585	0.0080	0.5979	0.0008	0.0008	0.5981	0.0010	0.0008	0.5978	0.0009	0.0008	25114
21	$	114.75	34.15	3.2656	182	0	2.9694	0.0062	2.9665	0.0073	2.9686	0.0066	0.5978	0.0007	0.0008	0.5981	0.0009	0.0008	0.5979	0.0008	0.0008	25164
22	$	310.57	34.02	1.2007	154	0	0.3989	0.0008	0.3984	0.0009	0.3985	0.0009	0.5997	0.0028	0.0039	0.6000	0.0031	0.0040	0.6000	0.0026	0.0039	9228
23	$	310.24	34.05	1.1993	154	0	0.3977	0.0009	0.3973	0.0010	0.3974	0.0010	0.5999	0.0028	0.0040	0.6002	0.0031	0.0040	0.6002	0.0026	0.0040	9223
24	$	310.40	34.06	1.1994	154	0	0.3982	0.0011	0.3972	0.0011	0.3974	0.0011	0.5996	0.0029	0.0040	0.6003	0.0031	0.0040	0.6002	0.0026	0.0039	9226
25	$	59.746	34.31	5.9956	95	0	10.038	0.0353	10.037	0.0405	10.035	0.0381	0.5970	0.0011	0.0005	0.5970	0.0012	0.0005	0.5970	0.0012	0.0005	46351
26	$	59.801	34.32	5.9994	95	0	10.043	0.0226	10.044	0.0280	10.044	0.0265	0.5972	0.0007	0.0005	0.5972	0.0009	0.0005	0.5972	0.0008	0.0005	46390
27	$	60.339	34.33	5.9901	96	0	10.004	0.0340	10.002	0.0380	10.000	0.0326	0.5974	0.0011	0.0005	0.5975	0.0012	0.0005	0.5976	0.0010	0.0005	46327
28	$	200.51	34.24	1.9174	166	0	1.0194	0.0023	1.0196	0.0027	1.0192	0.0026	0.5991	0.0013	0.0018	0.5990	0.0014	0.0018	0.5991	0.0012	0.0018	14802
29	$	200.84	34.27	1.9135	166	0	1.0148	0.0021	1.0146	0.0021	1.0144	0.0022	0.5992	0.0013	0.0018	0.5993	0.0013	0.0018	0.5993	0.0012	0.0018	14781
30	$	200.55	34.29	1.9143	166	0	1.0165	0.0019	1.0151	0.0021	1.0151	0.0022	0.5990	0.0012	0.0018	0.5994	0.0013	0.0018	0.5994	0.0012	0.0018	14793

[Test Run Date Codes # - 06/26/85 $ - 07/01/85]

Table 43A. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-1C Diameter 0.8747 Inches, Beta Ratio = 0.21688

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	180.20	34.48	10.026	198	0	28.120	0.0133	28.122	0.0136	28.125	0.0149	0.5964	0.0002	0.0004	0.5964	0.0002	0.0004	0.5964	0.0002	0.0004	77772
32	#	181.09	34.50	10.003	189	0	28.005	0.0122	28.001	0.0152	28.001	0.0150	0.5963	0.0002	0.0004	0.5963	0.0002	0.0004	0.5963	0.0002	0.0004	77627
33	#	179.94	34.53	10.004	188	0	28.006	0.0176	27.996	0.0191	27.999	0.0180	0.5964	0.0002	0.0004	0.5965	0.0002	0.0004	0.5964	0.0002	0.0004	77685

[Test Run Date Codes # - 07/01/85]

Table 43B. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37222

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
37	#	104.73	29.10	17.920	147	0	10.031	0.0168	10.031	0.0184	10.034	0.0179	0.6004	0.0005	0.0004	0.6004	0.0006	0.0004	0.6003	0.0006	0.0004	124285
38	#	104.65	29.11	17.986	147	0	10.106	0.0153	10.105	0.0151	10.104	0.0132	0.6004	0.0005	0.0004	0.6004	0.0005	0.0004	0.6004	0.0004	0.0004	124767
39	#	105.39	29.13	17.961	148	0	10.080	0.0162	10.079	0.0172	10.078	0.0184	0.6003	0.0005	0.0004	0.6003	0.0006	0.0004	0.6004	0.0006	0.0004	124647
40	#	190.05	29.17	9.842	186	0	3.0169	0.0071	3.0147	0.0064	3.0160	0.0068	0.6013	0.0008	0.0007	0.6015	0.0008	0.0007	0.6014	0.0008	0.0007	68363
41	#	190.28	29.19	9.828	187	0	3.0077	0.0086	3.0067	0.0073	3.0075	0.0082	0.6013	0.0009	0.0007	0.6014	0.0008	0.0007	0.6013	0.0009	0.0007	68291
42	#	190.12	29.21	9.850	199	0	3.0210	0.0055	3.0190	0.0059	3.0196	0.0058	0.6014	0.0007	0.0007	0.6016	0.0007	0.0007	0.6015	0.0007	0.0007	68477
46	#	59.886	29.43	29.882	84	0	27.978	0.0140	27.973	0.0130	27.970	0.0106	0.5995	0.0003	0.0003	0.5995	0.0003	0.0003	0.5996	0.0003	0.0003	208723
47	#	59.872	29.45	29.884	84	5	27.968	0.0130	27.961	0.0111	27.958	0.0107	0.5996	0.0003	0.0003	0.5997	0.0003	0.0003	0.5997	0.0003	0.0003	208821
48	#	60.533	29.47	29.860	85	0	27.923	0.0118	27.920	0.0123	27.922	0.0183	0.5996	0.0003	0.0003	0.5997	0.0003	0.0003	0.5996	0.0003	0.0003	208744
49	#	104.73	29.46	3.6108	142	0	0.4041	0.0009	0.4055	0.0008	0.4039	0.0008	0.6028	0.0026	0.0038	0.6017	0.0029	0.0038	0.6029	0.0028	0.0038	25237
50	#	105.06	29.48	3.6261	142	0	0.4077	0.0010	0.4089	0.0009	0.4069	0.0009	0.6026	0.0026	0.0038	0.6018	0.0029	0.0038	0.6032	0.0027	0.0038	25355
51	#	104.88	29.50	3.6163	148	0	0.4052	0.0012	0.4061	0.0012	0.4040	0.0009	0.6029	0.0027	0.0038	0.6022	0.0030	0.0038	0.6037	0.0028	0.0038	25297
52	#	65.444	29.54	5.7383	92	0	1.0221	0.0045	1.0218	0.0044	1.0200	0.0046	0.6023	0.0017	0.0016	0.6024	0.0018	0.0016	0.6030	0.0017	0.0016	40176
53	#	64.639	29.55	5.7264	91	0	1.0180	0.0046	1.0180	0.0048	1.0174	0.0041	0.6023	0.0017	0.0017	0.6023	0.0018	0.0017	0.6025	0.0016	0.0016	40101
54	#	64.659	29.56	5.7005	91	0	1.0088	0.0039	1.0085	0.0045	1.0077	0.0046	0.6023	0.0016	0.0017	0.6024	0.0018	0.0017	0.6026	0.0018	0.0017	39928
58	#	105.62	29.45	3.6333	149	0	0.4070	0.0003	0.4067	0.0003	0.4062	0.0003	0.6043	0.0025	0.0038	0.6046	0.0029	0.0038	0.6050	0.0027	0.0038	25389
59	#	105.04	29.44	3.6372	148	0	0.4078	0.0002	0.4073	0.0002	0.4070	0.0002	0.6044	0.0025	0.0038	0.6048	0.0029	0.0038	0.6050	0.0027	0.0038	25411
60	#	104.96	29.46	3.6339	148	0	0.4071	0.0002	0.4066	0.0002	0.4063	0.0003	0.6044	0.0025	0.0038	0.6047	0.0029	0.0038	0.6049	0.0027	0.0038	25398
63	#	64.759	29.46	5.7161	91	0	1.0133	0.0005	1.0126	0.0007	1.0140	0.0007	0.6026	0.0011	0.0017	0.6028	0.0012	0.0017	0.6024	0.0011	0.0017	39952
64	#	65.327	29.48	5.7131	92	0	1.0125	0.0003	1.0117	0.0003	1.0137	0.0003	0.6025	0.0011	0.0017	0.6027	0.0012	0.0017	0.6022	0.0011	0.0017	39948
65	#	64.624	29.48	5.7071	91	0	1.0105	0.0007	1.0099	0.0006	1.0114	0.0007	0.6025	0.0011	0.0017	0.6027	0.0012	0.0017	0.6022	0.0011	0.0017	39906
66	#	167.09	29.49	9.825	200	1	3.0054	0.0008	3.0034	0.0008	3.0057	0.0007	0.6014	0.0004	0.0007	0.6016	0.0004	0.0007	0.6014	0.0004	0.0007	68712
67	#	190.09	29.47	9.830	192	1	3.0096	0.0006	3.0078	0.0007	3.0097	0.0009	0.6013	0.0004	0.0007	0.6015	0.0004	0.0007	0.6013	0.0004	0.0007	68723
68	#	190.17	29.47	9.827	188	1	3.0076	0.0007	3.0058	0.0008	3.0079	0.0007	0.6013	0.0004	0.0007	0.6015	0.0004	0.0007	0.6013	0.0004	0.0007	68699
70	$	104.81	28.35	3.6221	145	0	0.4044	0.0002	0.4045	0.0002	0.4045	0.0002	0.6044	0.0023	0.0038	0.6043	0.0026	0.0038	0.6043	0.0024	0.0038	24716
71	$	104.98	28.37	3.6145	148	1	0.4027	0.0002	0.4027	0.0002	0.4025	0.0001	0.6044	0.0023	0.0038	0.6043	0.0026	0.0038	0.6045	0.0024	0.0038	24675
72	$	105.40	28.37	3.6113	146	1	0.4020	0.0002	0.4020	0.0002	0.4018	0.0002	0.6043	0.0023	0.0038	0.6044	0.0026	0.0038	0.6045	0.0024	0.0038	24653
73	$	64.678	28.38	5.7116	91	0	1.0103	0.0005	1.0092	0.0004	1.0101	0.0005	0.6029	0.0010	0.0017	0.6032	0.0011	0.0017	0.6030	0.0010	0.0017	38999
74	$	64.335	28.38	5.7117	90	0	1.0106	0.0005	1.0094	0.0005	1.0104	0.0004	0.6029	0.0010	0.0017	0.6032	0.0011	0.0017	0.6029	0.0010	0.0017	39000
75	$	65.329	28.38	5.7161	92	0	1.0123	0.0004	1.0112	0.0004	1.0124	0.0004	0.6028	0.0010	0.0017	0.6031	0.0011	0.0017	0.6028	0.0010	0.0017	39030

[Test Run Date Codes # - 09/18/85 $ - 09/20/85]

Table 43B. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37222

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
76	#	169.51	28.39	9.834	200	0	3.0080	0.0006	3.0064	0.0005	3.0067	0.0005	0.6016	0.0003	0.0007	0.6018	0.0004	0.0007	0.6017	0.0003	0.0007	67160
77	#	176.00	28.39	9.819	200	0	2.9980	0.0006	2.9961	0.0007	2.9980	0.0006	0.6017	0.0003	0.0007	0.6019	0.0004	0.0007	0.6017	0.0004	0.0007	67060
78	#	178.57	28.39	9.822	200	1	3.0008	0.0009	2.9990	0.0010	3.0000	0.0008	0.6016	0.0003	0.0007	0.6018	0.0004	0.0007	0.6017	0.0004	0.0007	67079
79	#	177.56	28.46	9.838	200	0	3.0111	0.0060	3.0095	0.0056	3.0108	0.0050	0.6016	0.0007	0.0007	0.6017	0.0007	0.0007	0.6016	0.0006	0.0007	67292
80	#	177.27	28.49	9.841	200	0	3.0134	0.0042	3.0110	0.0050	3.0123	0.0048	0.6015	0.0005	0.0007	0.6018	0.0006	0.0007	0.6016	0.0006	0.0007	67357
81	#	190.08	28.52	9.873	194	0	3.0321	0.0048	3.0295	0.0046	3.0304	0.0048	0.6016	0.0006	0.0007	0.6019	0.0006	0.0007	0.6018	0.0006	0.0007	67621
82	#	59.871	28.60	29.824	84	0	27.855	0.0123	27.853	0.0138	27.851	0.0164	0.5996	0.0003	0.0003	0.5996	0.0003	0.0003	0.5996	0.0003	0.0003	204615
83	#	59.834	28.61	29.827	84	0	27.854	0.0195	27.849	0.0167	27.848	0.0159	0.5997	0.0003	0.0003	0.5997	0.0003	0.0003	0.5997	0.0003	0.0003	204682
84	#	59.824	28.62	29.829	84	0	27.847	0.0135	27.840	0.0123	27.851	0.0138	0.5998	0.0003	0.0003	0.5999	0.0003	0.0003	0.5997	0.0003	0.0003	204740
85	#	104.65	28.65	17.917	143	0	10.028	0.0153	10.027	0.0154	10.028	0.0161	0.6004	0.0005	0.0004	0.6004	0.0005	0.0004	0.6004	0.0005	0.0004	123060
86	#	104.56	28.67	17.934	147	0	10.049	0.0068	10.050	0.0060	10.050	0.0070	0.6003	0.0003	0.0004	0.6003	0.0003	0.0004	0.6003	0.0003	0.0004	123229
87	#	104.59	28.69	17.892	147	0	10.003	0.0102	10.002	0.0092	10.002	0.0097	0.6003	0.0004	0.0004	0.6003	0.0003	0.0004	0.6003	0.0003	0.0004	122997
1	$	103.98	22.73	3.6397	95	0	0.0000	0.0000	0.4075	0.0002	0.4080	0.0003	0.0000	0.0000	0.0000	0.6046	0.0027	0.0038	0.6043	0.0024	0.0038	21868
2	$	103.84	22.73	3.6393	95	1	0.0000	0.0000	0.4074	0.0001	0.4078	0.0001	0.0000	0.0000	0.0000	0.6047	0.0027	0.0038	0.6043	0.0024	0.0038	21865
3	$	103.86	22.73	3.6384	95	0	0.0000	0.0000	0.4071	0.0002	0.4078	0.0002	0.0000	0.0000	0.0000	0.6047	0.0027	0.0038	0.6042	0.0024	0.0038	21860
7	$	64.710	22.76	5.7936	59	0	0.0000	0.0000	1.0381	0.0006	1.0392	0.0003	0.0000	0.0000	0.0000	0.6030	0.0011	0.0016	0.6027	0.0010	0.0016	34833
8	$	65.743	22.75	5.7832	60	0	0.0000	0.0000	1.0339	0.0006	1.0351	0.0004	0.0000	0.0000	0.0000	0.6031	0.0011	0.0016	0.6028	0.0010	0.0016	34763
9	$	65.764	22.75	5.7829	60	0	0.0000	0.0000	1.0343	0.0004	1.0343	0.0005	0.0000	0.0000	0.0000	0.6030	0.0011	0.0016	0.6030	0.0010	0.0016	34761
10	$	225.77	22.75	5.7938	186	0	0.0000	0.0000	1.0416	0.0004	1.0414	0.0003	0.0000	0.0000	0.0000	0.6020	0.0011	0.0016	0.6021	0.0009	0.0016	34826
11	$	224.62	22.76	5.7929	185	0	0.0000	0.0000	1.0389	0.0002	1.0394	0.0002	0.0000	0.0000	0.0000	0.6027	0.0011	0.0016	0.6025	0.0009	0.0016	34829
12	$	225.68	22.76	5.8078	186	0	0.0000	0.0000	1.0441	0.0004	1.0447	0.0003	0.0000	0.0000	0.0000	0.6027	0.0011	0.0016	0.6026	0.0009	0.0016	34919
13	$	331.36	22.76	5.7954	164	0	0.0000	0.0000	1.0397	0.0003	1.0403	0.0004	0.0000	0.0000	0.0000	0.6027	0.0011	0.0016	0.6026	0.0009	0.0016	34844
14	$	331.35	22.77	5.8029	164	1	0.0000	0.0000	1.0429	0.0002	1.0433	0.0003	0.0000	0.0000	0.0000	0.6026	0.0011	0.0016	0.6025	0.0009	0.0016	34897
15	$	331.44	22.78	5.8005	164	0	0.0000	0.0000	1.0419	0.0002	1.0420	0.0002	0.0000	0.0000	0.0000	0.6026	0.0011	0.0016	0.6026	0.0009	0.0016	34891
16	$	190.00	22.77	9.904	172	1	0.0000	0.0000	3.0439	0.0005	3.0458	0.0004	0.0000	0.0000	0.0000	0.6020	0.0004	0.0007	0.6018	0.0003	0.0007	59559
17	$	189.88	22.76	9.907	172	0	0.0000	0.0000	3.0467	0.0007	3.0484	0.0006	0.0000	0.0000	0.0000	0.6019	0.0004	0.0007	0.6017	0.0003	0.0007	59566
18	$	190.06	22.77	9.914	172	0	0.0000	0.0000	3.0503	0.0009	3.0516	0.0006	0.0000	0.0000	0.0000	0.6019	0.0004	0.0007	0.6018	0.0003	0.0007	59618
19	$	105.43	22.78	17.918	96	0	0.0000	0.0000	9.998	0.0021	10.001	0.0019	0.0000	0.0000	0.0000	0.6009	0.0002	0.0004	0.6008	0.0002	0.0004	107777
20	$	105.36	22.78	17.916	96	0	0.0000	0.0000	10.002	0.0031	10.004	0.0026	0.0000	0.0000	0.0000	0.6008	0.0002	0.0004	0.6007	0.0002	0.0004	107771
21	$	105.36	22.78	17.919	96	0	0.0000	0.0000	9.999	0.0021	10.004	0.0022	0.0000	0.0000	0.0000	0.6009	0.0002	0.0004	0.6008	0.0002	0.0004	107786

[Test Run Date Codes # - 09/20/85 $ - 01/13/87]

Table 43B. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37222

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
22 #	60.264	22.84	29.963	55	0	0.0000	0.0000	28.033	0.0160	28.042	0.0143	0.0000	0.0000	0.0000	0.6001	0.0003	0.0003	0.6000	0.0003	0.0003	180489
23 #	60.325	22.85	29.994	55	1	0.0000	0.0000	28.095	0.0165	28.098	0.0116	0.0000	0.0000	0.0000	0.6001	0.0003	0.0003	0.6001	0.0003	0.0003	180720
24 #	60.279	22.86	29.994	55	0	0.0000	0.0000	28.083	0.0076	28.091	0.0135	0.0000	0.0000	0.0000	0.6002	0.0003	0.0003	0.6001	0.0003	0.0003	180758
28 $	104.19	22.92	3.6009	95	0	0.0000	0.0000	0.3998	0.0002	0.3992	0.0002	0.0000	0.0000	0.0000	0.6039	0.0028	0.0039	0.6044	0.0025	0.0039	21732
29 $	97.356	22.88	3.6092	95	0	0.0000	0.0000	0.4016	0.0001	0.4007	0.0002	0.0000	0.0000	0.0000	0.6040	0.0027	0.0038	0.6046	0.0025	0.0038	21761
30 $	103.61	22.84	3.6006	94	0	0.0000	0.0000	0.3995	0.0003	0.3985	0.0004	0.0000	0.0000	0.0000	0.6041	0.0028	0.0039	0.6048	0.0026	0.0039	21689
31 $	64.972	22.84	5.7299	59	0	0.0000	0.0000	1.0146	0.0004	1.0146	0.0004	0.0000	0.0000	0.0000	0.6033	0.0011	0.0017	0.6032	0.0010	0.0017	34515
32 $	64.912	22.84	5.7284	59	0	0.0000	0.0000	1.0142	0.0008	1.0149	0.0010	0.0000	0.0000	0.0000	0.6032	0.0011	0.0017	0.6030	0.0011	0.0017	34506
33 $	64.624	22.86	5.7238	59	0	0.0000	0.0000	1.0126	0.0005	1.0128	0.0005	0.0000	0.0000	0.0000	0.6032	0.0011	0.0017	0.6031	0.0010	0.0017	34495
34 $	225.79	22.86	5.7428	186	1	0.0000	0.0000	1.0209	0.0002	1.0214	0.0003	0.0000	0.0000	0.0000	0.6027	0.0011	0.0016	0.6026	0.0010	0.0016	34609
35 $	225.81	22.88	5.7362	186	0	0.0000	0.0000	1.0179	0.0003	1.0180	0.0003	0.0000	0.0000	0.0000	0.6029	0.0011	0.0017	0.6029	0.0010	0.0017	34586
36 $	225.91	22.88	5.7301	186	0	0.0000	0.0000	1.0159	0.0003	1.0166	0.0002	0.0000	0.0000	0.0000	0.6029	0.0011	0.0017	0.6027	0.0010	0.0017	34549
37 $	190.64	22.88	9.861	174	0	0.0000	0.0000	3.0162	0.0006	3.0181	0.0007	0.0000	0.0000	0.0000	0.6021	0.0004	0.0007	0.6019	0.0004	0.0007	59454
38 $	190.62	22.87	9.862	174	0	0.0000	0.0000	3.0173	0.0006	3.0185	0.0004	0.0000	0.0000	0.0000	0.6021	0.0004	0.0007	0.6020	0.0004	0.0007	59448
39 $	189.89	22.87	9.860	173	1	0.0000	0.0000	3.0162	0.0007	3.0166	0.0010	0.0000	0.0000	0.0000	0.6021	0.0004	0.0007	0.6020	0.0004	0.0007	59435
40 $	104.60	22.88	17.920	96	0	0.0000	0.0000	10.001	0.0022	10.003	0.0016	0.0000	0.0000	0.0000	0.6009	0.0002	0.0004	0.6009	0.0002	0.0004	108045
41 $	104.49	22.88	17.920	96	0	0.0000	0.0000	10.000	0.0032	10.004	0.0016	0.0000	0.0000	0.0000	0.6010	0.0002	0.0004	0.6008	0.0002	0.0004	108049
42 $	105.59	22.88	17.910	97	0	0.0000	0.0000	9.989	0.0017	9.991	0.0026	0.0000	0.0000	0.0000	0.6010	0.0002	0.0004	0.6009	0.0002	0.0004	107988
43 $	104.64	23.04	17.975	96	0	0.0000	0.0000	10.065	0.0051	10.065	0.0065	0.0000	0.0000	0.0000	0.6008	0.0002	0.0004	0.6008	0.0003	0.0004	108785
44 $	104.77	23.05	17.970	96	1	0.0000	0.0000	10.060	0.0227	10.058	0.0288	0.0000	0.0000	0.0000	0.6008	0.0007	0.0004	0.6009	0.0009	0.0004	108782
45 $	104.18	23.07	17.976	95	0	0.0000	0.0000	10.065	0.0266	10.070	0.0269	0.0000	0.0000	0.0000	0.6009	0.0008	0.0004	0.6007	0.0008	0.0004	108869
46 $	60.412	23.18	30.077	55	0	0.0000	0.0000	28.225	0.0515	28.232	0.0478	0.0000	0.0000	0.0000	0.6004	0.0006	0.0003	0.6003	0.0006	0.0003	182624
47 $	61.020	23.20	30.041	56	0	0.0000	0.0000	28.172	0.0173	28.179	0.0137	0.0000	0.0000	0.0000	0.6002	0.0003	0.0003	0.6002	0.0003	0.0003	182494
48 $	59.972	23.22	30.064	55	0	0.0000	0.0000	28.214	0.0127	28.230	0.0105	0.0000	0.0000	0.0000	0.6002	0.0003	0.0003	0.6001	0.0003	0.0003	182716
49 $	104.44	23.13	3.6259	96	0	0.0000	0.0000	0.4055	0.0001	0.4053	0.0002	0.0000	0.0000	0.0000	0.6038	0.0027	0.0038	0.6040	0.0025	0.0038	21991
50 $	103.40	23.15	3.6322	95	1	0.0000	0.0000	0.4070	0.0002	0.4064	0.0002	0.0000	0.0000	0.0000	0.6038	0.0027	0.0038	0.6042	0.0025	0.0038	22039
51 $	103.45	23.14	3.6399	95	0	0.0000	0.0000	0.4084	0.0002	0.4080	0.0002	0.0000	0.0000	0.0000	0.6040	0.0027	0.0038	0.6043	0.0025	0.0038	22081

[Test Run Date Codes # - 01/13/87 $ - 01/15/87]

Table 43C. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-3C Diameter 2.0005 Inches, Beta Ratio = 0.49602

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	194.58	32.91	32.586	161	0	9.986	0.0122	9.978	0.0103	9.978	0.0126	0.6033	0.0004	0.0003	0.6036	0.0004	0.0003	0.6036	0.0004	0.0003	244848
2	#	195.59	32.93	32.633	162	0	10.016	0.0112	10.003	0.0099	10.004	0.0118	0.6033	0.0004	0.0003	0.6037	0.0003	0.0003	0.6036	0.0004	0.0003	245297
3	#	195.52	32.95	32.577	162	0	9.964	0.0122	9.967	0.0106	9.969	0.0103	0.6038	0.0004	0.0003	0.6037	0.0004	0.0003	0.6037	0.0003	0.0003	244980
4	#	120.23	33.00	54.516	183	0	27.984	0.0103	27.982	0.0070	27.984	0.0072	0.6030	0.0001	0.0002	0.6030	0.0001	0.0002	0.6030	0.0001	0.0002	410386
5	#	119.69	33.00	54.532	190	0	27.992	0.0052	27.990	0.0062	28.007	0.0033	0.6031	0.0001	0.0002	0.6031	0.0001	0.0002	0.6029	0.0001	0.0002	410506
6	#	119.93	33.01	54.621	184	13	28.091	0.0119	28.065	0.0105	28.056	0.0117	0.6030	0.0002	0.0002	0.6032	0.0002	0.0002	0.6033	0.0002	0.0002	411255
7	#	59.688	33.08	32.570	95	0	9.945	0.0129	9.956	0.0188	9.964	0.0160	0.6043	0.0005	0.0003	0.6040	0.0006	0.0003	0.6037	0.0006	0.0003	245583
8	#	60.370	33.09	32.543	96	0	9.948	0.0171	9.944	0.0219	9.941	0.0192	0.6037	0.0006	0.0003	0.6038	0.0007	0.0003	0.6039	0.0007	0.0003	245425
9	#	60.405	33.10	32.585	96	0	9.964	0.0078	9.964	0.0073	9.963	0.0092	0.6040	0.0004	0.0003	0.6040	0.0004	0.0003	0.6040	0.0004	0.0003	245793
10	#	290.29	33.13	6.5937	163	0	0.4053	0.0009	0.4060	0.0010	0.4043	0.0008	0.6060	0.0027	0.0038	0.6054	0.0037	0.0038	0.6067	0.0030	0.0038	49768
11	#	291.44	33.16	6.5550	163	0	0.4000	0.0010	0.4004	0.0011	0.3990	0.0009	0.6065	0.0028	0.0038	0.6061	0.0038	0.0038	0.6072	0.0030	0.0038	49506
12	#	290.87	33.19	6.5507	164	0	0.3993	0.0007	0.3995	0.0010	0.3981	0.0010	0.6066	0.0028	0.0038	0.6064	0.0038	0.0038	0.6075	0.0030	0.0038	49504
13	#	99.92	33.23	18.244	154	0	3.1090	0.0074	3.1091	0.0084	3.1101	0.0088	0.6054	0.0008	0.0007	0.6054	0.0010	0.0007	0.6053	0.0009	0.0007	137988
14	#	99.481	33.24	18.304	158	0	3.1345	0.0080	3.1331	0.0112	3.1324	0.0092	0.6049	0.0009	0.0007	0.6051	0.0012	0.0007	0.6051	0.0010	0.0007	138468
15	#	99.318	33.25	18.000	158	0	3.0308	0.0043	3.0307	0.0052	3.0297	0.0058	0.6050	0.0006	0.0007	0.6050	0.0007	0.0007	0.6051	0.0007	0.0007	136193
16	#	173.03	33.27	10.225	200	0	0.9738	0.0015	0.9729	0.0015	0.9739	0.0018	0.6062	0.0012	0.0017	0.6065	0.0016	0.0017	0.6062	0.0013	0.0017	77394
17	#	174.83	33.30	10.208	200	0	0.9718	0.0018	0.9700	0.0019	0.9706	0.0018	0.6059	0.0013	0.0017	0.6065	0.0016	0.0017	0.6063	0.0013	0.0017	77315
18	#	180.48	33.31	10.195	196	0	0.9677	0.0020	0.9671	0.0022	0.9681	0.0018	0.6064	0.0013	0.0017	0.6066	0.0017	0.0017	0.6063	0.0013	0.0017	77230
19	#	291.87	33.33	6.7734	163	0	0.4279	0.0012	0.4265	0.0015	0.4249	0.0015	0.6059	0.0027	0.0036	0.6069	0.0037	0.0036	0.6080	0.0029	0.0036	51334
20	#	291.05	33.35	6.7262	164	0	0.4204	0.0007	0.4197	0.0007	0.4188	0.0007	0.6070	0.0026	0.0037	0.6075	0.0036	0.0037	0.6081	0.0028	0.0037	50997
21	#	289.28	33.37	6.7150	161	0	0.4198	0.0008	0.4184	0.0010	0.4173	0.0010	0.6064	0.0026	0.0037	0.6074	0.0036	0.0037	0.6082	0.0029	0.0037	50933
22	#	120.12	33.60	13.309	184	0	1.6539	0.0026	1.6513	0.0032	1.6543	0.0029	0.6055	0.0008	0.0011	0.6060	0.0011	0.0011	0.6055	0.0009	0.0011	101418
23	#	120.65	33.61	13.336	182	0	1.6572	0.0028	1.6578	0.0032	1.6605	0.0030	0.6062	0.0008	0.0011	0.6061	0.0011	0.0011	0.6056	0.0009	0.0011	101648
24	#	119.56	33.63	13.323	188	0	1.6548	0.0027	1.6540	0.0035	1.6570	0.0035	0.6060	0.0008	0.0011	0.6062	0.0011	0.0011	0.6056	0.0010	0.0011	101588
25	#	291.56	33.65	6.6301	165	0	0.4076	0.0008	0.4071	0.0007	0.4080	0.0008	0.6077	0.0027	0.0038	0.6081	0.0037	0.0038	0.6073	0.0029	0.0038	50576
26	#	289.95	33.66	6.6185	163	0	0.4068	0.0009	0.4058	0.0011	0.4068	0.0011	0.6072	0.0027	0.0038	0.6080	0.0038	0.0038	0.6072	0.0030	0.0038	50498
27	#	289.59	33.67	6.6163	162	0	0.4065	0.0007	0.4052	0.0006	0.4067	0.0006	0.6072	0.0027	0.0038	0.6082	0.0037	0.0038	0.6071	0.0029	0.0038	50491
37	$	161.76	31.55	10.582	200	0	0.0000	0.0000	1.0413	0.0022	1.0418	0.0021	0.0000	0.0000	0.0000	0.6066	0.0011	0.0016	0.6065	0.0011	0.0016	77302
38	$	161.81	31.58	10.631	200	0	0.0000	0.0000	1.0512	0.0023	1.0517	0.0024	0.0000	0.0000	0.0000	0.6066	0.0011	0.0016	0.6064	0.0011	0.0016	77710
39	$	161.65	31.61	10.539	200	0	0.0000	0.0000	1.0328	0.0021	1.0336	0.0022	0.0000	0.0000	0.0000	0.6066	0.0011	0.0016	0.6064	0.0011	0.0016	77086

[Test Run Date Codes # - 06/26/85 $ - 11/22/85]

Table 43C. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-3C Diameter 2.0005 Inches, Beta Ratio = 0.49602

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
40	#	291.15	31.66	6.6734	178	0	0.0000	0.0000	0.4129	0.0014	0.4121	0.0013	0.0000	0.0000	0.0000	0.6076	0.0025	0.0037	0.6081	0.0024	0.0037	48864
41	#	291.14	31.70	6.6087	177	0	0.0000	0.0000	0.4041	0.0009	0.4044	0.0011	0.0000	0.0000	0.0000	0.6082	0.0024	0.0038	0.6079	0.0024	0.0038	48430
42	#	290.70	31.72	6.6273	177	0	0.0000	0.0000	0.4060	0.0006	0.4069	0.0006	0.0000	0.0000	0.0000	0.6085	0.0023	0.0038	0.6078	0.0023	0.0038	48587
43	#	100.07	31.83	17.837	139	0	0.0000	0.0000	2.9697	0.0115	2.9749	0.0123	0.0000	0.0000	0.0000	0.6055	0.0012	0.0007	0.6050	0.0013	0.0007	131067
44	#	100.06	31.85	17.864	139	0	0.0000	0.0000	2.9793	0.0029	2.9813	0.0042	0.0000	0.0000	0.0000	0.6054	0.0005	0.0007	0.6052	0.0006	0.0007	131320
45	#	100.03	31.87	17.851	139	0	0.0000	0.0000	2.9758	0.0062	2.9801	0.0076	0.0000	0.0000	0.0000	0.6054	0.0007	0.0007	0.6049	0.0009	0.0007	131283
46	#	60.408	31.95	32.682	84	0	0.0000	0.0000	10.024	0.0114	10.023	0.0112	0.0000	0.0000	0.0000	0.6039	0.0004	0.0003	0.6039	0.0004	0.0003	240748
47	#	60.366	31.97	32.647	84	0	0.0000	0.0000	10.001	0.0141	10.010	0.0130	0.0000	0.0000	0.0000	0.6039	0.0005	0.0003	0.6036	0.0005	0.0003	240590
48	#	60.422	31.99	32.688	84	0	0.0000	0.0000	10.021	0.0102	10.028	0.0079	0.0000	0.0000	0.0000	0.6041	0.0004	0.0003	0.6039	0.0004	0.0003	240992
49	#	119.56	32.04	54.295	163	0	0.0000	0.0000	27.729	0.0075	27.742	0.0061	0.0000	0.0000	0.0000	0.6032	0.0001	0.0002	0.6031	0.0001	0.0002	400708
50	#	119.66	32.03	54.299	167	0	0.0000	0.0000	27.724	0.0060	27.739	0.0078	0.0000	0.0000	0.0000	0.6033	0.0001	0.0002	0.6031	0.0001	0.0002	400654
51	#	119.73	32.03	54.167	167	0	0.0000	0.0000	27.595	0.0055	27.599	0.0067	0.0000	0.0000	0.0000	0.6032	0.0001	0.0002	0.6032	0.0001	0.0002	399684

[Test Run Date Codes # - 11/22/85]

Table 43D. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55796

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	80.163	34.93	23.213	128	0	3.0136	0.0038	3.0126	0.0044	3.0083	0.0039	0.6064	0.0006	0.0007	0.6065	0.0007	0.0007	0.6069	0.0006	0.0007	181701
2 #	79.566	34.93	23.226	127	0	3.0147	0.0048	3.0137	0.0051	3.0089	0.0048	0.6066	0.0006	0.0007	0.6067	0.0007	0.0007	0.6072	0.0006	0.0007	181803
3 #	79.505	34.93	23.227	127	0	3.0142	0.0040	3.0138	0.0047	3.0119	0.0046	0.6067	0.0006	0.0007	0.6067	0.0007	0.0007	0.6069	0.0006	0.0007	181814
4 #	190.76	34.92	8.5076	185	0	0.4007	0.0010	0.4009	0.0011	0.4007	0.0008	0.6095	0.0028	0.0038	0.6093	0.0034	0.0038	0.6095	0.0027	0.0038	66581
5 #	190.29	34.93	8.4810	181	0	0.3986	0.0007	0.3982	0.0009	0.3981	0.0011	0.6092	0.0027	0.0039	0.6094	0.0034	0.0039	0.6095	0.0028	0.0039	66386
6 #	190.67	34.94	8.4749	183	0	0.3977	0.0010	0.3976	0.0010	0.3972	0.0010	0.6094	0.0028	0.0039	0.6095	0.0034	0.0039	0.6098	0.0028	0.0039	66352
7 #	133.95	34.96	13.427	200	0	1.0024	0.0015	1.0025	0.0021	1.0019	0.0019	0.6082	0.0012	0.0016	0.6081	0.0015	0.0016	0.6083	0.0012	0.0016	105167
8 #	132.20	34.98	13.481	200	0	1.0100	0.0019	1.0102	0.0021	1.0092	0.0016	0.6083	0.0012	0.0016	0.6082	0.0015	0.0016	0.6086	0.0012	0.0016	105631
9 #	134.85	34.99	13.480	196	0	1.0106	0.0013	1.0099	0.0016	1.0094	0.0022	0.6081	0.0011	0.0016	0.6083	0.0014	0.0016	0.6085	0.0013	0.0016	105646
10 #	43.030	35.03	42.310	66	0	10.034	0.0100	10.040	0.0135	10.036	0.0107	0.6057	0.0005	0.0003	0.6055	0.0006	0.0003	0.6056	0.0005	0.0003	331847
11 #	43.083	35.04	42.554	69	0	10.164	0.0194	10.158	0.0126	10.153	0.0101	0.6053	0.0007	0.0003	0.6055	0.0005	0.0003	0.6056	0.0005	0.0003	333827
12 #	42.440	35.05	42.761	68	0	10.245	0.0105	10.252	0.0148	10.254	0.0109	0.6058	0.0005	0.0003	0.6056	0.0006	0.0003	0.6056	0.0005	0.0003	335521
13 #	149.57	35.08	42.319	186	0	10.059	0.0069	10.056	0.0076	10.048	0.0072	0.6051	0.0003	0.0003	0.6052	0.0003	0.0003	0.6054	0.0003	0.0003	332253
14 #	149.84	35.09	42.355	186	0	10.069	0.0074	10.070	0.0090	10.061	0.0066	0.6053	0.0003	0.0003	0.6053	0.0003	0.0003	0.6055	0.0002	0.0003	332600
15 #	149.97	35.10	42.264	186	0	10.025	0.0084	10.025	0.0083	10.024	0.0082	0.6053	0.0003	0.0003	0.6053	0.0003	0.0003	0.6054	0.0003	0.0003	331956
16 #	90.341	35.13	70.524	145	0	27.990	0.0108	27.984	0.0091	27.979	0.0084	0.6045	0.0002	0.0002	0.6046	0.0001	0.0002	0.6046	0.0001	0.0002	554242
17 #	89.725	35.14	70.578	144	0	28.026	0.0108	28.015	0.0072	28.007	0.0055	0.6046	0.0002	0.0002	0.6047	0.0001	0.0002	0.6048	0.0001	0.0002	554781
18 #	89.787	35.14	70.730	140	0	28.134	0.0111	28.132	0.0098	28.132	0.0080	0.6047	0.0002	0.0002	0.6047	0.0002	0.0002	0.6047	0.0001	0.0002	555978
34 $	43.059	33.83	42.193	68	0	9.985	0.0117	9.985	0.0118	9.983	0.0089	0.6054	0.0005	0.0003	0.6054	0.0005	0.0003	0.6055	0.0005	0.0003	323035
35 $	42.658	33.84	42.220	68	0	9.991	0.0065	9.992	0.0085	9.997	0.0066	0.6056	0.0004	0.0003	0.6056	0.0005	0.0003	0.6055	0.0004	0.0003	323312
36 $	42.751	33.85	42.175	68	0	9.965	0.0049	9.965	0.0069	9.979	0.0089	0.6058	0.0004	0.0003	0.6058	0.0004	0.0003	0.6053	0.0005	0.0003	323032
37 $	79.612	33.85	23.258	127	0	3.0208	0.0036	3.0216	0.0041	3.0201	0.0046	0.6067	0.0006	0.0007	0.6067	0.0006	0.0007	0.6068	0.0006	0.0007	178140
38 $	80.278	33.87	23.206	128	0	3.0108	0.0052	3.0088	0.0058	3.0084	0.0048	0.6064	0.0007	0.0007	0.6066	0.0007	0.0007	0.6066	0.0006	0.0007	177811
39 $	79.790	33.88	23.211	123	0	3.0095	0.0040	3.0092	0.0051	3.0100	0.0059	0.6066	0.0006	0.0007	0.6067	0.0007	0.0007	0.6066	0.0007	0.0007	177885
40 $	131.55	33.88	13.452	200	0	1.0061	0.0016	1.0057	0.0020	1.0057	0.0020	0.6081	0.0012	0.0016	0.6082	0.0014	0.0016	0.6082	0.0012	0.0016	103096
41 $	135.01	33.89	13.476	193	0	1.0101	0.0016	1.0098	0.0018	1.0091	0.0016	0.6080	0.0012	0.0016	0.6081	0.0013	0.0016	0.6083	0.0011	0.0016	103302
42 $	134.79	33.90	13.470	196	0	1.0090	0.0019	1.0090	0.0023	1.0085	0.0019	0.6080	0.0013	0.0016	0.6080	0.0014	0.0016	0.6082	0.0012	0.0016	103279
43 $	220.43	33.92	8.6677	182	0	0.4170	0.0007	0.4172	0.0007	0.4160	0.0007	0.6086	0.0027	0.0037	0.6084	0.0030	0.0037	0.6093	0.0025	0.0037	66483
44 $	219.47	33.94	8.6388	181	0	0.4137	0.0008	0.4137	0.0009	0.4135	0.0009	0.6090	0.0028	0.0037	0.6090	0.0030	0.0037	0.6091	0.0025	0.0037	66288
45 $	220.21	33.96	8.6504	181	0	0.4148	0.0010	0.4153	0.0010	0.4141	0.0008	0.6090	0.0028	0.0037	0.6087	0.0030	0.0037	0.6095	0.0025	0.0037	66404

[Test Run Date Codes # - 06/27/85 $ - 07/01/85]

Table 43D. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55796

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
46	#	149.92	34.09	42.213	186	0	10.002	0.0067	10.001	0.0073	10.000	0.0071	0.6052	0.0003	0.0003	0.6053	0.0003	0.0003	0.6053	0.0003	0.0003	324898
47	#	149.82	34.10	42.175	186	0	9.984	0.0053	9.985	0.0060	9.984	0.0059	0.6052	0.0002	0.0003	0.6052	0.0002	0.0003	0.6052	0.0002	0.0003	324668
48	#	149.79	34.11	42.144	186	0	9.967	0.0055	9.970	0.0062	9.968	0.0075	0.6053	0.0002	0.0003	0.6052	0.0002	0.0003	0.6053	0.0003	0.0003	324497
49	#	89.703	34.14	70.578	144	0	28.038	0.0073	28.033	0.0077	28.022	0.0071	0.6044	0.0001	0.0002	0.6044	0.0001	0.0002	0.6045	0.0001	0.0002	543758
50	#	90.433	34.14	70.621	145	0	28.073	0.0119	28.072	0.0113	28.071	0.0090	0.6044	0.0002	0.0002	0.6044	0.0002	0.0002	0.6044	0.0001	0.0002	544087
51	#	89.292	34.15	70.656	143	0	28.096	0.0046	28.090	0.0058	28.092	0.0091	0.6044	0.0001	0.0002	0.6045	0.0001	0.0002	0.6045	0.0001	0.0002	544468
52	$	135.66	28.40	13.380	190	0	0.9915	0.0016	0.9912	0.0018	0.9912	0.0013	0.6088	0.0012	0.0017	0.6089	0.0013	0.0017	0.6089	0.0012	0.0017	91398
53	$	134.99	28.42	13.382	181	0	0.9921	0.0014	0.9916	0.0014	0.9915	0.0016	0.6088	0.0011	0.0017	0.6089	0.0013	0.0017	0.6090	0.0012	0.0017	91454
54	$	135.37	28.45	13.373	189	0	0.9897	0.0014	0.9891	0.0014	0.9897	0.0013	0.6091	0.0011	0.0017	0.6093	0.0013	0.0017	0.6091	0.0012	0.0017	91450
55	$	220.49	28.82	8.4876	182	0	0.3964	0.0009	0.3954	0.0010	0.3956	0.0009	0.6109	0.0027	0.0039	0.6117	0.0031	0.0039	0.6115	0.0029	0.0039	58510
56	$	220.28	28.84	8.4980	182	0	0.3973	0.0006	0.3963	0.0007	0.3969	0.0006	0.6109	0.0027	0.0039	0.6117	0.0030	0.0039	0.6113	0.0028	0.0039	58607
57	$	220.52	28.87	8.4587	182	0	0.3936	0.0006	0.3925	0.0007	0.3932	0.0007	0.6109	0.0027	0.0039	0.6118	0.0031	0.0039	0.6112	0.0028	0.0039	58374
58	$	42.791	28.93	42.029	60	0	9.889	0.0120	9.889	0.0121	9.888	0.0120	0.6056	0.0005	0.0003	0.6056	0.0005	0.0003	0.6056	0.0005	0.0003	290423
59	$	42.836	28.94	42.074	60	0	9.903	0.0208	9.901	0.0248	9.905	0.0254	0.6058	0.0007	0.0003	0.6059	0.0009	0.0003	0.6058	0.0009	0.0003	290792
60	$	42.826	28.95	42.128	60	0	9.930	0.0152	9.928	0.0150	9.940	0.0181	0.6058	0.0006	0.0003	0.6059	0.0006	0.0003	0.6055	0.0007	0.0003	291232
61	$	80.210	28.97	23.145	112	0	2.9808	0.0054	2.9797	0.0060	2.9832	0.0064	0.6075	0.0007	0.0007	0.6076	0.0008	0.0007	0.6072	0.0008	0.0007	160073
62	$	80.467	28.98	23.178	113	0	2.9924	0.0038	2.9911	0.0040	2.9930	0.0040	0.6071	0.0006	0.0007	0.6073	0.0006	0.0007	0.6071	0.0006	0.0007	160331
63	$	80.485	29.00	23.134	113	0	2.9814	0.0058	2.9798	0.0055	2.9806	0.0059	0.6071	0.0007	0.0007	0.6073	0.0007	0.0007	0.6072	0.0007	0.0007	160102
64	$	90.411	29.06	70.644	127	0	28.002	0.0076	27.999	0.0073	28.015	0.0090	0.6049	0.0001	0.0002	0.6050	0.0001	0.0002	0.6048	0.0001	0.0002	489522
65	$	89.605	29.07	70.606	123	0	28.025	0.0085	28.022	0.0085	28.053	0.0047	0.6044	0.0001	0.0002	0.6044	0.0001	0.0002	0.6041	0.0001	0.0002	489363
66	$	89.645	29.08	70.741	126	0	28.081	0.0089	28.078	0.0100	28.092	0.0082	0.6049	0.0001	0.0002	0.6049	0.0002	0.0002	0.6048	0.0001	0.0002	490406
67	@	135.38	29.13	13.497	190	0	1.0094	0.0020	1.0106	0.0019	1.0101	0.0021	0.6088	0.0011	0.0016	0.6084	0.0012	0.0016	0.6086	0.0012	0.0016	93669
68	@	135.20	29.16	13.502	189	0	1.0102	0.0020	1.0115	0.0022	1.0096	0.0026	0.6087	0.0011	0.0016	0.6083	0.0012	0.0016	0.6089	0.0012	0.0016	93761
69	@	134.92	29.19	13.507	189	0	1.0106	0.0017	1.0120	0.0016	1.0102	0.0014	0.6089	0.0011	0.0016	0.6084	0.0012	0.0016	0.6090	0.0011	0.0016	93859
70	@	42.791	29.27	42.370	60	0	10.050	0.0087	10.051	0.0077	10.058	0.0057	0.6056	0.0005	0.0003	0.6056	0.0005	0.0003	0.6054	0.0004	0.0003	294933
71	@	43.431	29.29	42.320	61	0	10.010	0.0140	10.011	0.0132	10.022	0.0121	0.6061	0.0006	0.0003	0.6061	0.0006	0.0003	0.6058	0.0005	0.0003	294708
72	@	43.384	29.30	42.289	61	0	10.009	0.0147	10.010	0.0134	10.017	0.0163	0.6057	0.0006	0.0003	0.6057	0.0006	0.0003	0.6055	0.0006	0.0003	294561
73	@	220.49	29.33	8.5501	182	0	0.4028	0.0008	0.4044	0.0009	0.4029	0.0008	0.6104	0.0024	0.0038	0.6093	0.0027	0.0038	0.6104	0.0025	0.0038	59593
74	@	220.26	29.35	8.5235	182	0	0.4002	0.0008	0.4012	0.0009	0.4001	0.0007	0.6106	0.0024	0.0039	0.6098	0.0027	0.0038	0.6106	0.0025	0.0039	59433
75	@	220.58	29.37	8.5395	182	0	0.4102	0.0013	0.4030	0.0006	0.4013	0.0007	0.6043	0.0025	0.0037	0.6096	0.0026	0.0038	0.6108	0.0025	0.0037	59570

[Test Run Date Codes # - 07/01/85 $ - 09/18/85 @ - 09/20/85]

Table 43D. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55796

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
76	#	79.748	29.42	23.393	112	0	3.0711	0.0034	3.0493	0.0023	3.0489	0.0048	0.6049	0.0005	0.0007	0.6071	0.0005	0.0007	0.6071	0.0006	0.0007	163363
77	#	79.784	29.44	23.415	110	0	3.0731	0.0056	3.0526	0.0040	3.0527	0.0066	0.6053	0.0007	0.0007	0.6073	0.0006	0.0007	0.6073	0.0008	0.0007	163587
78	#	80.510	29.46	23.402	113	0	3.0726	0.0049	3.0510	0.0059	3.0521	0.0054	0.6050	0.0006	0.0007	0.6071	0.0007	0.0007	0.6070	0.0007	0.0007	163565
79	#	80.498	29.47	23.442	113	0	3.0827	0.0042	3.0617	0.0041	3.0601	0.0048	0.6050	0.0006	0.0007	0.6071	0.0006	0.0007	0.6072	0.0006	0.0007	163876
80	#	150.04	29.53	42.742	186	0	10.228	0.0149	10.226	0.0155	10.228	0.0156	0.6056	0.0005	0.0003	0.6057	0.0005	0.0003	0.6056	0.0005	0.0003	299186
81	#	149.74	29.58	42.636	186	0	10.173	0.0065	10.173	0.0060	10.185	0.0065	0.6058	0.0002	0.0003	0.6058	0.0002	0.0003	0.6054	0.0002	0.0003	298767
82	#	149.29	29.60	42.319	185	0	10.022	0.0058	10.021	0.0063	10.028	0.0067	0.6058	0.0002	0.0003	0.6058	0.0002	0.0003	0.6056	0.0002	0.0003	296671
83	#	89.832	29.63	70.331	124	0	27.764	0.0112	27.762	0.0099	27.785	0.0073	0.6049	0.0002	0.0002	0.6049	0.0002	0.0002	0.6046	0.0001	0.0002	493358
84	#	90.390	29.64	70.683	127	1	28.047	0.0135	28.043	0.0141	28.058	0.0105	0.6048	0.0002	0.0002	0.6049	0.0002	0.0002	0.6047	0.0002	0.0002	495937
85	#	89.657	29.65	71.222	126	0	28.467	0.0112	28.462	0.0111	28.488	0.0092	0.6049	0.0002	0.0002	0.6050	0.0002	0.0002	0.6047	0.0001	0.0002	499824

[Test Run Date Codes # - 09/20/85]

Table 43E. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-5C Diameter 2.6247 Inches, Beta Ratio = 0.65079

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	161.10	32.67	33.326	200	0	3.0220	0.0031	3.0228	0.0038	3.0191	0.0029	0.6090	0.0005	0.0007	0.6089	0.0006	0.0007	0.6093	0.0005	0.0007	249179
2 #	162.94	32.68	33.407	200	0	3.0365	0.0022	3.0358	0.0024	3.0320	0.0024	0.6090	0.0004	0.0007	0.6090	0.0006	0.0007	0.6094	0.0005	0.0007	249829
3 #	161.47	32.70	33.377	200	0	3.0317	0.0034	3.0314	0.0032	3.0281	0.0030	0.6089	0.0005	0.0007	0.6090	0.0006	0.0007	0.6093	0.0005	0.0007	249715
4 #	104.83	32.73	60.632	165	0	10.055	0.0043	10.053	0.0035	10.044	0.0042	0.6074	0.0002	0.0003	0.6075	0.0002	0.0003	0.6077	0.0002	0.0003	453901
5 #	105.57	32.75	60.840	167	1	10.120	0.0047	10.122	0.0037	10.112	0.0039	0.6075	0.0002	0.0003	0.6075	0.0002	0.0003	0.6077	0.0002	0.0003	455644
6 #	104.90	32.75	60.758	167	0	10.092	0.0065	10.093	0.0055	10.081	0.0062	0.6075	0.0002	0.0003	0.6075	0.0002	0.0003	0.6079	0.0002	0.0003	455028
7 #	64.872	32.79	101.11	104	0	28.034	0.0202	28.031	0.0161	28.014	0.0147	0.6066	0.0003	0.0002	0.6067	0.0002	0.0002	0.6068	0.0002	0.0002	757879
8 #	64.457	32.80	100.97	103	0	27.960	0.0171	27.948	0.0124	27.922	0.0085	0.6066	0.0002	0.0002	0.6067	0.0002	0.0002	0.6070	0.0002	0.0002	756958
9 #	64.406	32.80	100.93	103	0	27.929	0.0177	27.935	0.0199	27.885	0.0129	0.6067	0.0002	0.0002	0.6066	0.0003	0.0002	0.6071	0.0002	0.0002	756644
10 #	96.548	32.78	19.282	145	0	1.0050	0.0024	1.0059	0.0028	1.0043	0.0030	0.6110	0.0013	0.0017	0.6107	0.0017	0.0016	0.6112	0.0015	0.0017	144493
11 #	96.598	32.80	19.097	154	0	0.9855	0.0019	0.9858	0.0024	0.9846	0.0016	0.6111	0.0013	0.0017	0.6110	0.0017	0.0017	0.6114	0.0013	0.0017	143172
12 #	97.515	32.81	19.287	149	0	1.0044	0.0023	1.0048	0.0032	1.0037	0.0031	0.6113	0.0013	0.0017	0.6112	0.0018	0.0017	0.6115	0.0015	0.0017	144619
13 #	155.05	32.84	12.207	192	0	0.4007	0.0007	0.4010	0.0008	0.4003	0.0008	0.6126	0.0028	0.0039	0.6123	0.0038	0.0039	0.6129	0.0030	0.0039	91589
14 #	154.91	32.86	12.204	192	0	0.4008	0.0010	0.4007	0.0010	0.3996	0.0012	0.6124	0.0028	0.0039	0.6124	0.0038	0.0039	0.6133	0.0031	0.0039	91606
15 #	155.60	32.88	12.080	193	0	0.3922	0.0007	0.3921	0.0008	0.3918	0.0007	0.6127	0.0028	0.0039	0.6128	0.0039	0.0039	0.6130	0.0031	0.0039	90713
16 #	54.692	32.91	33.287	87	0	3.0148	0.0034	3.0126	0.0043	3.0117	0.0061	0.6090	0.0006	0.0007	0.6092	0.0007	0.0007	0.6093	0.0008	0.0007	250116
17 #	54.689	32.92	33.313	87	0	3.0222	0.0061	3.0137	0.0067	3.0150	0.0056	0.6087	0.0008	0.0007	0.6096	0.0009	0.0007	0.6094	0.0008	0.0007	250359
18 #	55.395	32.94	33.186	87	0	2.9975	0.0030	2.9940	0.0029	2.9886	0.0032	0.6089	0.0006	0.0007	0.6093	0.0007	0.0007	0.6098	0.0006	0.0007	249510
19 $	97.119	32.45	19.492	149	0	1.0262	0.0016	1.0257	0.0021	1.0263	0.0017	0.6112	0.0012	0.0016	0.6114	0.0016	0.0016	0.6112	0.0013	0.0016	145082
20 $	96.711	32.47	19.509	145	0	1.0273	0.0014	1.0276	0.0020	1.0265	0.0022	0.6114	0.0012	0.0016	0.6113	0.0016	0.0016	0.6116	0.0013	0.0016	145268
21 $	96.662	32.49	19.530	154	0	1.0314	0.0014	1.0303	0.0012	1.0290	0.0014	0.6109	0.0011	0.0016	0.6112	0.0015	0.0016	0.6116	0.0012	0.0016	145487
22 $	154.23	32.53	12.248	191	0	0.4027	0.0007	0.4027	0.0009	0.4021	0.0008	0.6131	0.0028	0.0038	0.6131	0.0038	0.0038	0.6135	0.0030	0.0038	91316
23 $	154.29	32.55	12.264	191	0	0.4034	0.0008	0.4030	0.0010	0.4033	0.0008	0.6134	0.0028	0.0038	0.6137	0.0038	0.0038	0.6134	0.0030	0.0038	91473
24 $	154.68	32.58	12.271	192	0	0.4041	0.0007	0.4035	0.0007	0.4036	0.0008	0.6132	0.0027	0.0038	0.6137	0.0038	0.0038	0.6136	0.0030	0.0038	91583
25 $	54.734	32.63	33.424	87	0	3.0335	0.0035	3.0354	0.0053	3.0338	0.0062	0.6096	0.0006	0.0007	0.6094	0.0008	0.0007	0.6096	0.0008	0.0007	249702
26 $	54.663	32.64	33.416	87	0	3.0337	0.0041	3.0307	0.0050	3.0292	0.0084	0.6094	0.0006	0.0007	0.6097	0.0008	0.0007	0.6099	0.0010	0.0007	249697
27 $	55.266	32.65	33.390	88	0	3.0292	0.0044	3.0275	0.0063	3.0278	0.0038	0.6094	0.0006	0.0007	0.6096	0.0009	0.0007	0.6095	0.0006	0.0007	249553
28 $	161.41	32.68	33.272	200	0	3.0093	0.0025	3.0083	0.0036	3.0081	0.0039	0.6093	0.0005	0.0007	0.6094	0.0006	0.0007	0.6094	0.0006	0.0007	248826
29 $	161.93	32.70	33.183	200	0	2.9921	0.0033	2.9915	0.0033	2.9916	0.0028	0.6094	0.0005	0.0007	0.6094	0.0006	0.0007	0.6094	0.0005	0.0007	248258
30 $	161.30	32.71	33.118	200	0	2.9808	0.0022	2.9799	0.0033	2.9811	0.0032	0.6093	0.0004	0.0007	0.6094	0.0006	0.0007	0.6093	0.0005	0.0007	247826

[Test Run Date Codes # - 06/25/85 $ - 06/26/85]

Table 43E. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-5C Diameter 2.6247 Inches, Beta Ratio = 0.65079

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	104.44	32.78	60.374	167	0	9.959	0.0091	9.959	0.0083	9.967	0.0069	0.6077	0.0003	0.0003	0.6077	0.0003	0.0003	0.6075	0.0003	0.0003	452432
32 #	104.75	32.79	60.362	158	0	9.953	0.0114	9.956	0.0109	9.957	0.0134	0.6078	0.0004	0.0003	0.6077	0.0004	0.0003	0.6077	0.0004	0.0003	452441
33 #	104.90	32.80	60.890	167	0	10.125	0.0040	10.130	0.0035	10.122	0.0057	0.6079	0.0002	0.0003	0.6077	0.0002	0.0003	0.6080	0.0002	0.0003	456490
34 #	64.900	32.86	101.23	98	0	28.054	0.0093	28.072	0.0091	28.054	0.0129	0.6071	0.0002	0.0002	0.6069	0.0002	0.0002	0.6071	0.0002	0.0002	759866
35 #	65.010	32.86	101.36	104	0	28.162	0.0160	28.144	0.0142	28.126	0.0195	0.6068	0.0002	0.0002	0.6069	0.0002	0.0002	0.6071	0.0002	0.0002	760848
36 #	64.905	32.87	100.34	104	0	27.592	0.0160	27.578	0.0113	27.538	0.0122	0.6068	0.0002	0.0002	0.6069	0.0002	0.0002	0.6074	0.0002	0.0002	753310

[Test Run Date Codes # - 06/26/85]

Table 43F. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-6C Diameter 2.9998 Inches, Beta Ratio = 0.74380

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	43.973	32.21	143.51	71	0	28.078	0.0271	28.067	0.0258	28.032	0.0123	0.6056	0.0003	0.0003	0.6057	0.0003	0.0003	0.6061	0.0002	0.0003	1062858
2 #	44.927	32.24	143.44	72	0	28.048	0.0161	28.032	0.0073	27.993	0.0148	0.6056	0.0002	0.0003	0.6058	0.0002	0.0003	0.6062	0.0002	0.0003	1063003
3 #	44.764	32.29	143.42	71	0	28.022	0.0180	28.042	0.0153	27.984	0.0088	0.6059	0.0003	0.0003	0.6056	0.0002	0.0003	0.6063	0.0002	0.0003	1063998
4 #	74.539	32.33	86.012	119	0	10.064	0.0069	10.064	0.0059	10.044	0.0066	0.6063	0.0003	0.0004	0.6063	0.0003	0.0004	0.6069	0.0003	0.0004	638615
5 #	74.859	32.35	86.111	113	0	10.098	0.0058	10.090	0.0053	10.061	0.0049	0.6059	0.0002	0.0004	0.6062	0.0002	0.0004	0.6071	0.0002	0.0004	639614
6 #	74.703	32.39	86.099	119	0	10.080	0.0048	10.079	0.0046	10.062	0.0041	0.6064	0.0002	0.0004	0.6064	0.0002	0.0004	0.6070	0.0002	0.0004	640052
7 #	130.47	32.44	46.935	194	0	2.9817	0.0028	2.9833	0.0030	2.9736	0.0029	0.6078	0.0005	0.0007	0.6076	0.0006	0.0007	0.6086	0.0005	0.0007	349270
8 #	130.03	32.46	47.179	194	0	3.0143	0.0020	3.0147	0.0028	3.0038	0.0029	0.6077	0.0004	0.0007	0.6076	0.0006	0.0007	0.6087	0.0005	0.0007	351232
9 #	129.60	32.49	47.162	199	1	3.0096	0.0025	3.0120	0.0021	3.0028	0.0017	0.6079	0.0005	0.0007	0.6077	0.0006	0.0007	0.6086	0.0004	0.0007	351323
10 #	105.07	32.50	17.335	168	0	0.4003	0.0007	0.4007	0.0007	0.3992	0.0008	0.6127	0.0028	0.0039	0.6124	0.0038	0.0039	0.6135	0.0030	0.0039	129158
11 #	104.52	32.51	17.312	167	0	0.3995	0.0008	0.3997	0.0011	0.3978	0.0009	0.6125	0.0028	0.0039	0.6123	0.0038	0.0039	0.6138	0.0030	0.0039	129015
12 #	104.27	32.52	17.296	163	0	0.3989	0.0008	0.3986	0.0008	0.3972	0.0007	0.6124	0.0028	0.0039	0.6126	0.0038	0.0039	0.6137	0.0030	0.0039	128923
13 #	69.609	32.55	27.341	111	0	1.0039	0.0014	1.0032	0.0016	1.0002	0.0013	0.6102	0.0012	0.0017	0.6104	0.0016	0.0017	0.6113	0.0013	0.0017	203921
14 #	70.087	32.56	27.373	105	0	1.0062	0.0020	1.0062	0.0017	1.0031	0.0025	0.6102	0.0013	0.0017	0.6102	0.0016	0.0017	0.6112	0.0014	0.0017	204201
15 #	69.560	32.57	27.315	111	0	1.0014	0.0018	1.0012	0.0021	0.9993	0.0016	0.6104	0.0012	0.0017	0.6105	0.0016	0.0017	0.6110	0.0013	0.0017	203815
16 #	39.640	32.61	47.121	63	0	3.0003	0.0032	3.0006	0.0035	2.9940	0.0033	0.6083	0.0006	0.0007	0.6083	0.0007	0.0007	0.6090	0.0007	0.0007	351888
17 #	40.377	32.62	46.972	63	0	2.9844	0.0022	2.9818	0.0035	2.9758	0.0032	0.6080	0.0006	0.0007	0.6083	0.0007	0.0007	0.6089	0.0007	0.0007	350844
18 #	40.279	32.63	46.999	64	0	2.9890	0.0060	2.9903	0.0058	2.9778	0.0029	0.6079	0.0008	0.0007	0.6078	0.0009	0.0007	0.6090	0.0006	0.0007	351118
19 $	105.12	34.30	17.515	168	0	0.4095	0.0007	0.4099	0.0008	0.4068	0.0008	0.6123	0.0027	0.0038	0.6119	0.0033	0.0038	0.6142	0.0027	0.0038	135382
20 $	104.50	34.31	17.481	167	0	0.4080	0.0008	0.4085	0.0009	0.4050	0.0007	0.6121	0.0027	0.0038	0.6118	0.0033	0.0038	0.6144	0.0027	0.0038	135139
21 $	104.36	34.32	17.485	167	0	0.4074	0.0009	0.4083	0.0008	0.4050	0.0007	0.6128	0.0027	0.0038	0.6120	0.0033	0.0038	0.6145	0.0027	0.0038	135204
22 $	69.694	34.37	27.429	111	0	1.0109	0.0017	1.0101	0.0017	1.0084	0.0014	0.6102	0.0012	0.0017	0.6104	0.0014	0.0017	0.6110	0.0012	0.0017	212304
23 $	69.716	34.37	27.694	111	0	1.0288	0.0014	1.0295	0.0012	1.0273	0.0013	0.6107	0.0011	0.0016	0.6105	0.0014	0.0016	0.6112	0.0011	0.0016	214357
24 $	69.705	34.38	27.612	111	0	1.0225	0.0017	1.0230	0.0018	1.0221	0.0017	0.6108	0.0012	0.0016	0.6106	0.0014	0.0016	0.6109	0.0012	0.0016	213766
25 $	39.649	34.43	47.077	63	0	3.0010	0.0044	2.9988	0.0047	2.9931	0.0064	0.6079	0.0007	0.0007	0.6081	0.0008	0.0007	0.6087	0.0008	0.0007	364827
26 $	40.190	34.44	47.117	64	0	3.0056	0.0045	3.0023	0.0064	2.9975	0.0043	0.6079	0.0007	0.0007	0.6082	0.0009	0.0007	0.6087	0.0007	0.0007	365206
28 $	39.708	34.47	47.136	60	0	3.0032	0.0034	3.0057	0.0054	2.9990	0.0033	0.6084	0.0006	0.0007	0.6081	0.0008	0.0007	0.6088	0.0006	0.0007	365575
29 $	129.75	34.50	47.884	194	0	3.1034	0.0024	3.1028	0.0023	3.0975	0.0022	0.6080	0.0004	0.0007	0.6080	0.0005	0.0007	0.6086	0.0004	0.0007	371600
30 $	129.64	34.51	47.820	199	0	3.0967	0.0032	3.0980	0.0035	3.0897	0.0027	0.6078	0.0005	0.0007	0.6077	0.0006	0.0007	0.6085	0.0005	0.0007	371181
31 $	130.05	34.51	47.741	194	0	3.0876	0.0028	3.0876	0.0029	3.0804	0.0030	0.6077	0.0005	0.0007	0.6077	0.0005	0.0007	0.6084	0.0005	0.0007	370563

[Test Run Date Codes # - 06/25/85 $ - 06/26/85]

Table 43F. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-6C Diameter 2.9998 Inches, Beta Ratio = 0.74380

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
32	#	74.497	34.54	85.822	119	0	10.031	0.0056	10.031	0.0057	9.999	0.0032	0.6061	0.0002	0.0004	0.6061	0.0002	0.0004	0.6071	0.0002	0.0004	666548
33	#	74.666	34.54	85.697	119	0	9.992	0.0036	9.994	0.0027	9.972	0.0038	0.6064	0.0002	0.0004	0.6063	0.0002	0.0004	0.6070	0.0002	0.0004	665582
34	#	74.674	34.53	85.770	119	0	10.010	0.0049	10.011	0.0047	9.987	0.0027	0.6064	0.0002	0.0004	0.6063	0.0002	0.0004	0.6071	0.0002	0.0004	666011
35	#	44.206	34.60	143.03	71	0	27.885	0.0120	27.907	0.0134	27.834	0.0145	0.6058	0.0002	0.0003	0.6056	0.0002	0.0003	0.6064	0.0002	0.0003	1112184
36	#	44.410	34.61	143.09	71	0	27.944	0.0132	27.923	0.0154	27.875	0.0074	0.6055	0.0002	0.0003	0.6057	0.0002	0.0003	0.6062	0.0002	0.0003	1112893
37	#	44.367	34.62	143.12	71	0	27.917	0.0147	27.926	0.0162	27.897	0.0095	0.6059	0.0002	0.0003	0.6058	0.0002	0.0003	0.6061	0.0002	0.0003	1113350
38	$	44.158	36.38	143.33	67	0	28.024	0.0150	28.024	0.0159	27.958	0.0184	0.6058	0.0002	0.0003	0.6058	0.0002	0.0003	0.6065	0.0003	0.0003	1154623
39	$	44.856	36.40	143.46	72	0	28.104	0.0189	28.088	0.0166	28.010	0.0139	0.6055	0.0003	0.0003	0.6056	0.0002	0.0003	0.6065	0.0002	0.0003	1156175
40	$	44.852	36.43	143.41	69	0	28.054	0.0098	28.047	0.0134	27.975	0.0097	0.6058	0.0002	0.0003	0.6059	0.0002	0.0003	0.6066	0.0002	0.0003	1156428
41	$	74.391	36.48	85.759	119	0	10.012	0.0071	10.016	0.0045	9.994	0.0046	0.6064	0.0003	0.0004	0.6063	0.0002	0.0004	0.6070	0.0002	0.0004	692221
42	$	74.573	36.51	85.749	119	0	10.025	0.0050	10.013	0.0031	9.988	0.0042	0.6059	0.0002	0.0004	0.6063	0.0002	0.0004	0.6071	0.0002	0.0004	692549
43	$	75.239	36.54	85.724	120	0	10.015	0.0061	10.008	0.0046	9.980	0.0055	0.6061	0.0002	0.0004	0.6063	0.0002	0.0004	0.6071	0.0002	0.0004	692753
44	$	129.18	36.60	47.452	192	0	3.0552	0.0028	3.0540	0.0031	3.0444	0.0030	0.6074	0.0005	0.0007	0.6075	0.0005	0.0007	0.6085	0.0005	0.0007	383917
45	$	128.00	36.61	47.654	200	0	3.0775	0.0031	3.0772	0.0034	3.0703	0.0037	0.6078	0.0005	0.0007	0.6078	0.0006	0.0007	0.6085	0.0005	0.0007	385630
46	$	128.00	36.62	47.903	200	0	3.1127	0.0022	3.1098	0.0029	3.1022	0.0025	0.6075	0.0004	0.0007	0.6078	0.0005	0.0007	0.6085	0.0004	0.0007	387723
47	$	39.448	36.65	47.320	63	0	3.0352	0.0082	3.0316	0.0060	3.0255	0.0069	0.6077	0.0010	0.0007	0.6081	0.0009	0.0007	0.6087	0.0009	0.0007	383224
48	$	39.971	36.66	47.311	63	0	3.0229	0.0044	3.0247	0.0035	3.0234	0.0051	0.6089	0.0007	0.0007	0.6087	0.0007	0.0007	0.6088	0.0007	0.0007	383231
49	$	40.108	36.66	47.303	60	0	3.0323	0.0034	3.0289	0.0045	3.0216	0.0061	0.6078	0.0006	0.0007	0.6081	0.0007	0.0007	0.6089	0.0008	0.0007	383160
50	$	69.877	36.67	27.576	111	0	1.0231	0.0018	1.0216	0.0021	1.0192	0.0021	0.6100	0.0012	0.0016	0.6104	0.0015	0.0016	0.6111	0.0013	0.0016	223411
51	$	70.427	36.68	27.926	112	0	1.0487	0.0013	1.0485	0.0015	1.0450	0.0017	0.6102	0.0011	0.0016	0.6102	0.0014	0.0016	0.6112	0.0012	0.0016	226295
52	$	70.102	36.69	27.699	109	0	1.0317	0.0012	1.0303	0.0013	1.0271	0.0017	0.6102	0.0011	0.0016	0.6106	0.0014	0.0016	0.6115	0.0012	0.0016	224498
53	$	105.25	36.71	17.509	168	0	0.4086	0.0006	0.4072	0.0007	0.4064	0.0008	0.6129	0.0027	0.0038	0.6139	0.0033	0.0038	0.6145	0.0027	0.0038	141965
54	$	105.02	36.72	17.554	167	0	0.4113	0.0008	0.4094	0.0010	0.4090	0.0007	0.6125	0.0027	0.0038	0.6138	0.0033	0.0038	0.6142	0.0027	0.0038	142360
55	$	104.34	36.74	17.493	162	0	0.4080	0.0009	0.4064	0.0010	0.4055	0.0008	0.6128	0.0027	0.0038	0.6140	0.0034	0.0038	0.6146	0.0027	0.0038	141920

[Test Run Date Codes # - 06/26/85 $ - 06/27/85]

Table 43G. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-7C Diameter 0.3754 Inches, Beta Ratio = 0.09308

Run No.	Date Code	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	335.04	23.29	0.6096	166	0	3.0363	0.0078	3.0334	0.0081	3.0353	0.0085	0.5991	0.0009	0.0012	0.5994	0.0009	0.0012	0.5992	0.0009	0.0012	3711
2	#	334.89	23.23	0.6080	166	0	3.0213	0.0104	3.0188	0.0100	3.0206	0.0105	0.5990	0.0011	0.0012	0.5993	0.0011	0.0012	0.5991	0.0011	0.0012	3696
3	#	336.82	23.18	0.6078	167	0	3.0183	0.0104	3.0150	0.0113	3.0174	0.0117	0.5991	0.0011	0.0012	0.5995	0.0012	0.0012	0.5992	0.0012	0.0012	3691
4	#	1206.1	23.25	0.2264	136	3	0.4103	0.0003	0.4091	0.0003	0.4101	0.0003	0.6053	0.0025	0.0043	0.6062	0.0029	0.0043	0.6054	0.0027	0.0042	1377
5	#	1206.1	23.29	0.2266	136	0	0.4114	0.0003	0.4101	0.0003	0.4109	0.0003	0.6050	0.0025	0.0042	0.6060	0.0029	0.0043	0.6054	0.0026	0.0042	1379
6	#	1205.9	23.34	0.2266	136	0	0.4110	0.0005	0.4098	0.0005	0.4107	0.0004	0.6053	0.0025	0.0042	0.6062	0.0029	0.0043	0.6055	0.0027	0.0042	1381
7	#	580.68	23.56	0.3544	144	0	1.0151	0.0010	1.0138	0.0010	1.0156	0.0010	0.6025	0.0011	0.0021	0.6029	0.0012	0.0021	0.6023	0.0011	0.0021	2171
8	#	580.74	23.57	0.3547	144	2	1.0170	0.0006	1.0156	0.0006	1.0173	0.0006	0.6024	0.0010	0.0021	0.6028	0.0012	0.0021	0.6023	0.0011	0.0021	2173
9	#	580.44	23.57	0.3558	144	3	1.0228	0.0006	1.0216	0.0008	1.0231	0.0007	0.6026	0.0010	0.0021	0.6029	0.0012	0.0021	0.6025	0.0011	0.0021	2180
14	$	580.67	22.82	0.3676	144	3	1.0979	0.0013	1.0975	0.0013	1.0957	0.0013	0.6009	0.0010	0.0020	0.6010	0.0010	0.0020	0.6015	0.0010	0.0020	2213
15	$	580.59	22.82	0.3668	144	1	1.0915	0.0016	1.0916	0.0017	1.0900	0.0017	0.6012	0.0010	0.0020	0.6012	0.0011	0.0020	0.6017	0.0010	0.0020	2208
16	$	580.54	22.84	0.3675	144	4	1.1019	0.0052	1.1035	0.0041	1.1001	0.0053	0.5997	0.0017	0.0020	0.5993	0.0015	0.0020	0.6002	0.0017	0.0020	2214
17	$	324.81	22.86	0.6042	161	0	2.9800	0.0091	2.9769	0.0094	2.9786	0.0097	0.5994	0.0010	0.0012	0.5997	0.0010	0.0012	0.5995	0.0010	0.0012	3641
18	$	326.76	22.89	0.5982	162	9	2.9566	0.0180	2.9546	0.0183	2.9496	0.0237	0.5958	0.0018	0.0012	0.5960	0.0019	0.0012	0.5966	0.0024	0.0012	3608
19	$	326.93	22.88	0.6006	162	5	2.9648	0.0152	2.9647	0.0169	2.9644	0.0173	0.5974	0.0016	0.0012	0.5974	0.0017	0.0012	0.5974	0.0018	0.0012	3621
20	$	225.34	22.85	0.9385	186	0	7.2335	0.0389	7.2310	0.0428	7.2324	0.0434	0.5975	0.0016	0.0009	0.5976	0.0018	0.0009	0.5976	0.0018	0.0009	5655
21	$	225.20	22.85	0.9349	186	3	7.1935	0.0513	7.1912	0.0466	7.1903	0.0424	0.5969	0.0021	0.0009	0.5970	0.0019	0.0009	0.5971	0.0018	0.0009	5633
22	$	225.33	22.80	0.9316	186	0	7.1254	0.0665	7.1248	0.0704	7.1253	0.0706	0.5977	0.0028	0.0009	0.5977	0.0030	0.0009	0.5977	0.0030	0.0009	5606
23	$	1206.1	22.96	0.2277	136	2	0.4181	0.0012	0.4162	0.0012	0.4175	0.0012	0.6032	0.0026	0.0042	0.6046	0.0027	0.0042	0.6036	0.0026	0.0042	1375
24	$	1206.1	23.03	0.2212	136	6	0.3962	0.0018	0.3935	0.0018	0.3952	0.0019	0.6020	0.0029	0.0044	0.6041	0.0030	0.0044	0.6027	0.0029	0.0043	1338
25	$	1206.2	23.23	0.2248	136	3	0.4069	0.0017	0.4052	0.0019	0.4060	0.0019	0.6037	0.0028	0.0043	0.6050	0.0030	0.0043	0.6043	0.0029	0.0043	1367
26	$	1206.1	23.44	0.2299	136	4	0.4263	0.0004	0.4237	0.0005	0.4248	0.0004	0.6030	0.0024	0.0041	0.6049	0.0025	0.0041	0.6041	0.0024	0.0041	1404
27	$	168.25	28.62	1.0997	200	0	9.975	0.0018	9.976	0.0020	9.977	0.0022	0.5965	0.0002	0.0008	0.5965	0.0002	0.0008	0.5965	0.0002	0.0008	7548
28	$	182.12	28.63	1.1089	200	0	10.141	0.0149	10.139	0.0145	10.139	0.0149	0.5966	0.0005	0.0008	0.5967	0.0005	0.0008	0.5967	0.0005	0.0008	7613
29	$	184.72	28.62	1.1005	200	2	9.989	0.0010	9.988	0.0010	9.988	0.0012	0.5966	0.0002	0.0008	0.5966	0.0002	0.0008	0.5966	0.0002	0.0008	7554
30	$	130.04	28.79	1.5670	175	3	20.287	0.0016	20.286	0.0019	20.286	0.0020	0.5961	0.0002	0.0008	0.5961	0.0002	0.0008	0.5961	0.0002	0.0008	10795
31	$	130.43	28.78	1.5669	183	0	20.285	0.0027	20.284	0.0026	20.285	0.0025	0.5960	0.0002	0.0008	0.5961	0.0002	0.0008	0.5960	0.0002	0.0008	10792
32	$	130.46	28.78	1.5658	176	1	20.257	0.0023	20.255	0.0026	20.255	0.0026	0.5960	0.0002	0.0008	0.5961	0.0002	0.0008	0.5961	0.0002	0.0008	10785

[Test Run Date Codes # - 09/18/85 $ - 09/19/85]

Table 43G. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-7C Diameter 0.3754 Inches, Beta Ratio = 0.09308

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
33	#	341.86	28.57	0.6086	168	0	3.0377	0.0005	3.0375	0.0005	3.0377	0.0005	0.5983	0.0004	0.0012	0.5983	0.0004	0.0012	0.5983	0.0004	0.0012	4173
34	#	340.46	28.57	0.6084	168	1	3.0360	0.0003	3.0353	0.0004	3.0354	0.0003	0.5983	0.0004	0.0012	0.5984	0.0004	0.0012	0.5983	0.0004	0.0012	4171
35	#	341.02	28.55	0.6091	168	0	3.0560	0.0011	3.0421	0.0007	3.0426	0.0007	0.5970	0.0004	0.0012	0.5984	0.0004	0.0012	0.5983	0.0004	0.0012	4174
36	$	149.39	28.48	1.5377	185	3	19.543	0.0031	19.543	0.0037	19.543	0.0036	0.5959	0.0002	0.0008	0.5959	0.0002	0.0008	0.5959	0.0002	0.0008	10522
37	$	150.24	28.51	1.5380	186	1	19.540	0.0017	19.539	0.0022	19.537	0.0021	0.5961	0.0001	0.0008	0.5961	0.0001	0.0008	0.5962	0.0001	0.0008	10531
38	$	149.95	28.51	1.5309	186	0	19.360	0.0024	19.359	0.0023	19.358	0.0024	0.5961	0.0001	0.0008	0.5961	0.0001	0.0008	0.5961	0.0001	0.0008	10483
39	$	199.35	28.37	1.1026	165	0	10.021	0.0026	10.021	0.0024	10.020	0.0028	0.5967	0.0002	0.0008	0.5968	0.0002	0.0008	0.5968	0.0002	0.0008	7527
40	$	200.61	28.37	1.0981	166	0	9.943	0.0027	9.940	0.0026	9.940	0.0027	0.5966	0.0002	0.0008	0.5967	0.0002	0.0008	0.5967	0.0002	0.0008	7496
41	$	200.94	28.37	1.0966	166	0	9.909	0.0214	9.904	0.0235	9.903	0.0230	0.5968	0.0007	0.0008	0.5970	0.0007	0.0008	0.5970	0.0007	0.0008	7486
42	$	326.85	28.30	0.6080	162	4	3.0327	0.0003	3.0309	0.0003	3.0301	0.0003	0.5982	0.0003	0.0012	0.5983	0.0004	0.0012	0.5984	0.0003	0.0012	4144
43	$	326.54	28.27	0.6073	162	1	3.0253	0.0003	3.0233	0.0003	3.0228	0.0003	0.5982	0.0003	0.0012	0.5984	0.0004	0.0012	0.5984	0.0003	0.0012	4137
44	$	326.70	28.28	0.6066	162	2	3.0180	0.0004	3.0159	0.0005	3.0153	0.0005	0.5983	0.0003	0.0012	0.5985	0.0004	0.0012	0.5985	0.0003	0.0012	4133

[Test Run Date Codes # - 09/19/85 $ - 09/20/85]

Table 43H. Orifice Discharge Coefficient Values - Meter Tube PE-6

Meter Tube PE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-8A Diameter 0.2513 Inches, Beta Ratio = 0.06231

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
62	#	1206.5	23.47	0.1000	136	0	0.0000	0.0000	0.4154	0.0009	0.4145	0.0009	0.0000	0.0000	0.0000	0.5930	0.0027	0.0044	0.5937	0.0025	0.0044	611
63	#	1206.6	23.50	0.1000	136	0	0.0000	0.0000	0.4152	0.0005	0.4140	0.0005	0.0000	0.0000	0.0000	0.5931	0.0026	0.0044	0.5939	0.0024	0.0044	612
64	#	1206.5	23.51	0.1005	136	0	0.0000	0.0000	0.4196	0.0005	0.4183	0.0005	0.0000	0.0000	0.0000	0.5932	0.0026	0.0044	0.5941	0.0024	0.0044	615
65	#	1206.6	23.51	0.1566	136	0	0.0000	0.0000	1.0284	0.0026	1.0274	0.0025	0.0000	0.0000	0.0000	0.5903	0.0013	0.0024	0.5906	0.0012	0.0024	958
66	#	1206.5	23.50	0.1573	136	0	0.0000	0.0000	1.0382	0.0013	1.0372	0.0011	0.0000	0.0000	0.0000	0.5900	0.0011	0.0024	0.5903	0.0010	0.0024	962
67	#	1206.7	23.49	0.1576	136	0	0.0000	0.0000	1.0422	0.0010	1.0414	0.0010	0.0000	0.0000	0.0000	0.5902	0.0011	0.0024	0.5904	0.0010	0.0024	964
68	#	802.83	23.49	0.2675	142	0	0.0000	0.0000	3.0358	0.0019	3.0351	0.0021	0.0000	0.0000	0.0000	0.5867	0.0004	0.0015	0.5868	0.0004	0.0015	1636
69	#	802.23	23.48	0.2678	142	1	0.0000	0.0000	3.0424	0.0017	3.0412	0.0016	0.0000	0.0000	0.0000	0.5867	0.0004	0.0015	0.5868	0.0004	0.0015	1638
70	#	802.04	23.48	0.2677	142	0	0.0000	0.0000	3.0431	0.0015	3.0419	0.0016	0.0000	0.0000	0.0000	0.5866	0.0004	0.0015	0.5867	0.0004	0.0015	1637
71	#	501.49	23.51	0.4835	146	0	0.0000	0.0000	10.016	0.0033	10.015	0.0034	0.0000	0.0000	0.0000	0.5839	0.0002	0.0011	0.5839	0.0002	0.0011	2959
72	#	502.73	23.50	0.4833	149	0	0.0000	0.0000	10.006	0.0019	10.006	0.0022	0.0000	0.0000	0.0000	0.5839	0.0002	0.0011	0.5839	0.0001	0.0011	2957
73	#	285.59	23.50	0.4836	153	0	0.0000	0.0000	10.014	0.0025	10.013	0.0024	0.0000	0.0000	0.0000	0.5840	0.0002	0.0011	0.5840	0.0002	0.0011	2958
74	$	1206.5	23.31	0.0987	136	0	0.0000	0.0000	0.4025	0.0006	0.4042	0.0006	0.0000	0.0000	0.0000	0.5949	0.0032	0.0046	0.5936	0.0028	0.0046	601
75	$	1206.4	23.31	0.0986	136	0	0.0000	0.0000	0.4020	0.0007	0.4035	0.0008	0.0000	0.0000	0.0000	0.5947	0.0032	0.0046	0.5936	0.0028	0.0046	601
76	$	1206.6	23.32	0.0988	136	0	0.0000	0.0000	0.4028	0.0006	0.4045	0.0006	0.0000	0.0000	0.0000	0.5953	0.0032	0.0046	0.5941	0.0028	0.0046	602
77	$	1206.6	23.32	0.1560	136	0	0.0000	0.0000	1.0204	0.0018	1.0215	0.0021	0.0000	0.0000	0.0000	0.5904	0.0013	0.0024	0.5901	0.0013	0.0024	950
78	$	1206.4	23.32	0.1565	136	0	0.0000	0.0000	1.0258	0.0020	1.0267	0.0019	0.0000	0.0000	0.0000	0.5905	0.0014	0.0024	0.5903	0.0012	0.0024	953
79	$	1206.7	23.33	0.1575	136	0	0.0000	0.0000	1.0404	0.0013	1.0410	0.0014	0.0000	0.0000	0.0000	0.5902	0.0013	0.0024	0.5900	0.0012	0.0024	960
80	$	802.03	23.32	0.2689	142	0	0.0000	0.0000	3.0691	0.0026	3.0706	0.0024	0.0000	0.0000	0.0000	0.5867	0.0005	0.0015	0.5865	0.0004	0.0015	1638
81	$	802.18	23.32	0.2691	142	0	0.0000	0.0000	3.0724	0.0029	3.0736	0.0031	0.0000	0.0000	0.0000	0.5867	0.0005	0.0015	0.5866	0.0005	0.0015	1639
82	$	801.98	23.32	0.2692	142	0	0.0000	0.0000	3.0746	0.0024	3.0759	0.0027	0.0000	0.0000	0.0000	0.5867	0.0005	0.0015	0.5866	0.0005	0.0015	1640

[Test Run Date Codes # - 01/15/87 $ - 01/16/87]

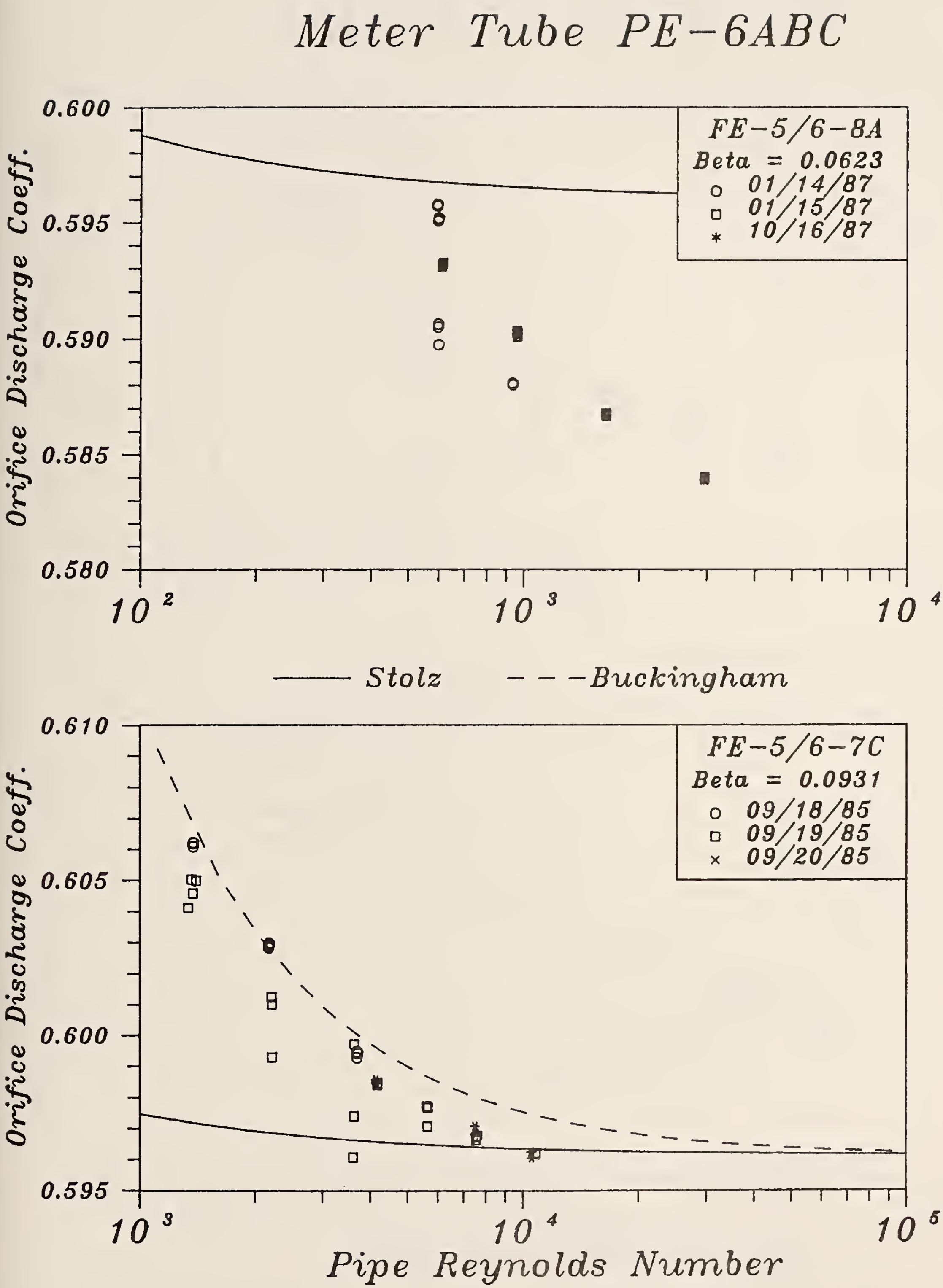


Figure 30A. Discharge Coefficient/Reynolds Number Plots, PE-6ABC 4-Inch Meter Tube, 8 Orifice Plates, Final Data Base

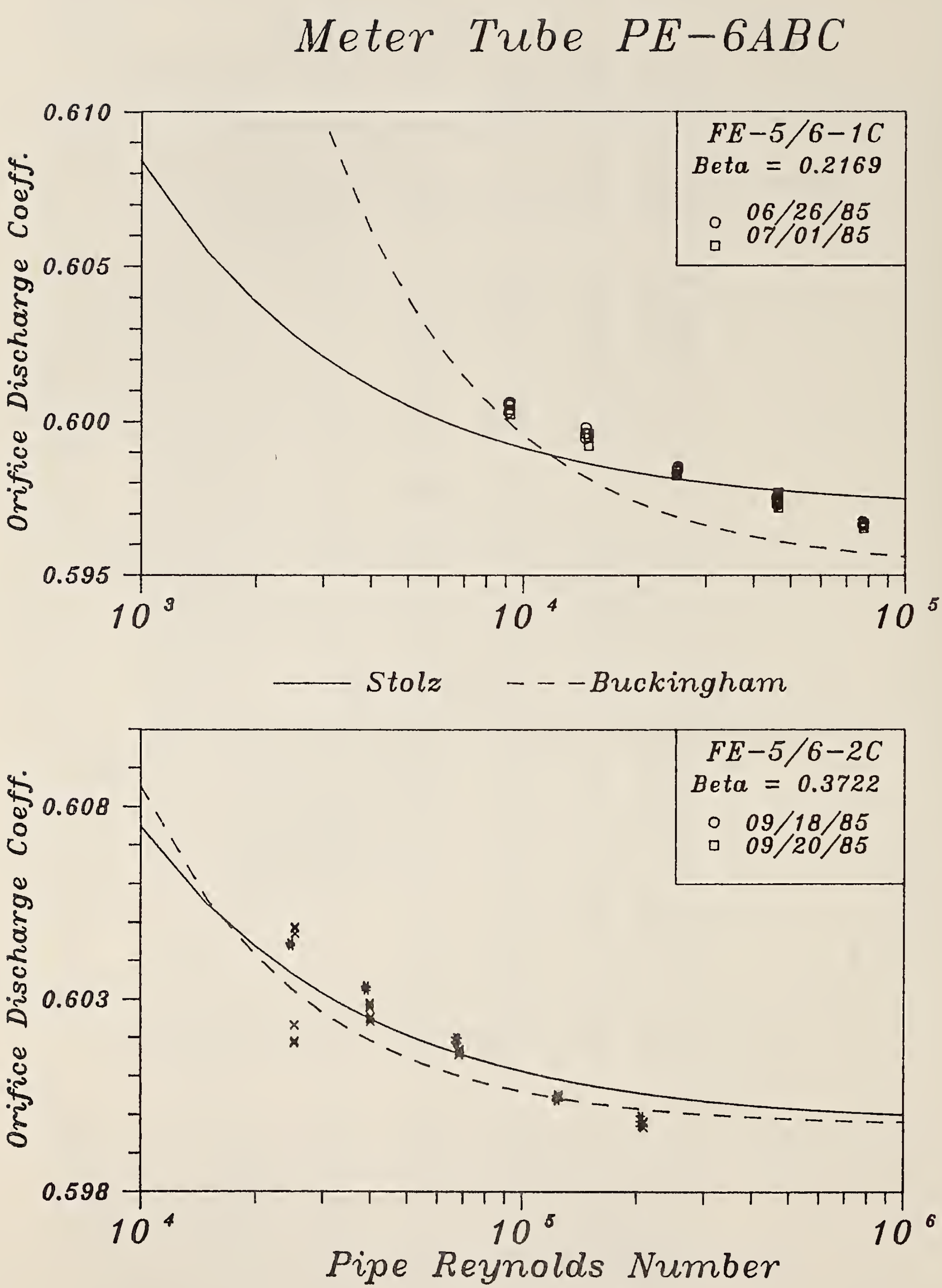


Figure 30B. Discharge Coefficient/Reynolds Number Plots, PE-6ABC 4-Inch Meter Tube, 8 Orifice Plates, Final Data Base

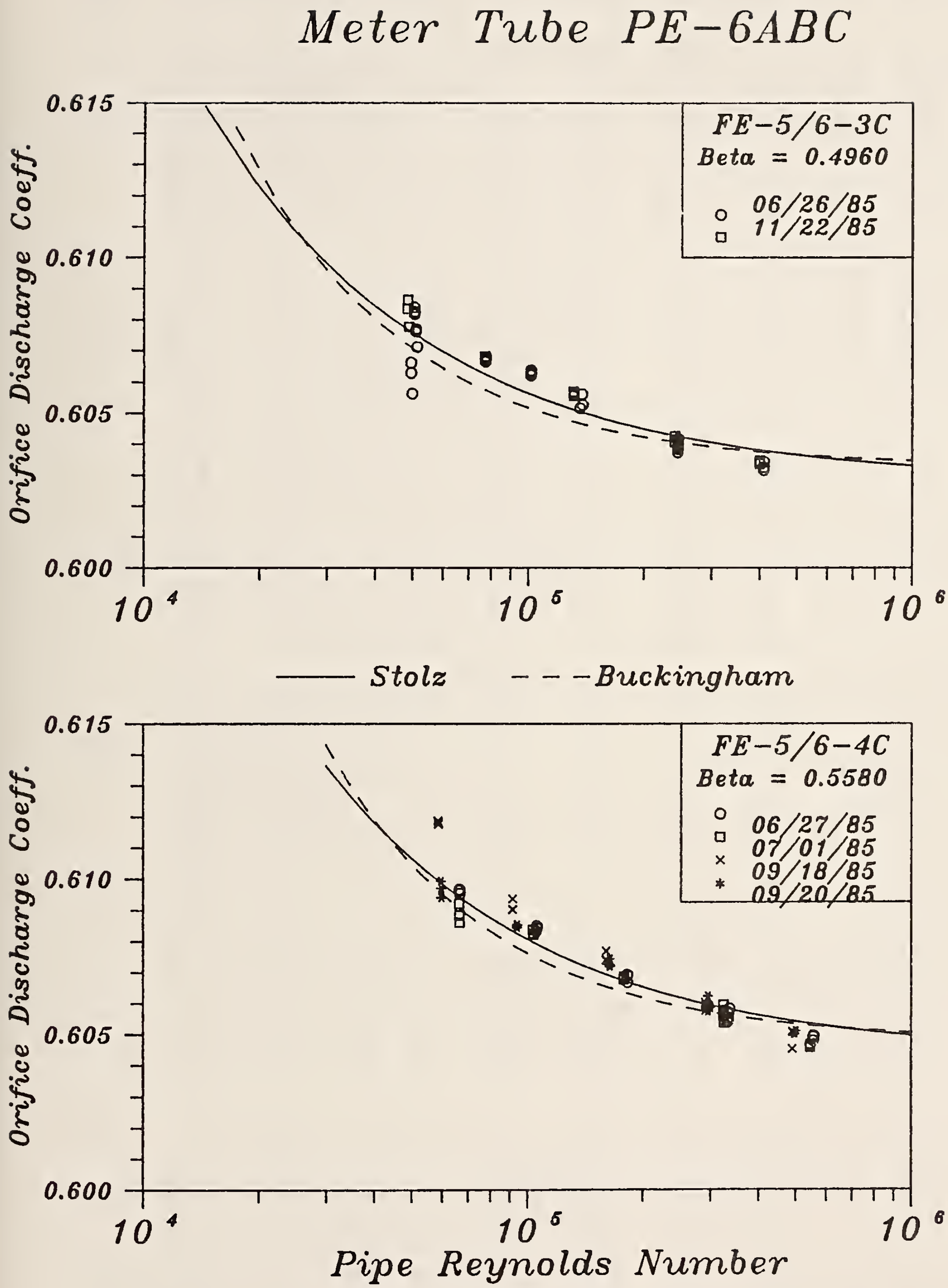


Figure 30C. Discharge Coefficient/Reynolds Number Plots, PE-6ABC 4-Inch Meter Tube, 8 Orifice Plates, Final Data Base

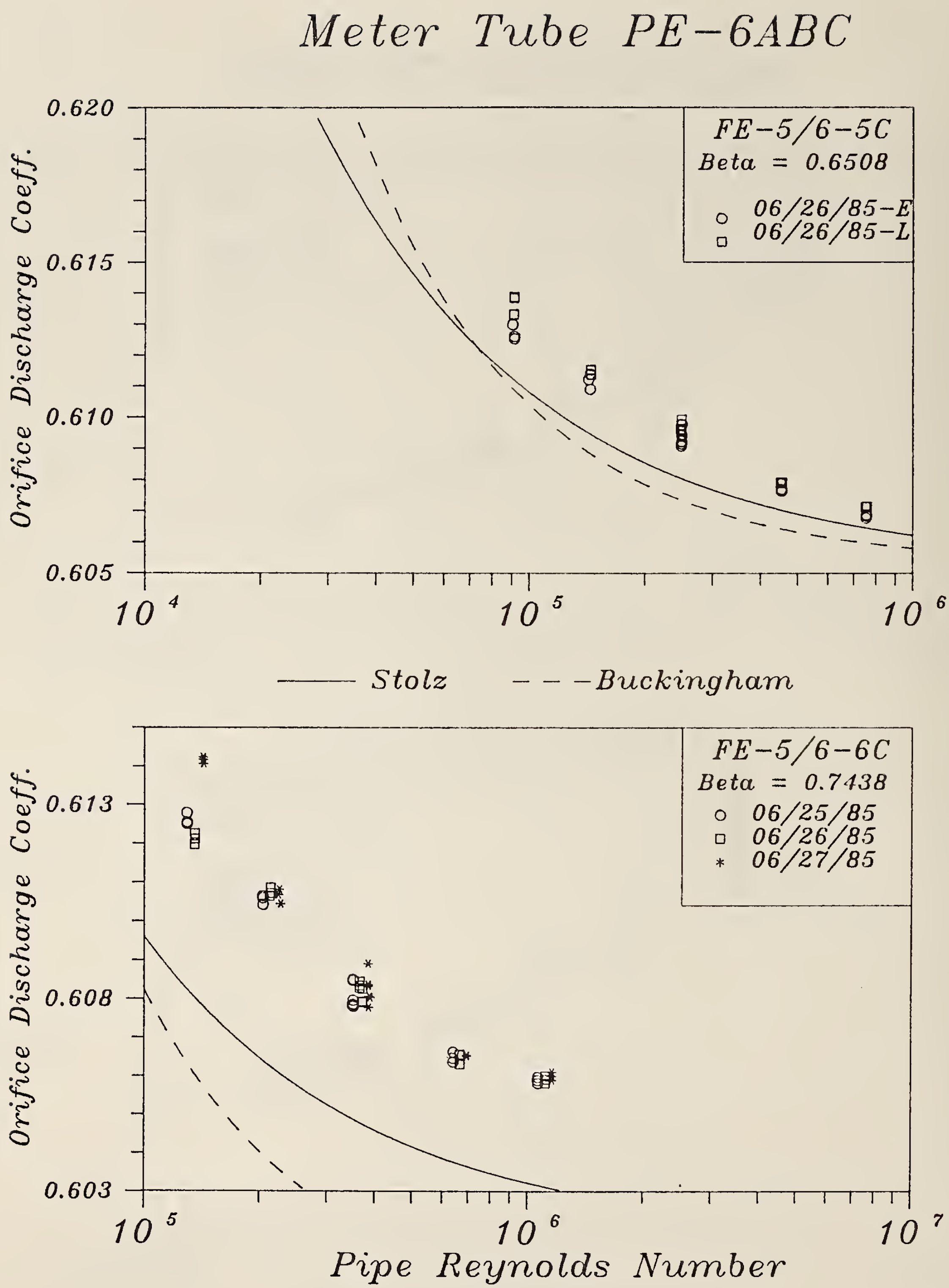


Figure 30D. Discharge Coefficient/Reynolds Number Plots, PE-6ABC 4-Inch Meter Tube, 8 Orifice Plates, Final Data Base

Table 44A. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-1C Diameter 1.2499 Inches, Beta Ratio = 0.20411

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	55.168	29.43	6.7787	77	1	3.0511	0.0026	3.0507	0.0035	3.0514	0.0019	0.5993	0.0005	0.0007	0.5994	0.0005	0.0007	0.5993	0.0005	0.0007	31184
2	#	55.308	29.41	6.7834	77	0	3.0583	0.0008	3.0567	0.0009	3.0564	0.0014	0.5990	0.0004	0.0007	0.5992	0.0004	0.0007	0.5992	0.0004	0.0007	31192
3	#	55.239	29.41	6.7808	77	0	3.0520	0.0013	3.0524	0.0011	3.0527	0.0016	0.5994	0.0005	0.0007	0.5994	0.0004	0.0007	0.5993	0.0005	0.0007	31180
4	#	150.21	29.32	2.4619	186	0	0.4000	0.0005	0.3998	0.0006	0.4001	0.0007	0.6012	0.0025	0.0039	0.6013	0.0023	0.0039	0.6011	0.0024	0.0039	11299
5	#	150.16	29.31	2.4644	186	0	0.4011	0.0004	0.4009	0.0005	0.4010	0.0005	0.6010	0.0025	0.0039	0.6011	0.0023	0.0039	0.6010	0.0024	0.0039	11308
6	#	150.01	29.31	2.4618	186	0	0.3996	0.0003	0.3996	0.0004	0.3999	0.0004	0.6015	0.0025	0.0039	0.6014	0.0023	0.0039	0.6012	0.0023	0.0039	11296
7	#	94.936	29.36	3.8976	132	8	1.0067	0.0005	1.0059	0.0007	1.0066	0.0005	0.5999	0.0010	0.0017	0.6001	0.0009	0.0017	0.5999	0.0010	0.0017	17903
8	#	95.547	29.36	3.8946	133	1	1.0046	0.0004	1.0047	0.0005	1.0049	0.0005	0.6001	0.0010	0.0017	0.6000	0.0009	0.0017	0.6000	0.0010	0.0017	17889
9	#	94.589	29.36	3.8926	131	0	1.0036	0.0005	1.0035	0.0005	1.0041	0.0006	0.6001	0.0010	0.0017	0.6001	0.0009	0.0017	0.5999	0.0010	0.0017	17880
10	#	269.64	29.42	6.7189	167	0	3.0033	0.0007	3.0018	0.0007	3.0034	0.0005	0.5987	0.0004	0.0007	0.5989	0.0003	0.0007	0.5987	0.0003	0.0007	30902
11	#	271.29	29.43	6.7175	168	2	3.0017	0.0009	3.0007	0.0007	3.0015	0.0006	0.5988	0.0004	0.0007	0.5989	0.0003	0.0007	0.5988	0.0003	0.0007	30902
12	#	271.37	29.42	6.7167	168	3	2.9997	0.0007	2.9989	0.0007	2.9994	0.0008	0.5989	0.0004	0.0007	0.5990	0.0003	0.0007	0.5989	0.0003	0.0007	30892
13	#	269.64	29.44	6.7458	167	0	3.0327	0.0063	3.0263	0.0019	3.0275	0.0017	0.5983	0.0007	0.0007	0.5989	0.0004	0.0007	0.5987	0.0004	0.0007	31039
14	#	269.78	29.49	6.7406	167	0	3.0106	0.0068	3.0209	0.0014	3.0224	0.0014	0.6000	0.0008	0.0007	0.5989	0.0003	0.0007	0.5988	0.0004	0.0007	31048
15	#	271.05	29.54	6.7242	168	0	3.0119	0.0069	3.0074	0.0018	3.0088	0.0016	0.5984	0.0008	0.0007	0.5988	0.0004	0.0007	0.5987	0.0004	0.0007	31006
16	#	135.23	29.62	13.465	184	0	12.099	0.0055	12.096	0.0060	12.100	0.0054	0.5978	0.0002	0.0004	0.5979	0.0002	0.0004	0.5978	0.0002	0.0004	62196
17	#	134.66	29.63	13.472	186	0	12.098	0.0058	12.106	0.0051	12.109	0.0049	0.5982	0.0002	0.0004	0.5980	0.0002	0.0004	0.5979	0.0002	0.0004	62242
18	#	135.08	29.67	13.482	188	2	12.128	0.0066	12.122	0.0055	12.128	0.0060	0.5979	0.0002	0.0004	0.5980	0.0002	0.0004	0.5979	0.0002	0.0004	62340
19	$	135.52	31.21	13.741	190	0	12.601	0.0113	12.603	0.0124	12.607	0.0136	0.5979	0.0003	0.0004	0.5979	0.0003	0.0004	0.5978	0.0004	0.0004	65642
20	$	135.22	31.25	13.750	189	1	12.616	0.0075	12.613	0.0082	12.620	0.0086	0.5980	0.0002	0.0004	0.5980	0.0002	0.0004	0.5979	0.0003	0.0004	65744
21	$	135.54	31.28	13.712	190	3	12.549	0.0070	12.549	0.0091	12.554	0.0090	0.5979	0.0002	0.0004	0.5979	0.0003	0.0004	0.5978	0.0003	0.0004	65601
22	$	269.61	31.31	6.7956	167	1	3.0734	0.0018	3.0724	0.0019	3.0741	0.0019	0.5988	0.0004	0.0007	0.5989	0.0004	0.0007	0.5987	0.0004	0.0007	32532
23	$	271.07	31.35	6.7857	168	2	3.0621	0.0020	3.0625	0.0013	3.0639	0.0013	0.5990	0.0004	0.0007	0.5990	0.0004	0.0007	0.5988	0.0004	0.0007	32512
24	$	271.16	31.39	6.7841	168	0	3.0614	0.0015	3.0621	0.0014	3.0632	0.0015	0.5989	0.0004	0.0007	0.5989	0.0004	0.0007	0.5987	0.0004	0.0007	32532
25	$	150.20	31.27	2.4767	186	1	0.4050	0.0001	0.4045	0.0001	0.4052	0.0002	0.6012	0.0024	0.0038	0.6016	0.0024	0.0038	0.6010	0.0024	0.0038	11847
26	$	150.65	31.17	2.4694	187	8	0.4025	0.0003	0.4017	0.0002	0.4027	0.0003	0.6012	0.0024	0.0038	0.6018	0.0024	0.0039	0.6011	0.0024	0.0038	11787
27	$	150.26	31.14	2.4662	186	0	0.4015	0.0002	0.4006	0.0002	0.4017	0.0002	0.6012	0.0024	0.0039	0.6019	0.0024	0.0039	0.6010	0.0024	0.0039	11764
28	$	94.926	31.14	3.8500	127	0	0.9822	0.0038	0.9813	0.0047	0.9835	0.0045	0.6001	0.0015	0.0017	0.6004	0.0017	0.0017	0.5997	0.0017	0.0017	18365
30	$	94.838	31.12	3.9004	133	47	1.0246	0.0008	1.0233	0.0007	1.0250	0.0006	0.5952	0.0010	0.0016	0.5956	0.0010	0.0017	0.5951	0.0010	0.0016	18598
31	$	94.835	31.15	3.9448	129	0	1.0311	0.0003	1.0299	0.0004	1.0315	0.0004	0.6001	0.0010	0.0017	0.6004	0.0010	0.0017	0.6000	0.0010	0.0017	18822

[Test Run Date Codes # - 12/05/85 $ - 12/06/85]

Table 44B. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-2B Diameter 2.2499 Inches, Beta Ratio = 0.36741

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	144.99	28.00	12.770	180	0	1.0055	0.0004	1.0056	0.0004	1.0043	0.0006	0.6018	0.0009	0.0016	0.6018	0.0010	0.0016	0.6022	0.0010	0.0016	56952
2 #	145.10	28.02	12.763	180	0	1.0044	0.0005	1.0044	0.0006	1.0039	0.0007	0.6018	0.0009	0.0016	0.6018	0.0010	0.0016	0.6020	0.0010	0.0016	56945
3 #	144.96	28.04	12.843	178	0	1.0164	0.0006	1.0160	0.0006	1.0161	0.0006	0.6020	0.0009	0.0016	0.6021	0.0010	0.0016	0.6021	0.0010	0.0016	57330
4 #	36.145	28.16	49.906	50	1	15.429	0.0195	15.432	0.0130	15.421	0.0173	0.6004	0.0006	0.0003	0.6004	0.0005	0.0003	0.6006	0.0006	0.0003	223355
5 #	36.227	28.17	49.965	51	0	15.464	0.0186	15.464	0.0124	15.456	0.0179	0.6005	0.0006	0.0003	0.6005	0.0005	0.0003	0.6006	0.0006	0.0003	223666
6 #	36.231	28.19	49.996	51	0	15.484	0.0057	15.484	0.0093	15.485	0.0058	0.6005	0.0005	0.0003	0.6005	0.0005	0.0003	0.6004	0.0005	0.0003	223901
7 #	215.62	28.18	8.1027	178	0	0.4040	0.0003	0.4046	0.0002	0.4042	0.0002	0.6025	0.0022	0.0038	0.6020	0.0023	0.0037	0.6023	0.0023	0.0038	36279
8 #	215.50	28.21	8.1003	178	0	0.4036	0.0002	0.4039	0.0002	0.4033	0.0002	0.6026	0.0022	0.0038	0.6023	0.0023	0.0038	0.6028	0.0023	0.0038	36292
9 #	215.46	28.24	8.0950	178	0	0.4026	0.0004	0.4030	0.0003	0.4026	0.0003	0.6030	0.0022	0.0038	0.6026	0.0023	0.0038	0.6030	0.0023	0.0038	36292
10 #	45.579	28.34	40.273	64	0	10.036	0.0142	10.040	0.0190	10.034	0.0137	0.6008	0.0006	0.0003	0.6007	0.0007	0.0003	0.6008	0.0005	0.0003	180948
11 #	46.336	28.35	40.406	65	0	10.114	0.0062	10.100	0.0069	10.099	0.0070	0.6005	0.0004	0.0003	0.6009	0.0004	0.0003	0.6009	0.0004	0.0003	181587
12 #	45.912	28.36	40.320	64	0	10.059	0.0103	10.061	0.0178	10.064	0.0158	0.6008	0.0005	0.0003	0.6008	0.0006	0.0003	0.6007	0.0006	0.0003	181242
13 #	83.279	28.39	22.183	117	0	3.0377	0.0023	3.0387	0.0030	3.0391	0.0034	0.6015	0.0004	0.0006	0.6014	0.0005	0.0006	0.6014	0.0005	0.0006	99780
14 #	83.311	28.41	22.225	116	0	3.0506	0.0018	3.0491	0.0023	3.0501	0.0027	0.6014	0.0004	0.0006	0.6015	0.0004	0.0006	0.6014	0.0005	0.0006	100011
15 #	83.120	28.42	22.239	116	0	3.0528	0.0016	3.0509	0.0027	3.0526	0.0024	0.6015	0.0004	0.0006	0.6017	0.0005	0.0006	0.6016	0.0004	0.0006	100096
16 $	145.39	30.22	12.832	180	1	1.0151	0.0004	1.0148	0.0004	1.0148	0.0003	0.6020	0.0010	0.0016	0.6021	0.0009	0.0016	0.6021	0.0009	0.0016	60035
17 $	145.34	30.21	12.718	180	2	0.9966	0.0004	0.9956	0.0003	0.9960	0.0005	0.6022	0.0010	0.0016	0.6025	0.0009	0.0016	0.6024	0.0010	0.0016	59487
18 $	145.18	30.21	12.701	180	0	0.9943	0.0003	0.9931	0.0003	0.9938	0.0003	0.6021	0.0010	0.0016	0.6025	0.0009	0.0016	0.6022	0.0010	0.0016	59409
19 $	215.62	30.19	8.1001	178	0	0.4029	0.0002	0.4017	0.0002	0.4028	0.0002	0.6032	0.0025	0.0038	0.6041	0.0022	0.0038	0.6033	0.0023	0.0038	37872
20 $	215.63	30.18	8.1018	178	2	0.4032	0.0002	0.4017	0.0002	0.4028	0.0002	0.6031	0.0025	0.0038	0.6042	0.0022	0.0038	0.6034	0.0023	0.0038	37872
21 $	214.51	30.17	8.1011	177	1	0.4032	0.0002	0.4019	0.0001	0.4025	0.0002	0.6031	0.0025	0.0038	0.6040	0.0022	0.0038	0.6036	0.0023	0.0038	37861
22 $	83.217	30.23	22.249	116	0	3.0568	0.0033	3.0566	0.0028	3.0591	0.0027	0.6015	0.0005	0.0006	0.6015	0.0005	0.0006	0.6013	0.0005	0.0006	104112
23 $	83.096	30.26	22.210	116	0	3.0468	0.0031	3.0452	0.0030	3.0465	0.0031	0.6015	0.0005	0.0006	0.6016	0.0005	0.0006	0.6015	0.0005	0.0006	103998
24 $	83.174	30.28	22.230	115	0	3.0556	0.0021	3.0528	0.0025	3.0539	0.0028	0.6012	0.0004	0.0006	0.6014	0.0004	0.0006	0.6013	0.0005	0.0006	104136
25 $	35.892	30.34	49.895	50	0	15.422	0.0095	15.426	0.0101	15.428	0.0093	0.6006	0.0005	0.0003	0.6005	0.0005	0.0003	0.6005	0.0005	0.0003	234027
26 $	36.632	30.34	49.926	51	0	15.447	0.0104	15.453	0.0117	15.453	0.0081	0.6005	0.0005	0.0003	0.6004	0.0005	0.0003	0.6004	0.0005	0.0003	234175
27 $	35.954	30.36	49.953	50	0	15.462	0.0272	15.459	0.0152	15.465	0.0149	0.6005	0.0007	0.0003	0.6006	0.0005	0.0003	0.6005	0.0005	0.0003	234402
28 $	45.993	30.36	40.226	64	0	10.019	0.0085	10.024	0.0122	10.030	0.0141	0.6007	0.0004	0.0003	0.6006	0.0005	0.0003	0.6004	0.0006	0.0003	188755
29 $	46.034	30.37	40.246	64	0	10.031	0.0069	10.025	0.0108	10.031	0.0104	0.6007	0.0004	0.0003	0.6009	0.0005	0.0003	0.6007	0.0005	0.0003	188893
30 $	45.999	30.37	40.148	64	0	9.986	0.0075	9.981	0.0070	9.993	0.0090	0.6006	0.0004	0.0003	0.6007	0.0004	0.0003	0.6004	0.0005	0.0003	188431

[Test Run Date Codes # - 12/04/85 $ - 12/05/85]

Table 44B. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-2B Diameter 2.2499 Inches, Beta Ratio = 0.36741

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	144.18	31.11	12.739	179	1	1.0005	0.0003	1.0006	0.0003	1.0008	0.0003	0.6021	0.0010	0.0016	0.6021	0.0010	0.0016	0.6020	0.0010	0.0016	60729
32 #	145.79	31.10	12.730	181	1	0.9996	0.0003	0.9994	0.0003	0.9989	0.0004	0.6020	0.0010	0.0016	0.6020	0.0010	0.0016	0.6022	0.0010	0.0016	60677
33 #	145.07	31.09	12.712	180	2	0.9963	0.0004	0.9960	0.0004	0.9954	0.0004	0.6021	0.0010	0.0016	0.6022	0.0010	0.0016	0.6023	0.0010	0.0016	60574
34 #	215.64	31.07	8.1111	178	0	0.4046	0.0002	0.4040	0.0002	0.4042	0.0002	0.6028	0.0024	0.0037	0.6033	0.0024	0.0038	0.6031	0.0024	0.0037	38635
35 #	215.55	31.06	8.1087	178	0	0.4040	0.0002	0.4036	0.0002	0.4040	0.0002	0.6031	0.0024	0.0038	0.6034	0.0024	0.0038	0.6031	0.0024	0.0038	38616
36 #	215.98	31.05	8.1070	178	0	0.4039	0.0002	0.4036	0.0001	0.4037	0.0002	0.6031	0.0024	0.0038	0.6033	0.0024	0.0038	0.6032	0.0024	0.0038	38599

[Test Run Date Codes # - 12/06/85]

Table 44C. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-3C Diameter 2.9994 Inches, Beta Ratio = 0.48980

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	80.479	28.50	23.644	112	0	1.0317	0.0009	1.0310	0.0006	1.0321	0.0006	0.6065	0.0009	0.0016	0.6067	0.0010	0.0016	0.6064	0.0010	0.0016	106606
2	#	79.496	28.51	23.621	110	0	1.0295	0.0011	1.0286	0.0012	1.0298	0.0009	0.6065	0.0010	0.0016	0.6068	0.0010	0.0016	0.6065	0.0010	0.0016	106523
3	#	80.484	28.53	23.515	112	0	1.0197	0.0009	1.0195	0.0012	1.0193	0.0009	0.6067	0.0010	0.0016	0.6068	0.0010	0.0016	0.6068	0.0010	0.0016	106090
4	#	35.611	28.57	40.264	50	0	3.0056	0.0048	3.0039	0.0057	3.0064	0.0041	0.6051	0.0007	0.0006	0.6053	0.0008	0.0006	0.6050	0.0007	0.0006	181815
5	#	44.904	28.59	40.111	63	0	2.9826	0.0017	2.9806	0.0033	2.9807	0.0023	0.6051	0.0005	0.0006	0.6053	0.0006	0.0006	0.6053	0.0005	0.0006	181207
6	#	45.236	28.60	40.008	63	0	2.9678	0.0069	2.9627	0.0061	2.9640	0.0058	0.6051	0.0008	0.0006	0.6056	0.0008	0.0006	0.6055	0.0008	0.0006	180777
7	#	124.91	28.61	14.930	174	0	0.4101	0.0003	0.4096	0.0005	0.4098	0.0004	0.6074	0.0022	0.0037	0.6078	0.0023	0.0037	0.6076	0.0023	0.0037	67478
8	#	125.91	28.62	14.988	168	0	0.4132	0.0003	0.4127	0.0004	0.4128	0.0003	0.6075	0.0022	0.0037	0.6079	0.0023	0.0037	0.6078	0.0023	0.0037	67754
9	#	125.71	28.65	14.978	175	0	0.4126	0.0004	0.4121	0.0004	0.4120	0.0003	0.6076	0.0022	0.0037	0.6079	0.0023	0.0037	0.6080	0.0023	0.0037	67754
10	#	157.39	28.72	40.706	195	0	3.0668	0.0022	3.0643	0.0023	3.0671	0.0020	0.6056	0.0004	0.0006	0.6059	0.0004	0.0006	0.6056	0.0004	0.0006	184412
11	#	157.19	28.74	40.799	195	0	3.0818	0.0015	3.0797	0.0015	3.0809	0.0019	0.6055	0.0003	0.0006	0.6057	0.0004	0.0006	0.6056	0.0004	0.0006	184912
12	#	156.55	28.74	41.018	194	0	3.1146	0.0019	3.1126	0.0018	3.1121	0.0020	0.6056	0.0004	0.0006	0.6058	0.0004	0.0006	0.6058	0.0004	0.0006	185907
13	#	64.547	28.77	99.137	90	0	18.285	0.0070	18.283	0.0060	18.283	0.0092	0.6041	0.0002	0.0002	0.6041	0.0002	0.0002	0.6041	0.0002	0.0002	449612
14	#	64.408	28.75	99.58	90	0	18.449	0.0079	18.446	0.0138	18.438	0.0097	0.6041	0.0002	0.0002	0.6041	0.0003	0.0002	0.6043	0.0002	0.0002	451440
15	#	65.017	28.75	99.094	88	0	18.261	0.0084	18.259	0.0091	18.252	0.0049	0.6042	0.0002	0.0002	0.6042	0.0002	0.0002	0.6043	0.0002	0.0002	449219
16	#	87.576	28.74	73.361	120	0	9.994	0.0053	9.996	0.0060	9.997	0.0070	0.6046	0.0002	0.0003	0.6046	0.0002	0.0003	0.6046	0.0003	0.0003	332496
17	#	87.475	28.75	73.183	122	0	9.945	0.0056	9.945	0.0063	9.943	0.0033	0.6046	0.0002	0.0003	0.6046	0.0002	0.0003	0.6047	0.0002	0.0003	331761
18	#	87.294	28.78	73.230	122	0	9.963	0.0041	9.961	0.0046	9.959	0.0050	0.6045	0.0002	0.0003	0.6046	0.0002	0.0003	0.6046	0.0002	0.0003	332189
19	$	87.940	30.86	73.438	123	0	10.032	0.0037	10.031	0.0047	10.033	0.0064	0.6043	0.0002	0.0003	0.6043	0.0002	0.0003	0.6042	0.0002	0.0003	348263
20	$	87.730	30.88	73.391	117	0	10.015	0.0052	10.016	0.0048	10.015	0.0068	0.6044	0.0002	0.0003	0.6044	0.0002	0.0003	0.6044	0.0003	0.0003	348186
21	$	87.543	30.90	73.222	122	0	9.968	0.0103	9.969	0.0100	9.976	0.0107	0.6044	0.0003	0.0003	0.6044	0.0003	0.0003	0.6042	0.0004	0.0003	347530
22	$	64.997	30.94	99.69	91	0	18.509	0.0072	18.513	0.0052	18.514	0.0042	0.6039	0.0002	0.0002	0.6038	0.0002	0.0002	0.6038	0.0002	0.0002	473568
23	$	64.457	30.94	99.70	90	0	18.499	0.0089	18.500	0.0091	18.512	0.0118	0.6041	0.0002	0.0002	0.6041	0.0002	0.0002	0.6039	0.0002	0.0002	473605
24	$	64.453	30.95	99.71	90	0	18.518	0.0056	18.521	0.0063	18.509	0.0059	0.6039	0.0002	0.0002	0.6038	0.0002	0.0002	0.6040	0.0002	0.0002	473733
25	$	156.53	30.96	40.324	194	0	3.0156	0.0015	3.0138	0.0017	3.0149	0.0023	0.6052	0.0004	0.0006	0.6054	0.0004	0.0006	0.6052	0.0004	0.0006	191631
26	$	156.49	31.00	40.136	194	0	2.9865	0.0020	2.9856	0.0026	2.9866	0.0018	0.6053	0.0004	0.0006	0.6054	0.0004	0.0006	0.6053	0.0004	0.0006	190897
27	$	157.25	31.03	40.112	195	0	2.9832	0.0024	2.9821	0.0032	2.9829	0.0028	0.6053	0.0004	0.0006	0.6054	0.0005	0.0006	0.6053	0.0004	0.0006	190904
28	$	44.382	31.08	40.591	62	0	3.0585	0.0020	3.0575	0.0023	3.0562	0.0046	0.6049	0.0005	0.0006	0.6050	0.0005	0.0006	0.6051	0.0007	0.0006	193387
29	$	45.382	31.09	40.513	62	0	3.0444	0.0032	3.0425	0.0031	3.0412	0.0032	0.6052	0.0006	0.0006	0.6053	0.0006	0.0006	0.6055	0.0006	0.0006	193056
30	$	45.082	31.11	40.579	63	0	3.0567	0.0055	3.0554	0.0045	3.0547	0.0040	0.6049	0.0007	0.0006	0.6050	0.0007	0.0006	0.6051	0.0006	0.0006	193448

[Test Run Date Codes # - 12/04/85 $ - 12/06/85]

Table 44C. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-3C Diameter 2.9994 Inches, Beta Ratio = 0.48980

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	80.078	31.15	23.775	111	0	1.0447	0.0013	1.0433	0.0015	1.0439	0.0009	0.6062	0.0010	0.0015	0.6066	0.0010	0.0015	0.6065	0.0010	0.0015	113435
32	#	80.143	31.17	23.771	111	0	1.0443	0.0008	1.0431	0.0012	1.0435	0.0010	0.6062	0.0010	0.0015	0.6066	0.0010	0.0015	0.6065	0.0010	0.0015	113463
33	#	79.952	31.20	23.762	111	0	1.0423	0.0009	1.0412	0.0009	1.0426	0.0007	0.6066	0.0010	0.0015	0.6069	0.0010	0.0016	0.6065	0.0010	0.0016	113491
34	#	125.01	31.23	14.860	174	0	0.4064	0.0003	0.4051	0.0003	0.4060	0.0002	0.6075	0.0024	0.0037	0.6085	0.0024	0.0038	0.6078	0.0024	0.0037	71019
35	#	124.91	31.26	14.844	174	0	0.4051	0.0004	0.4038	0.0003	0.4047	0.0004	0.6079	0.0024	0.0038	0.6089	0.0024	0.0038	0.6081	0.0024	0.0038	70989
36	#	125.18	31.30	14.846	175	0	0.4053	0.0005	0.4037	0.0004	0.4048	0.0004	0.6078	0.0024	0.0038	0.6090	0.0024	0.0038	0.6081	0.0025	0.0038	71059

[Test Run Date Codes # - 12/06/85]

Table 44D. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-4B Diameter 3.4999 Inches, Beta Ratio = 0.57153

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	113.74	27.67	57.100	159	0	3.0795	0.0032	3.0791	0.0031	3.0791	0.0027	0.6061	0.0004	0.0006	0.6062	0.0004	0.0006	0.6062	0.0004	0.0006	252822
2	#	113.88	27.68	57.326	156	0	3.1021	0.0028	3.1014	0.0022	3.1035	0.0017	0.6063	0.0004	0.0006	0.6064	0.0004	0.0006	0.6062	0.0004	0.0006	253878
3	#	113.61	27.69	57.413	158	0	3.1119	0.0022	3.1101	0.0029	3.1131	0.0024	0.6063	0.0004	0.0006	0.6064	0.0004	0.0006	0.6062	0.0004	0.0006	254320
4	#	44.300	27.70	146.05	62	0	20.253	0.0115	20.257	0.0150	20.261	0.0081	0.6045	0.0002	0.0002	0.6045	0.0003	0.0002	0.6044	0.0002	0.0002	647071
5	#	43.678	27.69	146.31	61	0	20.334	0.0105	20.330	0.0060	20.336	0.0164	0.6044	0.0002	0.0002	0.6045	0.0002	0.0002	0.6044	0.0003	0.0002	648090
6	#	43.675	27.69	146.42	61	0	20.378	0.0110	20.370	0.0094	20.351	0.0095	0.6042	0.0002	0.0002	0.6043	0.0002	0.0002	0.6046	0.0002	0.0002	648576
7	#	61.478	27.70	103.20	86	0	10.099	0.0100	10.099	0.0110	10.095	0.0074	0.6049	0.0003	0.0003	0.6049	0.0004	0.0003	0.6050	0.0003	0.0003	457227
8	#	61.699	27.72	102.92	86	0	10.038	0.0068	10.044	0.0069	10.046	0.0085	0.6051	0.0003	0.0003	0.6049	0.0003	0.0003	0.6048	0.0003	0.0003	456181
9	#	61.639	27.74	102.86	86	0	10.036	0.0078	10.031	0.0118	10.025	0.0100	0.6049	0.0003	0.0003	0.6050	0.0004	0.0003	0.6052	0.0003	0.0003	456147
10	#	31.909	27.77	56.547	43	0	3.0215	0.0036	3.0180	0.0025	3.0258	0.0035	0.6060	0.0007	0.0006	0.6064	0.0006	0.0006	0.6056	0.0007	0.0006	250926
11	#	32.269	27.79	56.475	45	0	3.0204	0.0032	3.0180	0.0033	3.0172	0.0018	0.6053	0.0007	0.0006	0.6056	0.0007	0.0006	0.6057	0.0006	0.0006	250713
12	#	32.370	27.81	56.573	45	0	3.0251	0.0047	3.0235	0.0032	3.0231	0.0056	0.6059	0.0007	0.0006	0.6061	0.0007	0.0006	0.6061	0.0008	0.0006	251262
13	#	86.695	27.84	20.736	121	0	0.4039	0.0006	0.4036	0.0006	0.4026	0.0004	0.6078	0.0023	0.0038	0.6080	0.0024	0.0038	0.6088	0.0024	0.0038	92154
14	#	87.405	27.87	20.682	122	0	0.4007	0.0004	0.4006	0.0006	0.4010	0.0004	0.6087	0.0023	0.0038	0.6087	0.0024	0.0038	0.6084	0.0024	0.0038	91977
15	#	87.408	27.89	20.698	122	0	0.4021	0.0005	0.4014	0.0007	0.4015	0.0004	0.6080	0.0023	0.0038	0.6086	0.0024	0.0038	0.6085	0.0024	0.0038	92086
16	#	55.332	27.93	32.904	77	0	1.0183	0.0012	1.0168	0.0011	1.0184	0.0019	0.6074	0.0010	0.0016	0.6079	0.0010	0.0016	0.6074	0.0011	0.0016	146524
17	#	54.825	27.94	32.962	75	0	1.0211	0.0006	1.0208	0.0008	1.0212	0.0021	0.6077	0.0010	0.0016	0.6078	0.0010	0.0016	0.6077	0.0012	0.0016	146814
18	#	54.557	27.96	32.950	75	0	1.0210	0.0013	1.0214	0.0009	1.0215	0.0015	0.6075	0.0010	0.0016	0.6073	0.0010	0.0016	0.6073	0.0011	0.0016	146823
19	$	55.212	30.43	32.715	75	0	1.0077	0.0019	1.0073	0.0022	1.0085	0.0013	0.6073	0.0012	0.0016	0.6074	0.0012	0.0016	0.6070	0.0011	0.0016	153741
20	$	54.684	30.43	32.719	76	0	1.0075	0.0017	1.0071	0.0018	1.0071	0.0012	0.6074	0.0012	0.0016	0.6075	0.0011	0.0016	0.6075	0.0010	0.0016	153760
21	$	54.652	30.44	32.695	76	0	1.0075	0.0009	1.0057	0.0013	1.0073	0.0017	0.6070	0.0011	0.0016	0.6075	0.0010	0.0016	0.6070	0.0011	0.0016	153677
22	$	87.002	30.44	20.538	121	0	0.3955	0.0006	0.3945	0.0007	0.3953	0.0006	0.6086	0.0026	0.0038	0.6094	0.0024	0.0039	0.6087	0.0024	0.0038	96537
23	$	87.731	30.45	20.633	122	0	0.3986	0.0003	0.3978	0.0003	0.3984	0.0004	0.6090	0.0026	0.0038	0.6096	0.0023	0.0038	0.6091	0.0024	0.0038	97005
24	$	87.744	30.47	20.640	122	0	0.3991	0.0003	0.3981	0.0005	0.3989	0.0004	0.6088	0.0026	0.0038	0.6095	0.0023	0.0038	0.6089	0.0024	0.0038	97075
25	$	31.601	30.51	56.613	44	0	3.0369	0.0030	3.0345	0.0037	3.0297	0.0036	0.6054	0.0007	0.0006	0.6056	0.0007	0.0006	0.6061	0.0007	0.0006	266495
26	$	31.588	30.51	56.541	44	0	3.0252	0.0042	3.0228	0.0027	3.0234	0.0040	0.6057	0.0007	0.0006	0.6060	0.0007	0.0006	0.6059	0.0007	0.0006	266156
27	$	31.532	30.52	56.569	44	0	3.0307	0.0066	3.0286	0.0058	3.0228	0.0104	0.6055	0.0009	0.0006	0.6057	0.0008	0.0006	0.6063	0.0012	0.0006	266347
28	$	62.258	30.56	102.74	87	0	10.015	0.0045	10.013	0.0061	10.021	0.0033	0.6049	0.0002	0.0003	0.6050	0.0002	0.0003	0.6048	0.0002	0.0003	484141
29	$	61.648	30.56	103.11	86	0	10.094	0.0067	10.091	0.0062	10.090	0.0059	0.6048	0.0003	0.0003	0.6049	0.0002	0.0003	0.6049	0.0002	0.0003	485899
30	$	61.697	30.54	102.95	86	0	10.056	0.0054	10.055	0.0038	10.059	0.0074	0.6050	0.0002	0.0003	0.6050	0.0002	0.0003	0.6049	0.0003	0.0003	484931

[Test Run Date Codes # - 12/04/85 $ - 12/05/85]

Table 44D. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-4B Diameter 3.4999 Inches, Beta Ratio = 0.57153

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	43.550	30.52	144.90	61	0	19.958	0.0112	19.963	0.0122	19.957	0.0090	0.6044	0.0002	0.0002	0.6043	0.0003	0.0002	0.6044	0.0002	0.0002	682229
32	#	44.411	30.52	145.36	62	0	20.091	0.0024	20.088	0.0078	20.088	0.0075	0.6043	0.0002	0.0002	0.6043	0.0002	0.0002	0.6043	0.0002	0.0002	684383
33	#	43.596	30.52	145.41	61	0	20.088	0.0176	20.097	0.0119	20.100	0.0085	0.6045	0.0003	0.0002	0.6044	0.0002	0.0002	0.6044	0.0002	0.0002	684616

[Test Run Date Codes # - 12/05/85]

Table 44E. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-5B Diameter 4.0002 Inches, Beta Ratio = 0.65323

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	65.270	28.82	28.722	91	0	0.4126	0.0004	0.4123	0.0005	0.4126	0.0006	0.6102	0.0022	0.0037	0.6105	0.0023	0.0037	0.6102	0.0024	0.0037	130403
2 #	64.557	28.84	28.726	90	0	0.4128	0.0005	0.4124	0.0006	0.4122	0.0007	0.6101	0.0022	0.0037	0.6105	0.0024	0.0037	0.6106	0.0024	0.0037	130476
3 #	65.267	28.86	28.734	91	0	0.4131	0.0007	0.4132	0.0007	0.4131	0.0007	0.6101	0.0023	0.0037	0.6100	0.0024	0.0037	0.6101	0.0024	0.0037	130571
4 #	40.298	28.90	44.487	56	0	0.9985	0.0019	0.9979	0.0014	0.9976	0.0026	0.6076	0.0011	0.0016	0.6077	0.0011	0.0016	0.6078	0.0013	0.0016	202326
5 #	39.595	28.90	44.373	55	0	0.9910	0.0019	0.9900	0.0019	0.9902	0.0016	0.6083	0.0012	0.0016	0.6086	0.0012	0.0016	0.6085	0.0012	0.0016	201809
6 #	40.256	28.92	44.404	56	0	0.9919	0.0015	0.9911	0.0017	0.9937	0.0011	0.6084	0.0011	0.0016	0.6087	0.0012	0.0016	0.6079	0.0011	0.0016	202036
7 #	145.58	28.95	45.110	181	0	1.0229	0.0009	1.0220	0.0010	1.0244	0.0012	0.6087	0.0009	0.0016	0.6089	0.0010	0.0016	0.6082	0.0010	0.0016	205383
8 #	145.01	28.98	45.165	180	0	1.0264	0.0009	1.0253	0.0010	1.0267	0.0008	0.6084	0.0009	0.0016	0.6087	0.0010	0.0016	0.6083	0.0010	0.0016	205768
9 #	144.90	28.98	45.273	180	0	1.0306	0.0009	1.0302	0.0009	1.0317	0.0009	0.6086	0.0009	0.0016	0.6087	0.0010	0.0016	0.6083	0.0010	0.0016	206257
10 #	85.103	28.98	77.692	119	0	3.0602	0.0021	3.0568	0.0016	3.0569	0.0023	0.6061	0.0004	0.0006	0.6064	0.0004	0.0006	0.6064	0.0004	0.0006	353958
11 #	84.490	28.99	77.693	118	0	3.0585	0.0019	3.0568	0.0024	3.0556	0.0022	0.6063	0.0004	0.0006	0.6064	0.0004	0.0006	0.6066	0.0004	0.0006	354037
12 #	84.528	29.00	77.410	117	0	3.0353	0.0016	3.0355	0.0022	3.0340	0.0020	0.6064	0.0004	0.0006	0.6063	0.0004	0.0006	0.6065	0.0004	0.0006	352822
13 #	44.330	29.02	140.57	62	0	10.063	0.0046	10.067	0.0044	10.051	0.0059	0.6048	0.0002	0.0003	0.6046	0.0002	0.0003	0.6051	0.0003	0.0003	640986
14 #	44.229	29.02	140.63	59	0	10.088	0.0071	10.081	0.0053	10.065	0.0055	0.6042	0.0003	0.0003	0.6045	0.0002	0.0003	0.6049	0.0003	0.0003	641256
15 #	44.339	29.02	140.75	62	0	10.095	0.0043	10.097	0.0044	10.078	0.0025	0.6045	0.0002	0.0003	0.6045	0.0002	0.0003	0.6051	0.0002	0.0003	641799
16 #	29.844	29.05	215.23	42	0	23.682	0.0182	23.683	0.0176	23.651	0.0101	0.6036	0.0003	0.0002	0.6036	0.0003	0.0002	0.6040	0.0003	0.0002	982065
17 #	29.943	29.09	214.34	42	0	23.455	0.0141	23.452	0.0168	23.474	0.0182	0.6040	0.0003	0.0002	0.6040	0.0003	0.0002	0.6037	0.0003	0.0002	978829
18 #	29.798	29.13	214.61	42	0	23.517	0.0145	23.522	0.0246	23.516	0.0165	0.6039	0.0003	0.0002	0.6039	0.0004	0.0002	0.6040	0.0003	0.0002	980907
19 $	65.131	29.70	28.429	91	0	0.4050	0.0007	0.4039	0.0008	0.4053	0.0005	0.6097	0.0026	0.0038	0.6105	0.0023	0.0038	0.6095	0.0024	0.0038	131541
20 $	64.481	29.73	28.410	90	0	0.4038	0.0004	0.4029	0.0005	0.4048	0.0006	0.6102	0.0026	0.0038	0.6109	0.0023	0.0038	0.6094	0.0024	0.0038	131537
21 $	64.575	29.73	28.400	90	0	0.4031	0.0004	0.4027	0.0006	0.4043	0.0005	0.6105	0.0026	0.0038	0.6108	0.0023	0.0038	0.6096	0.0024	0.0038	131489
22 $	39.623	29.77	45.271	55	0	1.0329	0.0013	1.0320	0.0023	1.0347	0.0012	0.6080	0.0011	0.0016	0.6082	0.0012	0.0016	0.6074	0.0011	0.0016	209780
23 $	40.315	29.77	45.379	54	0	1.0398	0.0018	1.0395	0.0020	1.0360	0.0018	0.6074	0.0012	0.0016	0.6075	0.0011	0.0016	0.6085	0.0011	0.0015	210282
24 $	40.347	29.78	45.449	56	0	1.0399	0.0014	1.0391	0.0017	1.0409	0.0017	0.6083	0.0011	0.0016	0.6085	0.0011	0.0016	0.6080	0.0011	0.0016	210648
25 $	29.350	29.82	214.98	41	0	23.612	0.0106	23.617	0.0083	23.618	0.0100	0.6038	0.0003	0.0002	0.6038	0.0003	0.0002	0.6038	0.0003	0.0002	997265
26 $	29.724	29.85	214.83	42	0	23.603	0.0247	23.596	0.0131	23.543	0.0131	0.6035	0.0004	0.0002	0.6036	0.0003	0.0002	0.6043	0.0003	0.0002	997176
27 $	29.750	29.87	215.13	42	0	23.668	0.0180	23.658	0.0167	23.639	0.0076	0.6035	0.0003	0.0002	0.6037	0.0003	0.0002	0.6039	0.0002	0.0002	999031
28 $	84.364	29.94	76.969	118	0	3.0048	0.0035	3.0018	0.0027	3.0048	0.0037	0.6060	0.0005	0.0006	0.6063	0.0004	0.0006	0.6060	0.0005	0.0006	357957
29 $	84.586	30.01	76.788	118	0	2.9901	0.0020	2.9871	0.0016	2.9884	0.0038	0.6061	0.0004	0.0006	0.6064	0.0004	0.0006	0.6063	0.0005	0.0006	357649
30 $	84.554	30.07	76.722	118	0	2.9868	0.0025	2.9832	0.0028	2.9796	0.0036	0.6059	0.0004	0.0006	0.6063	0.0004	0.0006	0.6066	0.0005	0.0006	357798

[Test Run Date Codes # - 12/04/85 $ - 12/05/85]

Table 44E. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-5B Diameter 4.0002 Inches, Beta Ratio = 0.65323

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	44.220	30.16	139.63	62	0	9.941	0.0055	9.945	0.0048	9.929	0.0077	0.6045	0.0003	0.0003	0.6044	0.0002	0.0003	0.6048	0.0003	0.0003	652445
32	#	44.973	30.19	139.94	63	0	9.992	0.0110	9.983	0.0095	9.975	0.0102	0.6043	0.0004	0.0003	0.6045	0.0003	0.0003	0.6048	0.0004	0.0003	654311
33	#	45.059	30.23	139.92	63	0	9.984	0.0088	9.980	0.0054	9.962	0.0064	0.6044	0.0003	0.0003	0.6045	0.0003	0.0003	0.6051	0.0003	0.0003	654774

[Test Run Date Codes # - 12/05/85]

Table 44F. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-6B Diameter 4.4997 Inches, Beta Ratio = 0.73480

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	100.04	28.70	61.211	139	0	1.0248	0.0012	1.0262	0.0007	1.0256	0.0010	0.6069	0.0011	0.0016	0.6065	0.0009	0.0016	0.6067	0.0010	0.0016	277185
2	#	99.66	28.74	60.965	139	0	1.0192	0.0011	1.0191	0.0013	1.0175	0.0006	0.6062	0.0011	0.0016	0.6062	0.0010	0.0016	0.6066	0.0010	0.0016	276312
3	#	99.90	28.79	61.054	136	0	1.0222	0.0011	1.0222	0.0009	1.0201	0.0009	0.6061	0.0011	0.0016	0.6062	0.0009	0.0016	0.6068	0.0010	0.0016	277016
4	#	159.75	28.89	38.861	198	0	0.4124	0.0004	0.4118	0.0005	0.4098	0.0004	0.6074	0.0025	0.0037	0.6078	0.0022	0.0037	0.6093	0.0023	0.0037	176700
5	#	159.98	28.96	38.848	198	0	0.4107	0.0003	0.4104	0.0003	0.4085	0.0004	0.6085	0.0025	0.0037	0.6087	0.0022	0.0037	0.6101	0.0023	0.0037	176912
6	#	159.85	29.02	38.836	198	0	0.4105	0.0004	0.4101	0.0004	0.4092	0.0004	0.6084	0.0025	0.0037	0.6087	0.0022	0.0037	0.6094	0.0023	0.0037	177087
7	#	60.019	29.08	105.25	84	0	3.0616	0.0038	3.0566	0.0024	3.0612	0.0041	0.6038	0.0005	0.0006	0.6043	0.0004	0.0006	0.6038	0.0005	0.0006	480522
8	#	59.370	29.08	105.27	83	0	3.0585	0.0031	3.0568	0.0019	3.0587	0.0039	0.6042	0.0005	0.0006	0.6044	0.0004	0.0006	0.6042	0.0005	0.0006	480615
9	#	59.360	29.10	105.40	83	0	3.0739	0.0037	3.0705	0.0021	3.0678	0.0021	0.6035	0.0005	0.0006	0.6038	0.0004	0.0006	0.6041	0.0004	0.0006	481445
10	#	390.18	29.22	105.05	161	0	3.0632	0.0028	3.0558	0.0021	3.0528	0.0020	0.6025	0.0004	0.0007	0.6032	0.0004	0.0007	0.6035	0.0004	0.0007	481061
11	#	387.77	29.26	104.90	160	0	3.0484	0.0026	3.0455	0.0021	3.0471	0.0018	0.6031	0.0004	0.0007	0.6034	0.0004	0.0007	0.6032	0.0004	0.0007	480818
12	#	387.90	29.33	105.00	160	0	3.0525	0.0027	3.0485	0.0019	3.0519	0.0019	0.6033	0.0004	0.0007	0.6036	0.0004	0.0007	0.6033	0.0004	0.0007	481966
13	#	115.03	29.48	314.20	160	0	27.570	0.0228	27.579	0.0215	27.640	0.0219	0.6007	0.0003	0.0003	0.6006	0.0003	0.0003	0.5999	0.0003	0.0003	1446944
14	#	115.03	29.51	314.18	160	0	27.559	0.0224	27.559	0.0283	27.638	0.0260	0.6008	0.0003	0.0003	0.6008	0.0003	0.0003	0.5999	0.0003	0.0003	1447792
15	#	114.93	29.58	314.53	160	0	27.627	0.0197	27.639	0.0192	27.703	0.0232	0.6007	0.0003	0.0003	0.6006	0.0002	0.0003	0.5999	0.0003	0.0003	1451595
16	#	195.70	29.64	189.19	162	0	9.981	0.0082	9.969	0.0060	9.973	0.0040	0.6011	0.0003	0.0004	0.6015	0.0002	0.0004	0.6014	0.0002	0.0004	874234
17	#	194.96	29.69	189.06	162	0	9.956	0.0077	9.953	0.0048	9.969	0.0038	0.6015	0.0003	0.0004	0.6016	0.0002	0.0004	0.6011	0.0002	0.0004	874585
18	#	194.51	29.72	188.94	161	0	9.935	0.0087	9.945	0.0065	9.949	0.0050	0.6018	0.0003	0.0004	0.6014	0.0003	0.0004	0.6013	0.0002	0.0004	874593
19	$	195.27	29.94	189.55	166	0	10.019	0.0089	10.020	0.0077	10.033	0.0063	0.6012	0.0003	0.0004	0.6011	0.0003	0.0004	0.6007	0.0002	0.0004	881520
20	$	195.85	29.96	189.65	164	0	10.018	0.0078	10.033	0.0064	10.034	0.0090	0.6015	0.0003	0.0004	0.6011	0.0003	0.0004	0.6011	0.0003	0.0004	882401
21	$	195.75	29.99	189.85	162	0	10.051	0.0099	10.045	0.0080	10.065	0.0084	0.6012	0.0003	0.0004	0.6013	0.0003	0.0004	0.6008	0.0003	0.0004	883881
22	$	115.47	30.13	314.62	161	0	27.679	0.0195	27.688	0.0174	27.734	0.0198	0.6004	0.0003	0.0003	0.6003	0.0002	0.0003	0.5998	0.0003	0.0003	1469136
23	$	115.00	30.20	313.04	160	0	27.424	0.0214	27.422	0.0262	27.465	0.0225	0.6001	0.0003	0.0003	0.6001	0.0003	0.0003	0.5997	0.0003	0.0003	1463949
24	$	114.84	30.27	314.22	160	0	27.645	0.0265	27.630	0.0354	27.689	0.0249	0.6000	0.0003	0.0003	0.6001	0.0004	0.0003	0.5995	0.0003	0.0003	1471622
25	$	389.82	30.33	104.92	161	0	3.0485	0.0029	3.0492	0.0023	3.0509	0.0030	0.6033	0.0004	0.0007	0.6032	0.0004	0.0007	0.6031	0.0005	0.0007	492037
26	$	389.65	30.39	104.91	161	0	3.0515	0.0033	3.0506	0.0023	3.0483	0.0021	0.6029	0.0005	0.0007	0.6030	0.0004	0.0007	0.6032	0.0004	0.0007	492591
27	$	387.47	30.46	104.97	160	1	3.0553	0.0022	3.0539	0.0018	3.0520	0.0021	0.6029	0.0004	0.0007	0.6030	0.0004	0.0007	0.6032	0.0004	0.0007	493595
28	$	59.574	30.50	104.45	84	0	3.0251	0.0025	3.0236	0.0031	3.0138	0.0020	0.6029	0.0004	0.0006	0.6031	0.0005	0.0006	0.6041	0.0004	0.0006	491585
29	$	59.367	30.51	104.46	83	0	3.0213	0.0023	3.0168	0.0021	3.0200	0.0054	0.6034	0.0004	0.0006	0.6038	0.0004	0.0006	0.6035	0.0006	0.0006	491731
30	$	59.804	30.53	104.49	83	0	3.0232	0.0027	3.0217	0.0034	3.0177	0.0022	0.6034	0.0004	0.0006	0.6035	0.0005	0.0006	0.6039	0.0004	0.0006	492087

[Test Run Date Codes # - 12/05/85 $ - 12/06/85]

Table 44F. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-6B Diameter 4.4997 Inches, Beta Ratio = 0.73480

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	99.143	30.58	62.012	138	0	1.0574	0.0009	1.0561	0.0013	1.0539	0.0010	0.6055	0.0010	0.0015	0.6058	0.0010	0.0015	0.6065	0.0010	0.0015	292346
32 #	99.86	30.61	62.062	139	0	1.0580	0.0011	1.0572	0.0011	1.0545	0.0011	0.6058	0.0010	0.0015	0.6060	0.0010	0.0015	0.6068	0.0010	0.0015	292767
33 #	99.92	30.65	62.059	139	0	1.0591	0.0009	1.0572	0.0006	1.0560	0.0012	0.6054	0.0010	0.0015	0.6060	0.0009	0.0015	0.6063	0.0010	0.0015	293000
34 #	159.72	30.74	38.587	198	0	0.4064	0.0004	0.4051	0.0004	0.4032	0.0003	0.6077	0.0024	0.0037	0.6087	0.0024	0.0038	0.6101	0.0025	0.0037	182525
35 #	159.64	30.80	38.595	198	2	0.4064	0.0002	0.4053	0.0004	0.4030	0.0004	0.6079	0.0024	0.0037	0.6087	0.0024	0.0038	0.6104	0.0025	0.0037	182795
36 #	159.66	30.85	38.615	198	0	0.4074	0.0003	0.4058	0.0003	0.4036	0.0003	0.6074	0.0024	0.0037	0.6086	0.0024	0.0038	0.6102	0.0025	0.0037	183084

[Test Run Date Codes # - 12/06/85]

Table 44G. Orifice Discharge Coefficient Values - Meter Tube PE-7

Meter Tube PE-7ABC Diameter 6.1237 Inches -- Orifice Plate FE-7/8-8B Diameter 0.6234 Inches, Beta Ratio = 0.10180

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	119.94	29.51	3.0798	167	0	10.135	0.0033	10.134	0.0051	10.137	0.0051	0.6011	0.0002	0.0006	0.6011	0.0002	0.0006	0.6010	0.0002	0.0006	14192
2	#	120.05	29.52	3.0697	167	8	10.064	0.0030	10.061	0.0025	10.065	0.0023	0.6012	0.0002	0.0006	0.6013	0.0002	0.0006	0.6012	0.0002	0.0006	14149
3	#	119.64	29.52	3.0626	165	1	10.012	0.0107	10.012	0.0116	10.014	0.0107	0.6014	0.0004	0.0006	0.6014	0.0004	0.0006	0.6013	0.0004	0.0006	14116
4	#	190.04	29.43	1.6746	186	0	2.9850	0.0022	2.9839	0.0024	2.9855	0.0026	0.6022	0.0004	0.0009	0.6023	0.0004	0.0009	0.6022	0.0004	0.0009	7704
5	#	190.13	29.41	1.6719	190	11	2.9730	0.0013	2.9702	0.0015	2.9723	0.0017	0.6025	0.0004	0.0009	0.6028	0.0004	0.0009	0.6026	0.0004	0.0009	7688
6	#	190.46	29.39	1.6724	196	45	3.0046	0.0016	3.0029	0.0019	3.0044	0.0019	0.5995	0.0004	0.0009	0.5996	0.0004	0.0009	0.5995	0.0004	0.0009	7687
7	#	300.01	29.28	0.6178	149	10	0.4029	0.0003	0.4020	0.0003	0.4025	0.0003	0.6048	0.0025	0.0041	0.6054	0.0023	0.0041	0.6050	0.0023	0.0041	2833
8	#	300.11	29.17	0.6159	151	3	0.3995	0.0002	0.3983	0.0002	0.3992	0.0002	0.6054	0.0025	0.0041	0.6063	0.0023	0.0041	0.6057	0.0024	0.0041	2817
9	#	301.44	29.10	0.6199	150	0	0.4042	0.0018	0.4029	0.0021	0.4039	0.0020	0.6058	0.0028	0.0041	0.6068	0.0027	0.0041	0.6061	0.0028	0.0040	2832
10	#	300.06	29.02	0.9726	149	9	1.0038	0.0018	1.0034	0.0020	1.0043	0.0022	0.6031	0.0011	0.0019	0.6032	0.0011	0.0019	0.6030	0.0012	0.0019	4435
11	#	300.21	29.06	0.9748	149	0	1.0064	0.0008	1.0050	0.0004	1.0058	0.0005	0.6037	0.0010	0.0019	0.6041	0.0009	0.0019	0.6039	0.0010	0.0019	4449
12	#	300.30	29.08	0.9738	149	0	1.0057	0.0007	1.0033	0.0004	1.0040	0.0004	0.6033	0.0010	0.0019	0.6040	0.0009	0.0019	0.6038	0.0009	0.0019	4446
13	$	300.44	30.80	0.6228	150	9	0.4081	0.0002	0.4085	0.0001	0.4072	0.0001	0.6059	0.0024	0.0040	0.6056	0.0024	0.0040	0.6065	0.0024	0.0040	2950
14	$	300.17	30.81	0.6211	149	2	0.4063	0.0002	0.4070	0.0002	0.4056	0.0002	0.6055	0.0024	0.0040	0.6050	0.0024	0.0040	0.6061	0.0024	0.0040	2942
15	$	301.79	30.79	0.6206	150	6	0.4048	0.0003	0.4055	0.0001	0.4043	0.0001	0.6062	0.0024	0.0040	0.6057	0.0024	0.0040	0.6066	0.0024	0.0040	2939
16	$	300.06	30.83	0.9742	149	0	1.0046	0.0010	1.0046	0.0007	1.0035	0.0006	0.6040	0.0010	0.0019	0.6040	0.0010	0.0019	0.6043	0.0010	0.0019	4617
17	$	300.34	30.84	0.9680	149	3	0.9929	0.0004	0.9927	0.0003	0.9915	0.0004	0.6037	0.0010	0.0019	0.6038	0.0010	0.0019	0.6042	0.0010	0.0019	4589
18	$	301.92	30.85	0.9730	150	0	1.0026	0.0008	1.0032	0.0003	1.0021	0.0003	0.6039	0.0010	0.0019	0.6037	0.0010	0.0019	0.6040	0.0010	0.0019	4613
19	$	177.52	30.87	1.6986	200	0	3.0729	0.0007	3.0731	0.0007	3.0717	0.0008	0.6022	0.0004	0.0009	0.6021	0.0003	0.0009	0.6023	0.0004	0.0009	8057
20	$	177.92	30.93	1.6957	200	1	3.0624	0.0004	3.0621	0.0005	3.0608	0.0004	0.6022	0.0003	0.0009	0.6022	0.0003	0.0009	0.6023	0.0003	0.0009	8053
21	$	190.38	30.95	1.6936	193	0	3.0529	0.0006	3.0540	0.0006	3.0532	0.0006	0.6024	0.0003	0.0009	0.6023	0.0003	0.0009	0.6023	0.0003	0.0009	8047
22	$	120.45	31.03	3.0586	169	0	9.990	0.0079	9.991	0.0093	9.991	0.0094	0.6014	0.0003	0.0006	0.6013	0.0003	0.0006	0.6013	0.0003	0.0006	14557
23	$	119.66	31.07	3.0612	168	2	10.007	0.0112	10.005	0.0123	10.003	0.0180	0.6014	0.0004	0.0006	0.6014	0.0004	0.0006	0.6015	0.0006	0.0006	14581
24	$	119.69	31.05	3.0599	161	0	10.005	0.0073	10.006	0.0081	10.007	0.0077	0.6012	0.0003	0.0006	0.6012	0.0003	0.0006	0.6011	0.0003	0.0006	14569

[Test Run Date Codes # - 12/05/85 $ - 12/06/85]

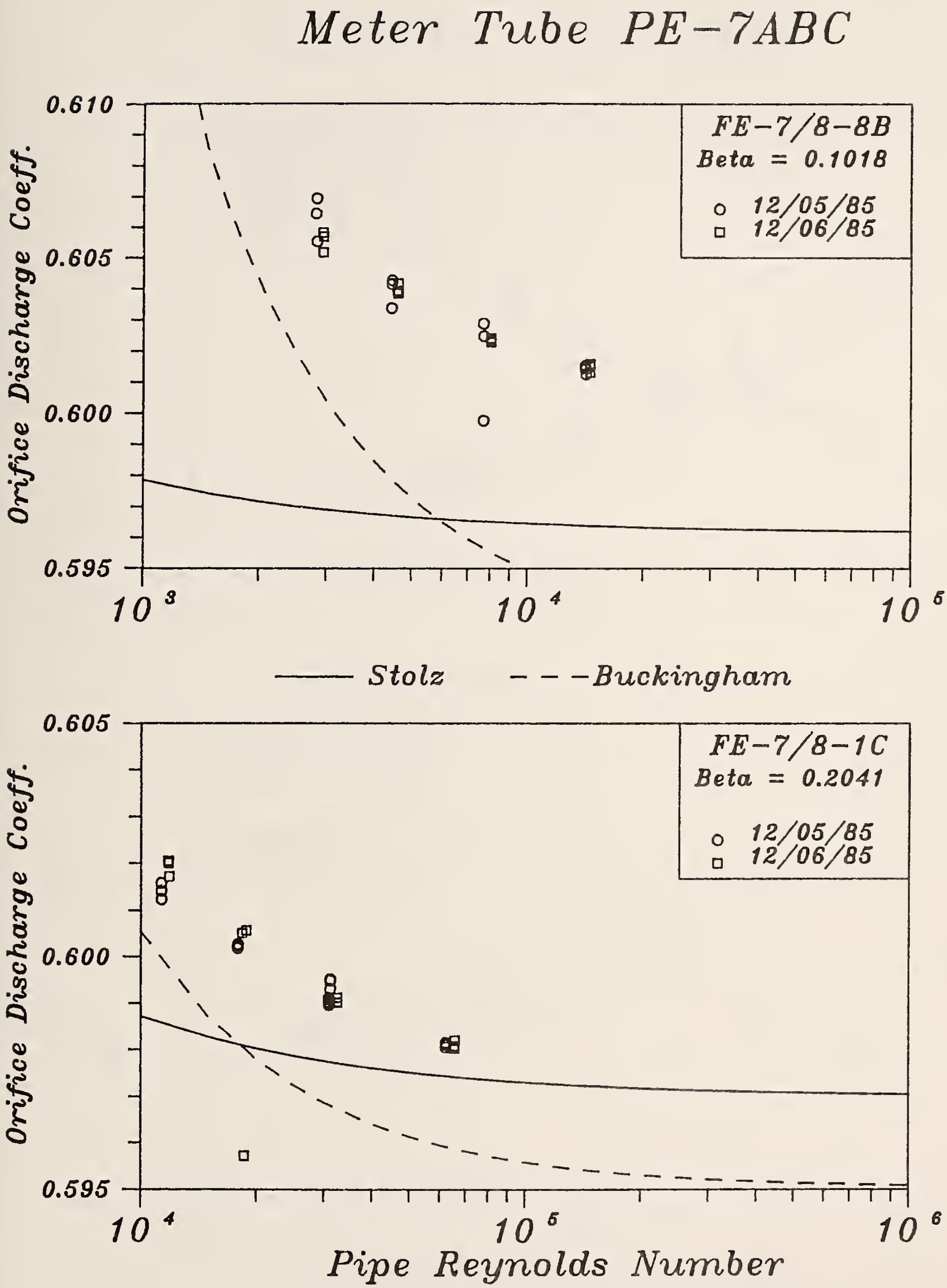


Figure 31A. Discharge Coefficient/Reynolds Number Plots, PE-7ABC 6-Inch Meter Tube, 7 Orifice Plates, Final Data Base

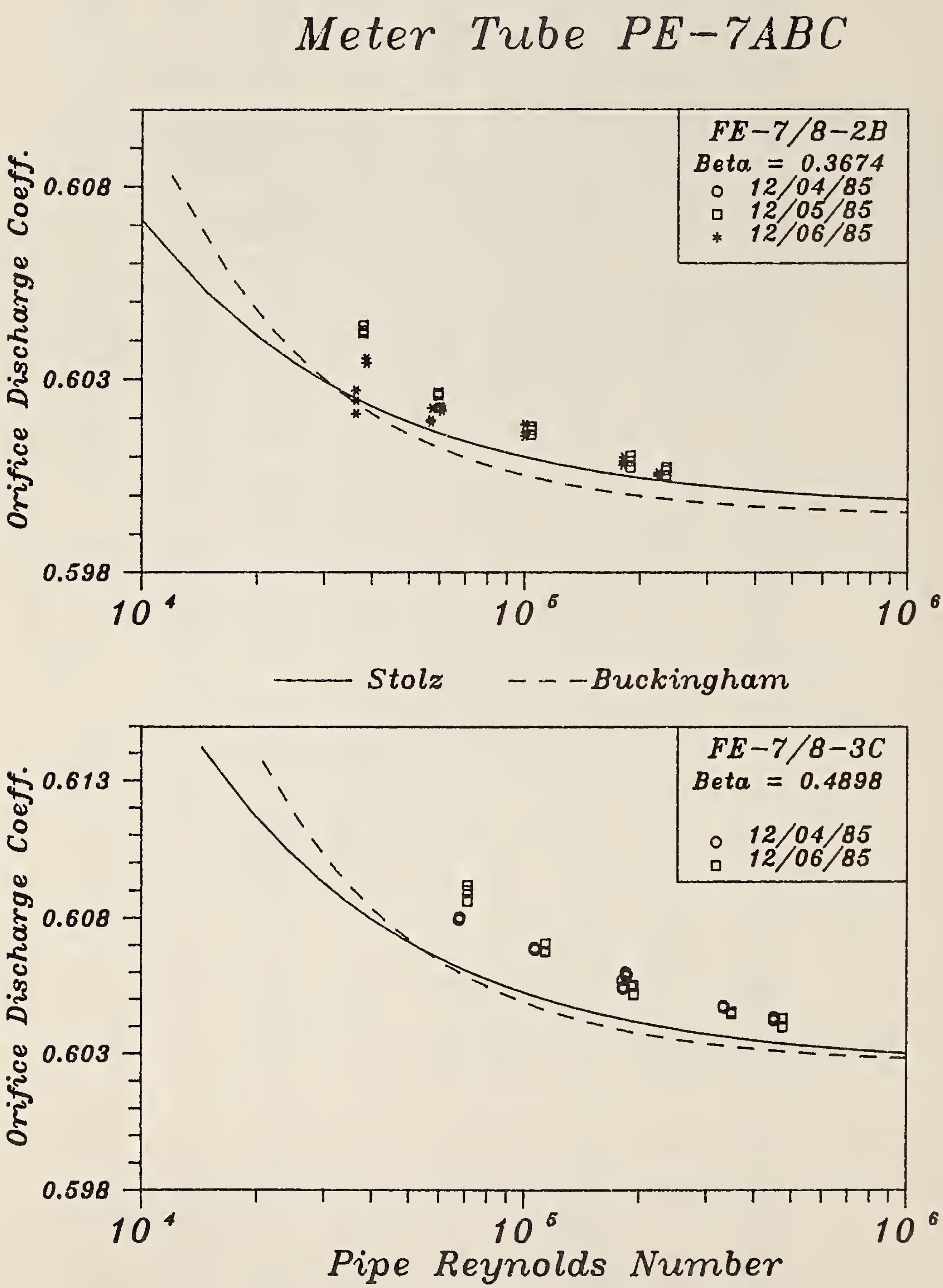


Figure 31B. Discharge Coefficient/Reynolds Number Plots, PE-7ABC 6-Inch Meter Tube, 7 Orifice Plates, Final Data Base

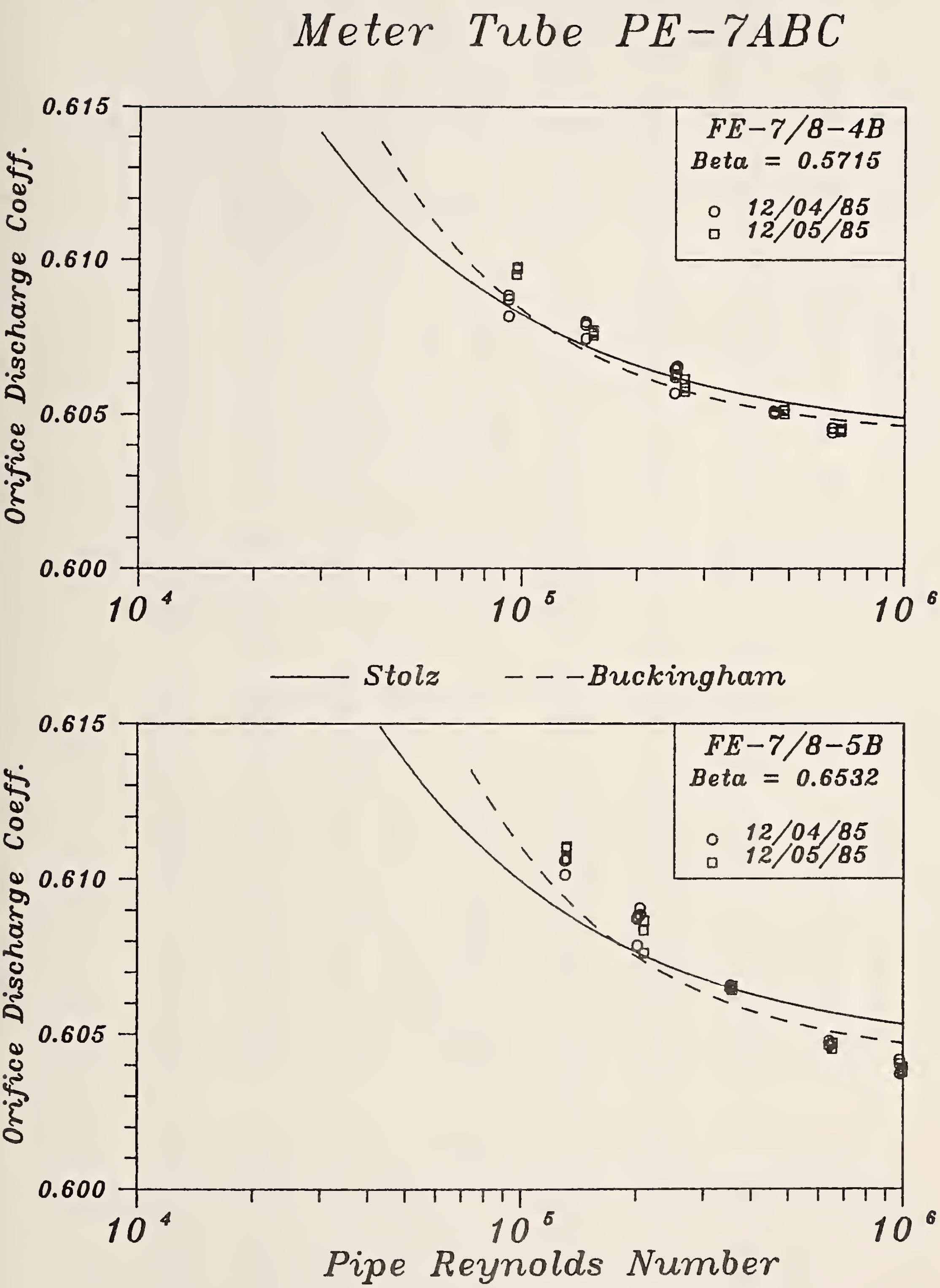


Figure 31C. Discharge Coefficient/Reynolds Number Plots, PE-7ABC 6-Inch Meter Tube, 7 Orifice Plates, Final Data Base

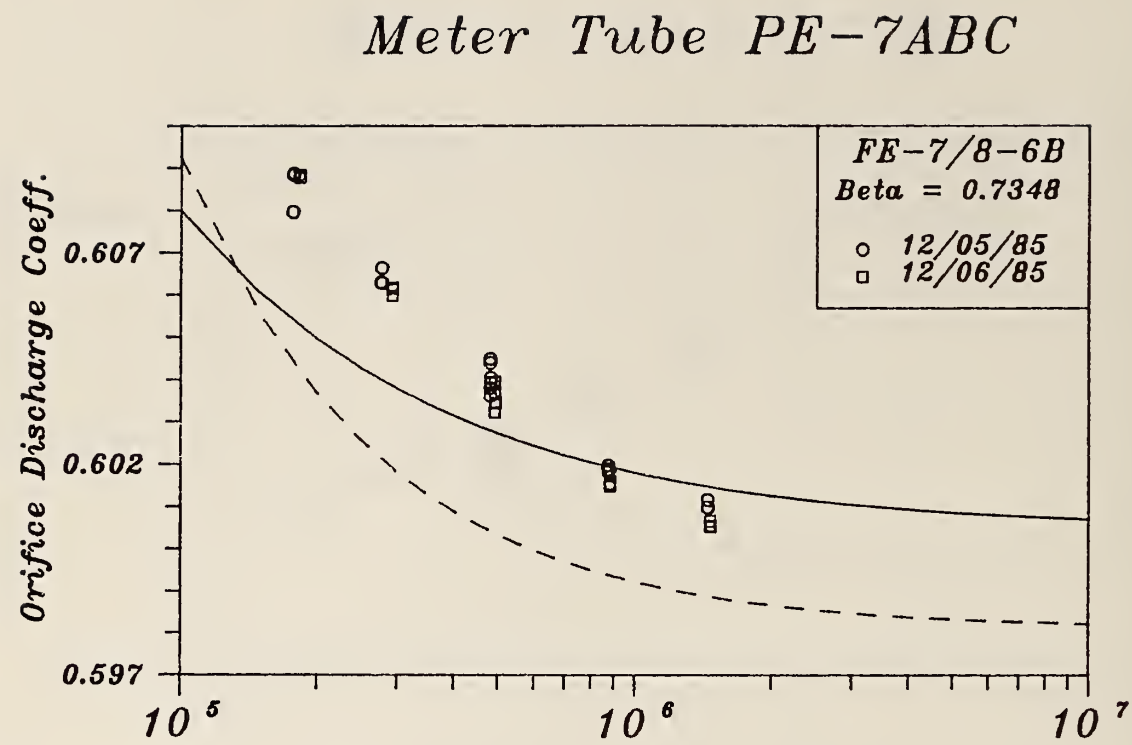


Figure 31D. Discharge Coefficient/Reynolds Number Plots, PE-7ABC 6-Inch Meter Tube, 7 Orifice Plates, Final Data Base

Table 45A. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-2A Diameter 2.2500 Inches, Beta Ratio = 0.36989

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	45.967	35.59	40.224	69	0	10.025	0.0118	10.030	0.0167	10.026	0.0093	0.6007	0.0005	0.0003	0.6006	0.0006	0.0003	0.6007	0.0005	0.0003	211518
2 #	45.984	35.59	40.250	69	0	10.041	0.0050	10.043	0.0081	10.044	0.0084	0.6007	0.0004	0.0003	0.6006	0.0004	0.0003	0.6006	0.0004	0.0003	211659
3 #	45.351	35.60	40.252	68	0	10.045	0.0101	10.044	0.0117	10.042	0.0074	0.6006	0.0005	0.0003	0.6006	0.0005	0.0003	0.6006	0.0004	0.0003	211707
4 #	215.58	35.56	8.0621	178	0	0.4016	0.0002	0.4031	0.0002	0.4011	0.0003	0.6016	0.0028	0.0038	0.6004	0.0030	0.0037	0.6020	0.0029	0.0038	42370
5 #	215.40	35.58	8.0615	178	0	0.4016	0.0002	0.4027	0.0002	0.4008	0.0003	0.6015	0.0028	0.0038	0.6008	0.0030	0.0038	0.6022	0.0029	0.0038	42384
6 #	215.55	35.59	8.0602	178	0	0.4010	0.0003	0.4022	0.0002	0.4005	0.0003	0.6019	0.0028	0.0038	0.6010	0.0030	0.0038	0.6023	0.0029	0.0038	42385
7 #	144.98	35.64	12.798	180	0	1.0117	0.0008	1.0122	0.0009	1.0112	0.0009	0.6017	0.0011	0.0016	0.6016	0.0012	0.0016	0.6018	0.0012	0.0016	67367
8 #	145.51	35.66	12.755	180	0	1.0051	0.0005	1.0053	0.0006	1.0041	0.0006	0.6016	0.0011	0.0016	0.6016	0.0012	0.0016	0.6019	0.0012	0.0016	67168
9 #	145.91	35.67	12.758	181	0	1.0060	0.0005	1.0062	0.0005	1.0047	0.0010	0.6015	0.0011	0.0016	0.6014	0.0012	0.0016	0.6019	0.0012	0.0016	67195
10 #	35.919	35.73	49.932	54	0	15.475	0.0124	15.472	0.0133	15.468	0.0183	0.6002	0.0005	0.0003	0.6003	0.0005	0.0003	0.6004	0.0006	0.0003	263300
11 #	35.254	35.74	49.936	53	0	15.479	0.0129	15.473	0.0178	15.469	0.0168	0.6002	0.0005	0.0003	0.6003	0.0006	0.0003	0.6004	0.0006	0.0003	263375
12 #	35.238	35.75	49.949	53	0	15.480	0.0053	15.479	0.0059	15.478	0.0148	0.6003	0.0005	0.0003	0.6003	0.0005	0.0003	0.6004	0.0005	0.0003	263493
13 #	83.092	35.74	21.991	125	0	2.9945	0.0030	2.9948	0.0035	2.9937	0.0028	0.6010	0.0005	0.0007	0.6009	0.0006	0.0007	0.6010	0.0005	0.0007	115987
14 #	83.189	35.76	21.971	125	0	2.9880	0.0023	2.9886	0.0023	2.9859	0.0028	0.6011	0.0005	0.0007	0.6010	0.0005	0.0007	0.6013	0.0005	0.0007	115928
15 #	83.079	35.77	21.996	125	0	2.9923	0.0026	2.9937	0.0033	2.9927	0.0023	0.6013	0.0005	0.0007	0.6012	0.0006	0.0007	0.6013	0.0005	0.0007	116080
16 $	36.418	32.88	49.540	61	0	15.222	0.0109	15.224	0.0113	15.224	0.0121	0.6002	0.0005	0.0003	0.6002	0.0005	0.0003	0.6002	0.0005	0.0003	246649
17 $	35.684	32.88	49.573	63	0	15.231	0.0240	15.228	0.0300	15.225	0.0243	0.6004	0.0007	0.0003	0.6005	0.0007	0.0003	0.6005	0.0007	0.0003	246815
18 $	35.374	32.90	49.493	62	0	15.189	0.0289	15.180	0.0342	15.189	0.0420	0.6003	0.0007	0.0003	0.6005	0.0008	0.0003	0.6003	0.0009	0.0003	246516
19 $	144.98	32.90	13.014	180	1	1.0459	0.0006	1.0462	0.0008	1.0446	0.0009	0.6015	0.0011	0.0016	0.6014	0.0011	0.0016	0.6019	0.0010	0.0016	64822
20 $	144.95	32.92	12.980	180	0	1.0398	0.0007	1.0396	0.0008	1.0393	0.0009	0.6017	0.0011	0.0016	0.6018	0.0011	0.0016	0.6019	0.0010	0.0016	64680
21 $	144.88	32.94	12.940	180	0	1.0337	0.0007	1.0340	0.0008	1.0330	0.0008	0.6016	0.0011	0.0016	0.6015	0.0011	0.0016	0.6018	0.0010	0.0016	64506
22 $	46.135	33.00	40.040	82	0	9.931	0.0058	9.931	0.0080	9.929	0.0070	0.6006	0.0004	0.0003	0.6006	0.0004	0.0003	0.6007	0.0004	0.0003	199841
23 $	45.711	33.02	39.945	81	0	9.882	0.0145	9.880	0.0152	9.878	0.0152	0.6007	0.0006	0.0003	0.6007	0.0006	0.0003	0.6008	0.0006	0.0003	199449
24 $	45.609	33.03	40.042	81	0	9.934	0.0143	9.934	0.0142	9.932	0.0142	0.6005	0.0006	0.0003	0.6005	0.0006	0.0003	0.6006	0.0006	0.0003	199973
25 $	215.22	33.02	8.0602	178	0	0.4003	0.0002	0.4007	0.0002	0.4007	0.0002	0.6022	0.0029	0.0038	0.6019	0.0027	0.0038	0.6019	0.0025	0.0038	40246
26 $	215.39	33.03	8.0567	178	0	0.4000	0.0002	0.3999	0.0002	0.3995	0.0002	0.6022	0.0029	0.0038	0.6023	0.0027	0.0038	0.6025	0.0025	0.0038	40236
27 $	215.39	33.06	8.0481	178	0	0.3999	0.0002	0.3988	0.0002	0.3987	0.0002	0.6016	0.0029	0.0038	0.6024	0.0027	0.0038	0.6025	0.0025	0.0038	40218
28 $	82.685	33.12	21.995	147	0	2.9947	0.0024	2.9918	0.0022	2.9920	0.0020	0.6008	0.0005	0.0007	0.6011	0.0005	0.0007	0.6011	0.0004	0.0007	110051
29 $	82.624	33.13	22.005	147	0	2.9946	0.0022	2.9913	0.0027	2.9928	0.0023	0.6011	0.0005	0.0007	0.6014	0.0005	0.0007	0.6013	0.0005	0.0007	110120
30 $	83.244	33.14	22.014	148	0.	2.9966	0.0024	2.9949	0.0021	2.9958	0.0025	0.6011	0.0005	0.0007	0.6013	0.0005	0.0007	0.6012	0.0005	0.0007	110187

[Test Run Date Codes # - 08/19/85 $ - 08/29/85]

Table 45B. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-3A Diameter 3.0003 Inches, Beta Ratio = 0.49324

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	80.333	30.83	23.811	143	0	1.0473	0.0016	1.0469	0.0015	1.0448	0.0010	0.6055	0.0012	0.0015	0.6056	0.0012	0.0015	0.6062	0.0012	0.0015	113606
2	#	80.348	30.84	23.773	143	0	1.0430	0.0007	1.0426	0.0007	1.0428	0.0010	0.6058	0.0012	0.0015	0.6059	0.0011	0.0015	0.6058	0.0012	0.0015	113448
3	#	79.254	30.85	23.743	141	0	1.0400	0.0014	1.0396	0.0012	1.0394	0.0008	0.6059	0.0012	0.0016	0.6060	0.0012	0.0016	0.6060	0.0012	0.0016	113326
4	#	112.25	30.87	14.845	200	0	0.4044	0.0004	0.4046	0.0003	0.4053	0.0003	0.6075	0.0029	0.0038	0.6074	0.0028	0.0038	0.6069	0.0030	0.0038	70887
5	#	112.74	30.89	14.865	200	0	0.4058	0.0004	0.4059	0.0004	0.4059	0.0004	0.6072	0.0029	0.0037	0.6072	0.0028	0.0037	0.6072	0.0030	0.0037	71011
6	#	114.70	30.90	14.852	200	0	0.4045	0.0004	0.4047	0.0004	0.4049	0.0003	0.6077	0.0029	0.0038	0.6076	0.0028	0.0038	0.6074	0.0030	0.0038	70966
7	#	45.681	30.95	40.028	81	0	2.9655	0.0046	2.9640	0.0040	2.9685	0.0026	0.6049	0.0007	0.0006	0.6050	0.0007	0.0006	0.6046	0.0006	0.0006	191458
8	#	44.970	30.96	40.073	80	0	2.9717	0.0034	2.9708	0.0030	2.9722	0.0031	0.6050	0.0006	0.0006	0.6050	0.0006	0.0006	0.6049	0.0006	0.0006	191715
9	#	44.975	30.97	40.065	80	0	2.9717	0.0023	2.9711	0.0027	2.9704	0.0026	0.6048	0.0006	0.0006	0.6049	0.0006	0.0006	0.6049	0.0006	0.0006	191715
10	#	156.92	31.01	40.141	195	0	2.9840	0.0012	2.9824	0.0015	2.9838	0.0015	0.6047	0.0004	0.0006	0.6049	0.0004	0.0006	0.6047	0.0004	0.0006	192240
11	#	156.99	31.02	40.315	195	0	3.0097	0.0018	3.0089	0.0020	3.0112	0.0021	0.6048	0.0004	0.0006	0.6048	0.0004	0.0006	0.6046	0.0005	0.0006	193117
12	#	157.01	31.03	40.251	195	0	2.9987	0.0012	2.9974	0.0014	3.0011	0.0017	0.6049	0.0004	0.0006	0.6050	0.0004	0.0006	0.6047	0.0005	0.0006	192851
13	#	64.329	31.06	98.780	115	0	18.149	0.0074	18.148	0.0066	18.146	0.0057	0.6034	0.0002	0.0002	0.6034	0.0002	0.0002	0.6035	0.0002	0.0002	473570
14	#	64.893	31.07	99.069	116	0	18.244	0.0089	18.244	0.0090	18.261	0.0053	0.6036	0.0002	0.0002	0.6036	0.0002	0.0002	0.6033	0.0002	0.0002	475054
15	#	64.939	31.08	99.067	116	0	18.257	0.0054	18.258	0.0050	18.253	0.0059	0.6034	0.0002	0.0002	0.6034	0.0002	0.0002	0.6034	0.0002	0.0002	475147
16	#	87.463	31.10	73.195	156	0	9.959	0.0054	9.959	0.0055	9.960	0.0037	0.6036	0.0002	0.0003	0.6036	0.0002	0.0003	0.6036	0.0002	0.0003	351208
17	#	87.570	31.12	73.182	156	0	9.950	0.0050	9.949	0.0062	9.955	0.0063	0.6038	0.0002	0.0003	0.6038	0.0002	0.0003	0.6036	0.0003	0.0003	351290
18	#	87.579	31.14	73.180	156	0	9.955	0.0034	9.955	0.0042	9.955	0.0045	0.6036	0.0002	0.0003	0.6036	0.0002	0.0003	0.6036	0.0002	0.0003	351428
19	$	87.070	32.05	72.558	155	0	9.793	0.0077	9.793	0.0079	9.798	0.0058	0.6035	0.0003	0.0003	0.6035	0.0003	0.0003	0.6033	0.0002	0.0003	355119
20	$	87.912	32.08	72.725	152	0	9.833	0.0048	9.833	0.0054	9.840	0.0052	0.6036	0.0002	0.0003	0.6036	0.0002	0.0003	0.6034	0.0002	0.0003	356157
21	$	87.941	32.09	72.731	156	0	9.838	0.0040	9.837	0.0041	9.840	0.0042	0.6035	0.0002	0.0003	0.6036	0.0002	0.0003	0.6035	0.0002	0.0003	356262
22	$	64.099	32.13	97.716	115	13	17.703	0.0150	17.704	0.0195	17.699	0.0152	0.6045	0.0003	0.0002	0.6045	0.0004	0.0002	0.6045	0.0003	0.0002	479044
23	$	64.723	32.13	97.876	115	0	17.827	0.0138	17.824	0.0139	17.827	0.0068	0.6033	0.0003	0.0002	0.6034	0.0003	0.0002	0.6034	0.0002	0.0002	479826
24	$	64.927	32.13	97.867	116	0	17.832	0.0117	17.833	0.0124	17.831	0.0109	0.6032	0.0002	0.0002	0.6032	0.0003	0.0002	0.6032	0.0002	0.0002	479784
25	$	156.86	32.13	40.076	195	0	2.9815	0.0014	2.9802	0.0017	2.9813	0.0020	0.6041	0.0004	0.0006	0.6042	0.0004	0.0006	0.6041	0.0004	0.0006	196471
26	$	157.12	32.16	40.198	195	7	2.9990	0.0026	2.9953	0.0031	2.9958	0.0023	0.6042	0.0005	0.0006	0.6045	0.0005	0.0006	0.6045	0.0004	0.0006	197189
27	$	156.87	32.20	40.061	195	0	2.9811	0.0020	2.9777	0.0025	2.9782	0.0027	0.6039	0.0005	0.0006	0.6043	0.0005	0.0006	0.6042	0.0004	0.0006	196679
28	$	116.06	32.22	14.714	200	0	0.4004	0.0005	0.3989	0.0005	0.3987	0.0003	0.6052	0.0029	0.0038	0.6064	0.0027	0.0038	0.6065	0.0025	0.0038	72270
29	$	112.56	32.24	14.684	200	0	0.3971	0.0003	0.3970	0.0003	0.3969	0.0003	0.6065	0.0029	0.0038	0.6066	0.0027	0.0038	0.6066	0.0025	0.0038	72151
30	$	112.69	32.25	14.646	200	0	0.3949	0.0004	0.3947	0.0004	0.3943	0.0004	0.6066	0.0030	0.0038	0.6068	0.0028	0.0038	0.6070	0.0026	0.0038	71978

[Test Run Date Codes # - 08/26/85 $ - 08/29/85]

Table 45B. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-3A Diameter 3.0003 Inches, Beta Ratio = 0.49324

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	79.808	32.30	23.174	140	0	0.9945	0.0012	0.9921	0.0013	0.9910	0.0010	0.6048	0.0012	0.0016	0.6056	0.0012	0.0016	0.6059	0.0011	0.0016	114010
32	#	79.814	32.32	23.118	142	0	0.9888	0.0008	0.9864	0.0010	0.9857	0.0006	0.6051	0.0012	0.0016	0.6058	0.0012	0.0016	0.6061	0.0011	0.0016	113780
33	#	79.745	32.33	23.015	142	0	0.9795	0.0012	0.9777	0.0014	0.9773	0.0012	0.6053	0.0013	0.0016	0.6058	0.0012	0.0016	0.6060	0.0011	0.0016	113296

[Test Run Date Codes # - 08/29/85]

Table 45C. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-4A Diameter 3.4984 Inches, Beta Ratio = 0.57512

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	44.002	29.64	148.12	78	0	20.763	0.0098	20.763	0.0103	20.764	0.0095	0.6053	0.0002	0.0002	0.6053	0.0002	0.0002	0.6053	0.0002	0.0002	689063
2	#	43.700	29.64	148.16	78	0	20.778	0.0114	20.781	0.0118	20.773	0.0070	0.6052	0.0002	0.0002	0.6052	0.0002	0.0002	0.6053	0.0002	0.0002	689245
3	#	43.702	29.64	148.20	78	0	20.785	0.0115	20.787	0.0093	20.789	0.0051	0.6053	0.0002	0.0002	0.6052	0.0002	0.0002	0.6052	0.0002	0.0002	689417
4	#	61.669	29.68	103.17	108	0	10.048	0.0047	10.050	0.0061	10.059	0.0032	0.6060	0.0002	0.0003	0.6060	0.0003	0.0003	0.6057	0.0002	0.0003	480342
5	#	62.146	29.79	103.17	111	0	10.057	0.0068	10.056	0.0075	10.052	0.0039	0.6058	0.0003	0.0003	0.6058	0.0003	0.0003	0.6059	0.0002	0.0003	481487
6	#	61.658	29.80	103.08	110	0	10.039	0.0064	10.039	0.0060	10.038	0.0038	0.6058	0.0003	0.0003	0.6058	0.0003	0.0003	0.6058	0.0002	0.0003	481164
7	#	112.47	29.88	56.898	200	0	3.0466	0.0030	3.0457	0.0029	3.0495	0.0028	0.6070	0.0005	0.0006	0.6071	0.0005	0.0006	0.6067	0.0005	0.0006	266052
8	#	112.56	29.80	56.931	200	1	3.0524	0.0020	3.0512	0.0019	3.0542	0.0019	0.6068	0.0004	0.0006	0.6069	0.0004	0.0006	0.6066	0.0005	0.0006	265749
9	#	112.32	29.92	56.940	200	0	3.0531	0.0029	3.0512	0.0029	3.0538	0.0026	0.6068	0.0005	0.0006	0.6070	0.0005	0.0006	0.6067	0.0005	0.0006	266472
10	#	31.461	29.97	56.431	56	0	2.9979	0.0039	2.9958	0.0038	2.9940	0.0032	0.6069	0.0008	0.0006	0.6071	0.0007	0.0006	0.6073	0.0007	0.0006	264371
11	#	31.441	29.98	56.395	56	0	2.9947	0.0024	2.9931	0.0024	2.9948	0.0017	0.6068	0.0007	0.0006	0.6070	0.0007	0.0006	0.6068	0.0007	0.0006	264258
12	#	32.072	29.99	56.374	57	0	2.9916	0.0030	2.9916	0.0027	2.9950	0.0065	0.6069	0.0007	0.0006	0.6069	0.0007	0.0006	0.6066	0.0009	0.0006	264218
13	#	56.631	30.03	32.628	101	0	0.9961	0.0016	0.9957	0.0016	0.9962	0.0012	0.6087	0.0013	0.0016	0.6089	0.0013	0.0016	0.6087	0.0013	0.0016	153056
14	#	55.527	30.05	32.469	99	1	0.9863	0.0017	0.9847	0.0015	0.9855	0.0017	0.6088	0.0013	0.0016	0.6093	0.0013	0.0016	0.6090	0.0014	0.0016	152375
15	#	56.466	30.06	32.781	97	0	1.0071	0.0011	1.0065	0.0012	1.0073	0.0010	0.6082	0.0013	0.0016	0.6084	0.0012	0.0016	0.6082	0.0013	0.0016	153869
16	#	85.700	30.10	20.632	153	0	0.3964	0.0006	0.3957	0.0007	0.3967	0.0005	0.6102	0.0030	0.0038	0.6107	0.0029	0.0039	0.6099	0.0031	0.0038	96925
17	#	86.325	30.13	20.761	147	0	0.4010	0.0008	0.4007	0.0008	0.4018	0.0006	0.6105	0.0030	0.0038	0.6107	0.0029	0.0038	0.6099	0.0031	0.0038	97592
18	#	85.609	30.15	20.650	151	0	0.3979	0.0008	0.3968	0.0007	0.3971	0.0010	0.6096	0.0030	0.0038	0.6104	0.0029	0.0038	0.6102	0.0032	0.0038	97114
19	$	32.080	33.20	56.500	57	0	3.0099	0.0053	3.0094	0.0070	3.0116	0.0041	0.6067	0.0008	0.0006	0.6067	0.0009	0.0006	0.6065	0.0007	0.0006	283151
20	$	31.524	33.21	56.496	56	0	3.0139	0.0035	3.0118	0.0033	3.0111	0.0030	0.6062	0.0007	0.0006	0.6064	0.0007	0.0006	0.6065	0.0007	0.0006	283191
21	$	31.563	33.22	56.486	56	0	3.0112	0.0033	3.0108	0.0033	3.0088	0.0020	0.6064	0.0007	0.0006	0.6064	0.0007	0.0006	0.6066	0.0006	0.0006	283196
22	$	85.778	33.22	20.634	153	1	0.3975	0.0006	0.3986	0.0005	0.3981	0.0003	0.6097	0.0030	0.0038	0.6088	0.0028	0.0038	0.6092	0.0025	0.0038	103448
23	$	85.801	33.23	20.662	153	0	0.3984	0.0004	0.3997	0.0004	0.3993	0.0006	0.6098	0.0030	0.0038	0.6088	0.0027	0.0038	0.6091	0.0026	0.0038	103611
24	$	86.293	33.24	20.757	154	0	0.4032	0.0005	0.4032	0.0005	0.4026	0.0004	0.6090	0.0029	0.0038	0.6089	0.0027	0.0038	0.6094	0.0025	0.0038	104111
25	$	56.230	33.28	33.037	100	0	1.0247	0.0014	1.0248	0.0012	1.0245	0.0019	0.6080	0.0012	0.0016	0.6079	0.0012	0.0016	0.6080	0.0012	0.0016	165836
26	$	55.703	33.29	33.037	99	0	1.0240	0.0008	1.0239	0.0010	1.0249	0.0014	0.6082	0.0012	0.0016	0.6082	0.0011	0.0016	0.6079	0.0011	0.0016	165869
27	$	55.639	33.30	33.047	99	0	1.0247	0.0012	1.0246	0.0016	1.0254	0.0009	0.6082	0.0012	0.0016	0.6082	0.0012	0.0016	0.6079	0.0011	0.0016	165954
28	$	42.872	33.33	147.22	77	0	20.564	0.0091	20.567	0.0106	20.552	0.0098	0.6048	0.0002	0.0002	0.6047	0.0002	0.0002	0.6049	0.0002	0.0002	739739
29	$	43.152	33.33	146.95	77	0	20.496	0.0056	20.497	0.0046	20.490	0.0110	0.6046	0.0002	0.0002	0.6046	0.0002	0.0002	0.6047	0.0002	0.0002	738384
30	$	43.705	33.33	146.95	78	0	20.488	0.0068	20.491	0.0063	20.493	0.0040	0.6048	0.0002	0.0002	0.6047	0.0002	0.0002	0.6047	0.0002	0.0002	738405

[Test Run Date Codes # - 08/26/85 $ - 08/29/85]

Table 45C. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-4A Diameter 3.4984 Inches, Beta Ratio = 0.57512

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	60.842	33.32	102.90	109	0	10.028	0.0063	10.029	0.0062	10.029	0.0067	0.6053	0.0003	0.0003	0.6053	0.0003	0.0003	0.6053	0.0003	0.0003	516941
32	#	61.623	33.32	103.06	110	0	10.057	0.0062	10.058	0.0061	10.059	0.0032	0.6054	0.0003	0.0003	0.6053	0.0003	0.0003	0.6053	0.0002	0.0003	517733
33	#	61.537	33.33	103.10	110	0	10.061	0.0031	10.061	0.0032	10.067	0.0043	0.6055	0.0002	0.0003	0.6055	0.0002	0.0003	0.6053	0.0002	0.0003	518047
34	#	85.644	33.33	20.708	153	1	0.4001	0.0004	0.4016	0.0004	0.4017	0.0005	0.6098	0.0029	0.0038	0.6087	0.0027	0.0038	0.6086	0.0025	0.0038	104054
35	#	85.720	33.34	20.748	153	0	0.4023	0.0004	0.4034	0.0005	0.4031	0.0004	0.6093	0.0029	0.0038	0.6085	0.0027	0.0038	0.6087	0.0025	0.0038	104277
36	#	85.650	33.36	20.757	145	0	0.4025	0.0003	0.4036	0.0004	0.4034	0.0004	0.6095	0.0029	0.0038	0.6087	0.0027	0.0038	0.6088	0.0025	0.0038	104363
37	$	56.244	33.76	32.528	75	0	0.9931	0.0009	0.9925	0.0011	0.9942	0.0009	0.6081	0.0012	0.0016	0.6083	0.0011	0.0016	0.6078	0.0010	0.0016	164886
38	$	56.167	33.78	32.500	75	0	0.9929	0.0009	0.9921	0.0012	0.9924	0.0011	0.6076	0.0012	0.0016	0.6079	0.0011	0.0016	0.6078	0.0010	0.0016	164809
39	$	55.573	33.80	32.433	74	0	0.9885	0.0005	0.9880	0.0005	0.9879	0.0009	0.6077	0.0011	0.0016	0.6079	0.0010	0.0016	0.6079	0.0010	0.0016	164535
40	$	32.367	33.86	56.477	43	0	3.0078	0.0035	3.0060	0.0041	3.0117	0.0042	0.6067	0.0007	0.0006	0.6069	0.0007	0.0006	0.6063	0.0007	0.0006	286864
41	$	32.333	33.88	56.596	43	0	3.0216	0.0029	3.0206	0.0042	3.0207	0.0044	0.6066	0.0007	0.0006	0.6067	0.0007	0.0006	0.6067	0.0007	0.0006	287583
42	$	31.329	33.89	56.445	42	0	3.0078	0.0041	3.0065	0.0037	3.0077	0.0030	0.6063	0.0008	0.0006	0.6065	0.0007	0.0006	0.6063	0.0007	0.0006	286874
43	$	86.030	33.90	20.662	116	0	0.4002	0.0004	0.3997	0.0004	0.3995	0.0004	0.6085	0.0027	0.0038	0.6088	0.0024	0.0038	0.6090	0.0023	0.0038	105033
44	$	86.660	33.93	20.688	117	0	0.4004	0.0003	0.4000	0.0003	0.4007	0.0005	0.6091	0.0027	0.0038	0.6094	0.0024	0.0038	0.6088	0.0023	0.0038	105231
45	$	85.180	33.95	20.651	115	0	0.3994	0.0003	0.3990	0.0003	0.3989	0.0004	0.6088	0.0027	0.0038	0.6091	0.0024	0.0038	0.6092	0.0024	0.0038	105086
46	$	62.311	34.03	102.94	84	0	10.027	0.0068	10.028	0.0064	10.039	0.0059	0.6057	0.0003	0.0003	0.6056	0.0003	0.0003	0.6053	0.0002	0.0003	524678
47	$	61.647	34.04	102.73	83	0	9.994	0.0089	9.995	0.0088	10.000	0.0109	0.6054	0.0003	0.0003	0.6054	0.0003	0.0003	0.6052	0.0004	0.0003	523710
48	$	61.652	34.06	102.84	83	0	10.014	0.0088	10.015	0.0086	10.021	0.0091	0.6055	0.0003	0.0003	0.6054	0.0003	0.0003	0.6053	0.0003	0.0003	524497
49	$	43.592	34.10	147.56	59	0	20.646	0.0146	20.648	0.0148	20.656	0.0124	0.6050	0.0003	0.0002	0.6050	0.0003	0.0002	0.6049	0.0002	0.0002	753148
50	$	43.840	34.11	148.26	59	0	20.843	0.0092	20.844	0.0102	20.858	0.0150	0.6050	0.0002	0.0002	0.6050	0.0002	0.0002	0.6048	0.0003	0.0002	756898
51	$	43.813	34.12	147.46	59	0	20.628	0.0077	20.630	0.0102	20.616	0.0099	0.6049	0.0002	0.0002	0.6048	0.0002	0.0002	0.6050	0.0002	0.0002	752929

[Test Run Date Codes # - 08/29/85 $ - 08/30/85]

Table 45D. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-5C Diameter 3.9994 Inches, Beta Ratio = 0.65748

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	166.22	31.70	215.30	200	2	23.533	0.0174	23.533	0.0194	23.580	0.0186	0.6043	0.0003	0.0003	0.6043	0.0003	0.0003	0.6037	0.0003	0.0003	1046085
2	#	188.47	31.71	216.20	200	0	23.734	0.0102	23.732	0.0120	23.770	0.0157	0.6043	0.0002	0.0003	0.6043	0.0002	0.0003	0.6038	0.0002	0.0003	1050687
3	#	184.24	31.73	216.32	200	0	23.767	0.0145	23.768	0.0161	23.795	0.0109	0.6042	0.0002	0.0003	0.6042	0.0002	0.0003	0.6038	0.0002	0.0003	1051695
4	#	301.66	31.76	140.32	150	0	9.980	0.0035	9.980	0.0037	9.999	0.0051	0.6048	0.0002	0.0003	0.6048	0.0002	0.0003	0.6042	0.0002	0.0003	682628
5	#	300.78	31.82	140.29	150	0	9.985	0.0044	9.985	0.0045	9.987	0.0059	0.6046	0.0002	0.0003	0.6046	0.0002	0.0003	0.6045	0.0002	0.0003	683364
6	#	300.08	31.95	140.20	149	0	9.965	0.0050	9.963	0.0055	9.971	0.0041	0.6048	0.0002	0.0004	0.6048	0.0002	0.0004	0.6046	0.0002	0.0003	684760
7	#	44.846	31.98	140.82	80	0	10.046	0.0093	10.046	0.0084	10.053	0.0100	0.6050	0.0003	0.0003	0.6050	0.0003	0.0003	0.6048	0.0004	0.0003	688224
8	#	44.248	32.00	140.43	79	0	9.986	0.0116	9.986	0.0103	9.998	0.0097	0.6051	0.0004	0.0003	0.6052	0.0004	0.0003	0.6048	0.0004	0.0003	686609
9	#	44.794	32.02	140.50	80	0	9.995	0.0134	9.994	0.0145	10.006	0.0072	0.6052	0.0005	0.0003	0.6052	0.0005	0.0003	0.6048	0.0003	0.0003	687212
10	#	84.865	32.04	77.259	147	0	3.0087	0.0021	3.0088	0.0028	3.0147	0.0028	0.6065	0.0005	0.0006	0.6065	0.0005	0.0006	0.6059	0.0005	0.0006	378051
11	#	84.729	32.08	76.994	151	1	2.9856	0.0021	2.9849	0.0019	2.9881	0.0025	0.6068	0.0005	0.0006	0.6069	0.0004	0.0006	0.6065	0.0005	0.0006	377063
12	#	84.598	32.11	76.775	144	0	2.9701	0.0025	2.9690	0.0026	2.9720	0.0030	0.6066	0.0005	0.0006	0.6068	0.0005	0.0006	0.6065	0.0005	0.0006	376227
13	#	145.53	32.15	45.339	181	1	1.0305	0.0007	1.0312	0.0008	1.0316	0.0008	0.6082	0.0012	0.0016	0.6080	0.0011	0.0016	0.6079	0.0012	0.0016	222361
14	#	144.80	32.20	45.272	180	1	1.0277	0.0005	1.0281	0.0006	1.0290	0.0010	0.6081	0.0012	0.0016	0.6080	0.0011	0.0016	0.6078	0.0012	0.0016	222265
15	#	144.91	32.23	45.291	180	0	1.0285	0.0009	1.0288	0.0011	1.0292	0.0008	0.6082	0.0012	0.0016	0.6081	0.0011	0.0016	0.6080	0.0012	0.0016	222496
16	#	39.319	32.30	45.425	70	0	1.0348	0.0010	1.0354	0.0011	1.0355	0.0017	0.6081	0.0012	0.0016	0.6079	0.0012	0.0016	0.6079	0.0014	0.0016	223476
17	#	39.869	32.32	45.344	71	0	1.0321	0.0021	1.0328	0.0018	1.0323	0.0021	0.6078	0.0014	0.0016	0.6076	0.0013	0.0016	0.6077	0.0014	0.0016	223168
18	#	40.472	32.34	45.276	72	0	1.0286	0.0017	1.0290	0.0013	1.0293	0.0023	0.6079	0.0013	0.0016	0.6078	0.0012	0.0016	0.6077	0.0014	0.0016	222930
19	#	65.034	32.38	28.390	112	0	0.4023	0.0007	0.4030	0.0006	0.4037	0.0006	0.6096	0.0030	0.0038	0.6090	0.0028	0.0038	0.6085	0.0031	0.0038	139901
20	#	64.942	32.40	28.416	116	0	0.4030	0.0007	0.4038	0.0007	0.4047	0.0005	0.6095	0.0030	0.0038	0.6090	0.0028	0.0038	0.6083	0.0031	0.0038	140087
21	#	65.411	32.42	28.395	117	0	0.4031	0.0005	0.4038	0.0004	0.4035	0.0007	0.6090	0.0029	0.0038	0.6085	0.0028	0.0038	0.6088	0.0031	0.0038	140040
22	$	65.575	32.41	28.218	117	0	0.3985	0.0006	0.3982	0.0005	0.3972	0.0007	0.6087	0.0030	0.0038	0.6090	0.0028	0.0038	0.6098	0.0026	0.0038	139139
23	$	65.657	32.44	28.196	117	1	0.3979	0.0005	0.3973	0.0004	0.3966	0.0006	0.6087	0.0030	0.0038	0.6092	0.0028	0.0038	0.6097	0.0026	0.0038	139117
24	$	65.583	32.48	28.202	117	0	0.3978	0.0005	0.3975	0.0005	0.3966	0.0005	0.6089	0.0030	0.0038	0.6091	0.0028	0.0038	0.6098	0.0026	0.0038	139262
25	$	39.949	32.52	45.035	71	0	1.0179	0.0015	1.0171	0.0014	1.0182	0.0008	0.6079	0.0013	0.0016	0.6081	0.0012	0.0016	0.6078	0.0011	0.0016	222565
26	$	39.496	32.53	44.960	67	0	1.0150	0.0015	1.0147	0.0017	1.0144	0.0013	0.6077	0.0013	0.0016	0.6078	0.0013	0.0016	0.6079	0.0011	0.0016	222243
27	$	39.917	32.54	44.914	71	0	1.0120	0.0028	1.0110	0.0019	1.0125	0.0029	0.6080	0.0015	0.0016	0.6083	0.0013	0.0016	0.6079	0.0014	0.0016	222061
28	$	44.261	32.60	140.54	78	0	10.018	0.0086	10.020	0.0093	10.015	0.0072	0.6047	0.0003	0.0003	0.6046	0.0003	0.0003	0.6048	0.0003	0.0003	695728
29	$	44.843	32.61	140.47	80	0	10.011	0.0076	10.011	0.0079	10.012	0.0085	0.6046	0.0003	0.0003	0.6046	0.0003	0.0003	0.6046	0.0003	0.0003	695495
30	$	44.689	32.62	140.24	80	0	9.967	0.0073	9.968	0.0077	9.978	0.0083	0.6049	0.0003	0.0003	0.6049	0.0003	0.0003	0.6046	0.0003	0.0003	694495

[Test Run Date Codes # - 08/26/85 $ - 08/29/85]

Table 45D. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-5C Diameter 3.9994 Inches, Beta Ratio = 0.65748

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	84.128	32.65	77.570	150	0	3.0391	0.0022	3.0385	0.0022	3.0361	0.0024	0.6060	0.0005	0.0006	0.6060	0.0004	0.0006	0.6063	0.0004	0.0006	384382
32	#	84.597	32.69	77.289	151	0	3.0161	0.0027	3.0158	0.0027	3.0117	0.0028	0.6061	0.0005	0.0006	0.6061	0.0005	0.0006	0.6065	0.0005	0.0006	383308
33	#	84.531	32.72	77.196	148	0	3.0079	0.0027	3.0065	0.0030	3.0065	0.0032	0.6062	0.0005	0.0006	0.6063	0.0005	0.0006	0.6063	0.0005	0.0006	383085
34	#	189.56	32.82	214.96	200	0	23.509	0.0136	23.505	0.0171	23.515	0.0191	0.6038	0.0002	0.0003	0.6038	0.0003	0.0003	0.6037	0.0003	0.0003	1068911
35	#	178.05	32.82	214.76	200	0	23.455	0.0141	23.456	0.0139	23.471	0.0236	0.6039	0.0002	0.0003	0.6039	0.0002	0.0003	0.6037	0.0003	0.0003	1067943
36	#	183.56	32.81	214.77	200	0	23.463	0.0178	23.454	0.0188	23.472	0.0149	0.6038	0.0003	0.0003	0.6039	0.0003	0.0003	0.6037	0.0002	0.0003	1067744

[Test Run Date Codes # - 08/29/85]

Table 45E. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-6A Diameter 4.4992 Inches, Beta Ratio = 0.73965

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	59.233	37.81	105.41	90	0	0.0000	0.0000	3.0589	0.0030	3.0608	0.0035	0.0000	0.0000	0.0000	0.6025	0.0005	0.0006	0.6023	0.0005	0.0006	578921
2	#	59.547	37.81	105.38	90	0	0.0000	0.0000	3.0552	0.0017	3.0586	0.0021	0.0000	0.0000	0.0000	0.6027	0.0005	0.0006	0.6023	0.0004	0.0006	578742
3	#	59.697	37.81	105.24	90	0	0.0000	0.0000	3.0439	0.0028	3.0488	0.0039	0.0000	0.0000	0.0000	0.6030	0.0005	0.0006	0.6025	0.0005	0.0006	577974
4	#	159.67	37.83	38.731	198	0	0.0000	0.0000	0.4060	0.0009	0.4076	0.0007	0.0000	0.0000	0.0000	0.6076	0.0031	0.0038	0.6064	0.0027	0.0038	212796
5	#	159.49	37.85	39.004	198	0	0.0000	0.0000	0.4124	0.0005	0.4139	0.0006	0.0000	0.0000	0.0000	0.6072	0.0030	0.0037	0.6060	0.0026	0.0037	214376
6	#	159.62	37.87	39.010	198	0	0.0000	0.0000	0.4122	0.0003	0.4140	0.0005	0.0000	0.0000	0.0000	0.6074	0.0030	0.0037	0.6061	0.0026	0.0037	214492
7	#	99.022	37.90	61.217	149	0	0.0000	0.0000	1.0227	0.0011	1.0269	0.0009	0.0000	0.0000	0.0000	0.6051	0.0012	0.0016	0.6039	0.0011	0.0016	336792
8	#	99.64	37.91	61.103	150	0	0.0000	0.0000	1.0196	0.0012	1.0221	0.0017	0.0000	0.0000	0.0000	0.6049	0.0013	0.0016	0.6042	0.0012	0.0016	336227
9	#	99.71	37.92	61.104	150	0	0.0000	0.0000	1.0199	0.0015	1.0219	0.0012	0.0000	0.0000	0.0000	0.6048	0.0013	0.0016	0.6042	0.0011	0.0016	336296
10	#	390.95	38.03	104.96	156	0	0.0000	0.0000	3.0324	0.0020	3.0370	0.0017	0.0000	0.0000	0.0000	0.6025	0.0005	0.0007	0.6021	0.0004	0.0007	578869
11	#	391.18	38.02	104.78	154	0	0.0000	0.0000	3.0221	0.0019	3.0284	0.0019	0.0000	0.0000	0.0000	0.6026	0.0005	0.0007	0.6019	0.0004	0.0007	577803
12	#	391.53	38.01	104.66	150	0	0.0000	0.0000	3.0130	0.0018	3.0187	0.0017	0.0000	0.0000	0.0000	0.6028	0.0005	0.0007	0.6022	0.0004	0.0007	577028
13	#	119.58	38.05	316.22	177	0	0.0000	0.0000	27.751	0.0129	27.761	0.0080	0.0000	0.0000	0.0000	0.6001	0.0002	0.0003	0.6000	0.0002	0.0003	1744720
14	#	120.12	38.05	316.63	177	0	0.0000	0.0000	27.809	0.0170	27.838	0.0110	0.0000	0.0000	0.0000	0.6002	0.0002	0.0003	0.5999	0.0002	0.0003	1747017
15	#	119.83	38.07	316.92	179	0	0.0000	0.0000	27.842	0.0103	27.891	0.0092	0.0000	0.0000	0.0000	0.6004	0.0002	0.0003	0.5999	0.0002	0.0003	1749252
16	#	199.70	38.12	190.25	165	0	0.0000	0.0000	10.031	0.0031	10.041	0.0055	0.0000	0.0000	0.0000	0.6005	0.0002	0.0004	0.6002	0.0002	0.0004	1051138
17	#	199.65	38.18	190.24	165	0	0.0000	0.0000	10.027	0.0072	10.039	0.0063	0.0000	0.0000	0.0000	0.6006	0.0003	0.0004	0.6002	0.0003	0.0004	1052296
18	#	199.63	38.22	190.23	165	0	0.0000	0.0000	10.025	0.0038	10.035	0.0054	0.0000	0.0000	0.0000	0.6007	0.0002	0.0004	0.6003	0.0002	0.0004	1053042
19	$	99.126	35.84	61.083	149	0	1.0160	0.0009	1.0155	0.0011	1.0219	0.0010	0.6056	0.0011	0.0016	0.6058	0.0013	0.0016	0.6039	0.0012	0.0016	322803
20	$	100.10	35.87	61.065	150	0	1.0173	0.0009	1.0174	0.0012	1.0200	0.0011	0.6050	0.0011	0.0016	0.6050	0.0013	0.0016	0.6042	0.0012	0.0016	322900
21	$	99.58	35.89	60.894	150	0	1.0103	0.0011	1.0094	0.0011	1.0151	0.0008	0.6055	0.0012	0.0016	0.6057	0.0013	0.0016	0.6040	0.0012	0.0016	322120
22	$	60.176	35.94	104.41	91	0	2.9964	0.0030	2.9934	0.0029	2.9998	0.0020	0.6028	0.0005	0.0006	0.6031	0.0005	0.0006	0.6025	0.0005	0.0006	552869
23	$	60.270	35.96	104.25	91	1	2.9817	0.0033	2.9782	0.0042	2.9968	0.0035	0.6034	0.0005	0.0006	0.6037	0.0006	0.0006	0.6019	0.0006	0.0006	552250
24	$	59.796	35.97	104.17	90	0	2.9758	0.0030	2.9728	0.0046	2.9926	0.0038	0.6035	0.0005	0.0006	0.6038	0.0006	0.0006	0.6018	0.0006	0.0006	551917
25	$	160.47	36.02	38.578	199	0	0.4057	0.0004	0.4038	0.0005	0.4041	0.0003	0.6053	0.0028	0.0037	0.6067	0.0030	0.0038	0.6065	0.0029	0.0037	204597
26	$	159.49	36.05	38.466	198	1	0.4023	0.0004	0.4006	0.0005	0.4019	0.0005	0.6061	0.0028	0.0038	0.6074	0.0031	0.0038	0.6064	0.0030	0.0038	204126
27	$	159.80	36.09	38.420	198	0	0.4016	0.0003	0.4002	0.0004	0.4009	0.0005	0.6059	0.0028	0.0038	0.6069	0.0031	0.0038	0.6064	0.0030	0.0038	204043
28	$	114.55	36.19	311.88	169	0	26.949	0.0089	26.953	0.0086	26.998	0.0130	0.6004	0.0002	0.0003	0.6004	0.0002	0.0003	0.5999	0.0002	0.0003	1659627
29	$	114.79	36.20	311.69	172	0	26.931	0.0092	26.926	0.0090	26.964	0.0139	0.6003	0.0002	0.0003	0.6003	0.0002	0.0003	0.5999	0.0002	0.0003	1658912
30	$	115.37	36.22	311.66	173	0	26.936	0.0083	26.928	0.0093	26.970	0.0102	0.6002	0.0002	0.0003	0.6002	0.0002	0.0003	0.5998	0.0002	0.0003	1659429

[Test Run Date Codes # - 08/16/85 $ - 08/19/85]

Table 45E. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-6A Diameter 4.4992 Inches, Beta Ratio = 0.73965

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	196.06	36.28	190.32	162	0	10.017	0.0051	10.020	0.0045	10.043	0.0054	0.6010	0.0002	0.0004	0.6009	0.0002	0.0004	0.6002	0.0002	0.0004	1014557
32	#	195.73	36.33	189.57	162	0	9.932	0.0065	9.937	0.0079	9.958	0.0062	0.6012	0.0003	0.0004	0.6010	0.0003	0.0004	0.6004	0.0003	0.0004	1011520
33	#	195.86	36.38	189.59	162	0	9.935	0.0045	9.935	0.0050	9.964	0.0059	0.6012	0.0002	0.0004	0.6012	0.0002	0.0004	0.6003	0.0002	0.0004	1012653

[Test Run Date Codes # - 08/19/85]

Table 45F. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-7A Diameter 0.6251 Inches, Beta Ratio = 0.10276

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	301.68	22.20	0.6212	150	1	0.0000	0.0000	0.4040	0.0002	0.4046	0.0002	0.0000	0.0000	0.0000	0.6035	0.0030	0.0040	0.6031	0.0025	0.0040	2444
32	#	300.68	22.19	0.6210	149	2	0.0000	0.0000	0.4036	0.0001	0.4042	0.0001	0.0000	0.0000	0.0000	0.6037	0.0030	0.0040	0.6032	0.0025	0.0040	2442
33	#	299.99	22.19	0.6210	150	5	0.0000	0.0000	0.4033	0.0001	0.4040	0.0001	0.0000	0.0000	0.0000	0.6039	0.0030	0.0040	0.6033	0.0025	0.0040	2442
34	#	300.46	22.21	0.9811	149	0	0.0000	0.0000	1.0155	0.0003	1.0162	0.0004	0.0000	0.0000	0.0000	0.6012	0.0012	0.0019	0.6010	0.0010	0.0019	3860
35	#	300.36	22.20	0.9810	149	0	0.0000	0.0000	1.0156	0.0004	1.0164	0.0004	0.0000	0.0000	0.0000	0.6011	0.0012	0.0019	0.6009	0.0010	0.0019	3859
36	#	300.77	22.19	0.9813	149	0	0.0000	0.0000	1.0161	0.0004	1.0167	0.0004	0.0000	0.0000	0.0000	0.6012	0.0012	0.0019	0.6010	0.0010	0.0019	3859
37	#	175.97	22.21	1.6896	162	0	0.0000	0.0000	3.0300	0.0017	3.0320	0.0016	0.0000	0.0000	0.0000	0.5994	0.0005	0.0009	0.5992	0.0004	0.0009	6648
38	#	174.90	22.23	1.6885	161	0	0.0000	0.0000	3.0252	0.0018	3.0266	0.0018	0.0000	0.0000	0.0000	0.5995	0.0005	0.0009	0.5993	0.0004	0.0009	6647
39	#	174.89	22.24	1.6884	161	0	0.0000	0.0000	3.0253	0.0019	3.0270	0.0022	0.0000	0.0000	0.0000	0.5994	0.0005	0.0009	0.5993	0.0004	0.0009	6648
40	#	111.39	22.28	3.0635	103	0	0.0000	0.0000	10.000	0.0029	10.001	0.0027	0.0000	0.0000	0.0000	0.5982	0.0002	0.0006	0.5982	0.0002	0.0006	12074
41	#	112.57	22.28	3.0701	104	0	0.0000	0.0000	10.047	0.0022	10.049	0.0020	0.0000	0.0000	0.0000	0.5981	0.0002	0.0006	0.5981	0.0002	0.0006	12100
42	#	112.60	22.28	3.0691	104	3	0.0000	0.0000	10.037	0.0022	10.038	0.0031	0.0000	0.0000	0.0000	0.5982	0.0002	0.0006	0.5982	0.0002	0.0006	12096
43	$	301.26	22.25	0.6243	150	0	0.0000	0.0000	0.4074	0.0001	0.4085	0.0001	0.0000	0.0000	0.0000	0.6040	0.0028	0.0040	0.6032	0.0026	0.0040	2459
44	$	299.88	22.24	0.6246	149	0	0.0000	0.0000	0.4073	0.0001	0.4085	0.0001	0.0000	0.0000	0.0000	0.6044	0.0028	0.0040	0.6035	0.0026	0.0040	2459
45	$	300.66	22.24	0.6247	149	0	0.0000	0.0000	0.4074	0.0001	0.4086	0.0001	0.0000	0.0000	0.0000	0.6044	0.0028	0.0040	0.6035	0.0026	0.0040	2460
46	$	300.46	22.20	1.0027	149	0	0.0000	0.0000	1.0607	0.0001	1.0611	0.0001	0.0000	0.0000	0.0000	0.6012	0.0011	0.0018	0.6011	0.0010	0.0018	3945
47	$	300.21	22.20	1.0033	149	0	0.0000	0.0000	1.0614	0.0004	1.0618	0.0004	0.0000	0.0000	0.0000	0.6014	0.0011	0.0018	0.6013	0.0010	0.0018	3947
48	$	300.10	22.19	1.0031	149	0	0.0000	0.0000	1.0613	0.0002	1.0618	0.0003	0.0000	0.0000	0.0000	0.6013	0.0011	0.0018	0.6012	0.0010	0.0018	3945
49	$	175.11	22.21	1.6887	161	0	0.0000	0.0000	3.0232	0.0019	3.0251	0.0018	0.0000	0.0000	0.0000	0.5997	0.0004	0.0009	0.5995	0.0004	0.0009	6645
50	$	175.06	22.21	1.6885	161	0	0.0000	0.0000	3.0233	0.0013	3.0244	0.0012	0.0000	0.0000	0.0000	0.5996	0.0004	0.0009	0.5995	0.0004	0.0009	6644
51	$	175.15	22.22	1.6887	161	0	0.0000	0.0000	3.0246	0.0015	3.0258	0.0014	0.0000	0.0000	0.0000	0.5996	0.0004	0.0009	0.5995	0.0004	0.0009	6646
52	$	112.66	22.25	3.0656	104	0	0.0000	0.0000	10.016	0.0026	10.017	0.0027	0.0000	0.0000	0.0000	0.5981	0.0002	0.0006	0.5981	0.0002	0.0006	12074
53	$	111.73	22.26	3.0646	103	0	0.0000	0.0000	10.009	0.0014	10.010	0.0013	0.0000	0.0000	0.0000	0.5982	0.0002	0.0006	0.5981	0.0002	0.0006	12073
54	$	112.59	22.25	3.0637	104	0	0.0000	0.0000	10.002	0.0037	10.003	0.0033	0.0000	0.0000	0.0000	0.5982	0.0002	0.0006	0.5982	0.0002	0.0006	12067

[Test Run Date Codes # - 01/20/87 $ - 01/21/87]

Table 45G. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-8A Diameter 1.2503 Inches, Beta Ratio = 0.20554

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	54.726	31.16	6.7815	96	0	3.0440	0.0039	3.0441	0.0045	3.0467	0.0034	0.6000	0.0006	0.0007	0.6000	0.0006	0.0007	0.5997	0.0006	0.0007	32580
2 #	55.199	31.17	6.7739	98	0	3.0396	0.0038	3.0386	0.0028	3.0403	0.0033	0.5998	0.0006	0.0007	0.5998	0.0005	0.0007	0.5997	0.0006	0.0007	32550
3 #	55.137	31.17	6.7779	98	0	3.0416	0.0046	3.0422	0.0059	3.0429	0.0041	0.5999	0.0007	0.0007	0.5999	0.0007	0.0007	0.5998	0.0006	0.0007	32570
4 #	94.817	31.17	3.9346	169	0	1.0195	0.0009	1.0219	0.0010	1.0221	0.0010	0.6015	0.0012	0.0017	0.6008	0.0011	0.0017	0.6008	0.0012	0.0017	18907
5 #	94.695	31.19	3.8747	169	0	0.9702	0.0012	0.9905	0.0013	0.9910	0.0012	0.6072	0.0013	0.0018	0.6010	0.0012	0.0017	0.6008	0.0013	0.0018	18627
6 #	95.227	31.22	3.8754	170	1	0.9710	0.0011	0.9907	0.0008	0.9912	0.0008	0.6071	0.0013	0.0018	0.6010	0.0012	0.0017	0.6009	0.0013	0.0018	18642
7 #	149.79	31.20	2.4691	186	0	0.3781	0.0003	0.4006	0.0004	0.4011	0.0003	0.6198	0.0032	0.0042	0.6022	0.0028	0.0039	0.6018	0.0030	0.0044	11872
8 #	149.95	31.24	2.4636	186	0	0.3763	0.0004	0.3989	0.0004	0.3994	0.0004	0.6199	0.0032	0.0042	0.6021	0.0028	0.0039	0.6017	0.0030	0.0044	11856
9 #	149.80	31.26	2.4598	186	0	0.3748	0.0003	0.3974	0.0003	0.3981	0.0003	0.6202	0.0032	0.0042	0.6023	0.0028	0.0039	0.6019	0.0030	0.0044	11842
10 #	270.85	31.35	6.7740	168	0	3.0244	0.0014	3.0421	0.0013	3.0428	0.0014	0.6013	0.0004	0.0007	0.5995	0.0004	0.0007	0.5995	0.0004	0.0007	32674
11 #	269.42	31.37	6.7657	167	0	3.0123	0.0016	3.0341	0.0016	3.0350	0.0018	0.6018	0.0004	0.0007	0.5996	0.0004	0.0007	0.5995	0.0004	0.0007	32648
12 #	269.33	31.40	6.7542	167	1	3.0006	0.0014	3.0229	0.0013	3.0241	0.0011	0.6019	0.0004	0.0007	0.5997	0.0004	0.0007	0.5996	0.0004	0.0007	32612
13 #	117.19	31.46	13.634	200	0	12.345	0.0104	12.368	0.0105	12.368	0.0101	0.5990	0.0003	0.0004	0.5985	0.0003	0.0004	0.5985	0.0003	0.0004	65914
14 #	119.48	31.47	13.676	200	0	12.418	0.0108	12.443	0.0114	12.442	0.0117	0.5991	0.0003	0.0004	0.5985	0.0003	0.0004	0.5985	0.0003	0.0004	66133
15 #	120.00	31.51	13.699	200	0	12.466	0.0110	12.487	0.0108	12.486	0.0097	0.5990	0.0003	0.0004	0.5984	0.0003	0.0004	0.5985	0.0003	0.0004	66298
16 #	149.78	31.54	12.278	186	0	10.000	0.0064	10.022	0.0073	10.022	0.0073	0.5993	0.0003	0.0004	0.5987	0.0003	0.0004	0.5987	0.0003	0.0004	59457
17 #	150.16	31.56	12.271	186	2	9.992	0.0032	10.014	0.0039	10.012	0.0037	0.5993	0.0002	0.0004	0.5986	0.0002	0.0004	0.5987	0.0002	0.0004	59449
18 #	150.09	31.58	12.291	186	0	10.023	0.0042	10.045	0.0048	10.045	0.0053	0.5993	0.0002	0.0004	0.5987	0.0002	0.0004	0.5987	0.0002	0.0004	59571
22 $	115.60	33.22	13.813	200	0	12.704	0.0133	12.703	0.0163	12.703	0.0151	0.5984	0.0004	0.0004	0.5984	0.0004	0.0004	0.5984	0.0004	0.0004	69253
23 $	114.59	33.23	13.821	200	0	12.710	0.0151	12.710	0.0153	12.711	0.0153	0.5986	0.0004	0.0004	0.5986	0.0004	0.0004	0.5986	0.0004	0.0004	69308
24 $	116.20	33.26	13.798	200	2	12.679	0.0061	12.677	0.0060	12.670	0.0059	0.5983	0.0002	0.0004	0.5983	0.0002	0.0004	0.5985	0.0002	0.0004	69232
25 $	149.86	33.29	12.276	186	1	10.029	0.0049	10.027	0.0049	10.028	0.0049	0.5985	0.0002	0.0004	0.5986	0.0002	0.0004	0.5986	0.0002	0.0004	61636
26 $	150.71	33.31	12.298	187	0	10.063	0.0072	10.062	0.0070	10.061	0.0070	0.5986	0.0003	0.0004	0.5986	0.0003	0.0004	0.5986	0.0003	0.0004	61768
27 $	150.02	33.33	12.283	186	4	10.042	0.0072	10.041	0.0081	10.034	0.0054	0.5985	0.0003	0.0004	0.5985	0.0003	0.0004	0.5987	0.0002	0.0004	61720
28 $	270.84	33.33	6.7162	168	0	2.9949	0.0019	2.9918	0.0019	2.9916	0.0016	0.5992	0.0004	0.0007	0.5995	0.0004	0.0007	0.5996	0.0004	0.0007	33748
29 $	271.15	33.35	6.7129	168	0	2.9914	0.0016	2.9884	0.0015	2.9889	0.0017	0.5993	0.0004	0.0007	0.5996	0.0004	0.0007	0.5995	0.0004	0.0007	33745
30 $	270.82	33.37	6.7133	168	0	2.9917	0.0016	2.9894	0.0013	2.9908	0.0012	0.5993	0.0004	0.0007	0.5995	0.0004	0.0007	0.5994	0.0003	0.0007	33761
32 $	55.131	33.39	6.6733	98	0	2.9536	0.0032	2.9524	0.0033	2.9526	0.0048	0.5996	0.0006	0.0007	0.5997	0.0006	0.0007	0.5997	0.0007	0.0007	33573
33 $	54.641	33.40	6.6647	97	0	2.9452	0.0022	2.9441	0.0018	2.9444	0.0017	0.5996	0.0005	0.0007	0.5998	0.0005	0.0007	0.5997	0.0005	0.0007	33537
34 $	55.109	33.41	6.6705	98	0	2.9524	0.0027	2.9494	0.0027	2.9505	0.0029	0.5994	0.0005	0.0007	0.5997	0.0005	0.0007	0.5996	0.0005	0.0007	33573

[Test Run Date Codes # - 08/26/85 $ - 08/30/85]

Table 45G. Orifice Discharge Coefficient Values - Meter Tube PE-8

Meter Tube PE-8ABC Diameter 6.0829 Inches -- Orifice Plate FE-7/8-8A Diameter 1.2503 Inches, Beta Ratio = 0.20554

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
35	#	149.79	33.36	2.5040	186	0	0.4172	0.0008	0.4172	0.0010	0.4157	0.0009	0.5987	0.0026	0.0037	0.5986	0.0024	0.0037	0.5997	0.0023	0.0037	12590
36	#	149.91	33.36	2.4458	186	0	0.3975	0.0004	0.3962	0.0005	0.3972	0.0004	0.5990	0.0027	0.0039	0.6000	0.0024	0.0039	0.5992	0.0023	0.0039	12297
37	#	149.90	33.38	2.5098	186	0	0.4183	0.0005	0.4178	0.0007	0.4170	0.0006	0.5992	0.0025	0.0037	0.5996	0.0023	0.0037	0.6001	0.0022	0.0037	12624
38	#	84.643	33.46	3.9236	150	0	1.0198	0.0009	1.0184	0.0009	1.0192	0.0008	0.5999	0.0011	0.0017	0.6003	0.0010	0.0017	0.6001	0.0009	0.0017	19768
39	#	85.308	33.49	3.9189	152	0	1.0160	0.0014	1.0151	0.0015	1.0164	0.0016	0.6003	0.0011	0.0017	0.6006	0.0011	0.0017	0.6002	0.0010	0.0017	19756
40	#	85.236	33.50	3.9144	152	0	1.0145	0.0011	1.0135	0.0016	1.0145	0.0012	0.6001	0.0011	0.0017	0.6004	0.0011	0.0017	0.6001	0.0010	0.0017	19738
44	#	55.024	33.64	2.4933	74	0	0.4084	0.0006	0.4081	0.0005	0.4084	0.0006	0.6024	0.0026	0.0038	0.6027	0.0024	0.0038	0.6025	0.0023	0.0038	12608
45	#	54.544	33.64	2.4867	73	0	0.4076	0.0002	0.4071	0.0002	0.4077	0.0003	0.6015	0.0026	0.0038	0.6018	0.0023	0.0038	0.6014	0.0023	0.0038	12574
46	#	54.586	33.64	2.4852	73	0	0.4067	0.0002	0.4063	0.0003	0.4068	0.0003	0.6018	0.0026	0.0038	0.6021	0.0023	0.0038	0.6017	0.0023	0.0038	12567
47	#	149.40	33.63	2.4929	185	0	0.4095	0.0002	0.4090	0.0002	0.4095	0.0002	0.6015	0.0026	0.0038	0.6019	0.0023	0.0038	0.6016	0.0022	0.0038	12603
48	#	150.68	33.63	2.4869	187	2	0.4071	0.0002	0.4067	0.0002	0.4071	0.0001	0.6018	0.0026	0.0038	0.6021	0.0023	0.0038	0.6019	0.0022	0.0038	12573
49	#	150.14	33.62	2.4907	186	1	0.4081	0.0002	0.4077	0.0003	0.4082	0.0003	0.6020	0.0026	0.0038	0.6024	0.0023	0.0038	0.6020	0.0022	0.0038	12590
50	#	54.340	33.69	6.7927	73	0	3.0618	0.0017	3.0606	0.0019	3.0618	0.0011	0.5994	0.0005	0.0007	0.5995	0.0005	0.0007	0.5994	0.0004	0.0007	34383
51	#	55.539	33.69	6.7878	72	0	3.0554	0.0013	3.0546	0.0013	3.0556	0.0016	0.5996	0.0005	0.0007	0.5997	0.0004	0.0007	0.5996	0.0004	0.0007	34359
52	#	55.111	33.69	6.8070	74	1	3.0711	0.0014	3.0702	0.0016	3.0713	0.0021	0.5998	0.0005	0.0007	0.5999	0.0005	0.0007	0.5998	0.0005	0.0007	34456
53	#	94.371	33.67	3.9400	127	0	1.0263	0.0006	1.0257	0.0006	1.0268	0.0006	0.6005	0.0011	0.0017	0.6007	0.0010	0.0017	0.6004	0.0009	0.0017	19935
54	#	95.055	33.66	3.9394	128	1	1.0262	0.0006	1.0255	0.0006	1.0260	0.0006	0.6005	0.0011	0.0017	0.6007	0.0010	0.0017	0.6006	0.0009	0.0017	19928
55	#	95.127	33.66	3.9384	128	0	1.0250	0.0006	1.0242	0.0007	1.0251	0.0006	0.6007	0.0011	0.0017	0.6009	0.0010	0.0017	0.6006	0.0009	0.0017	19923

[Test Run Date Codes # - 08/30/85]

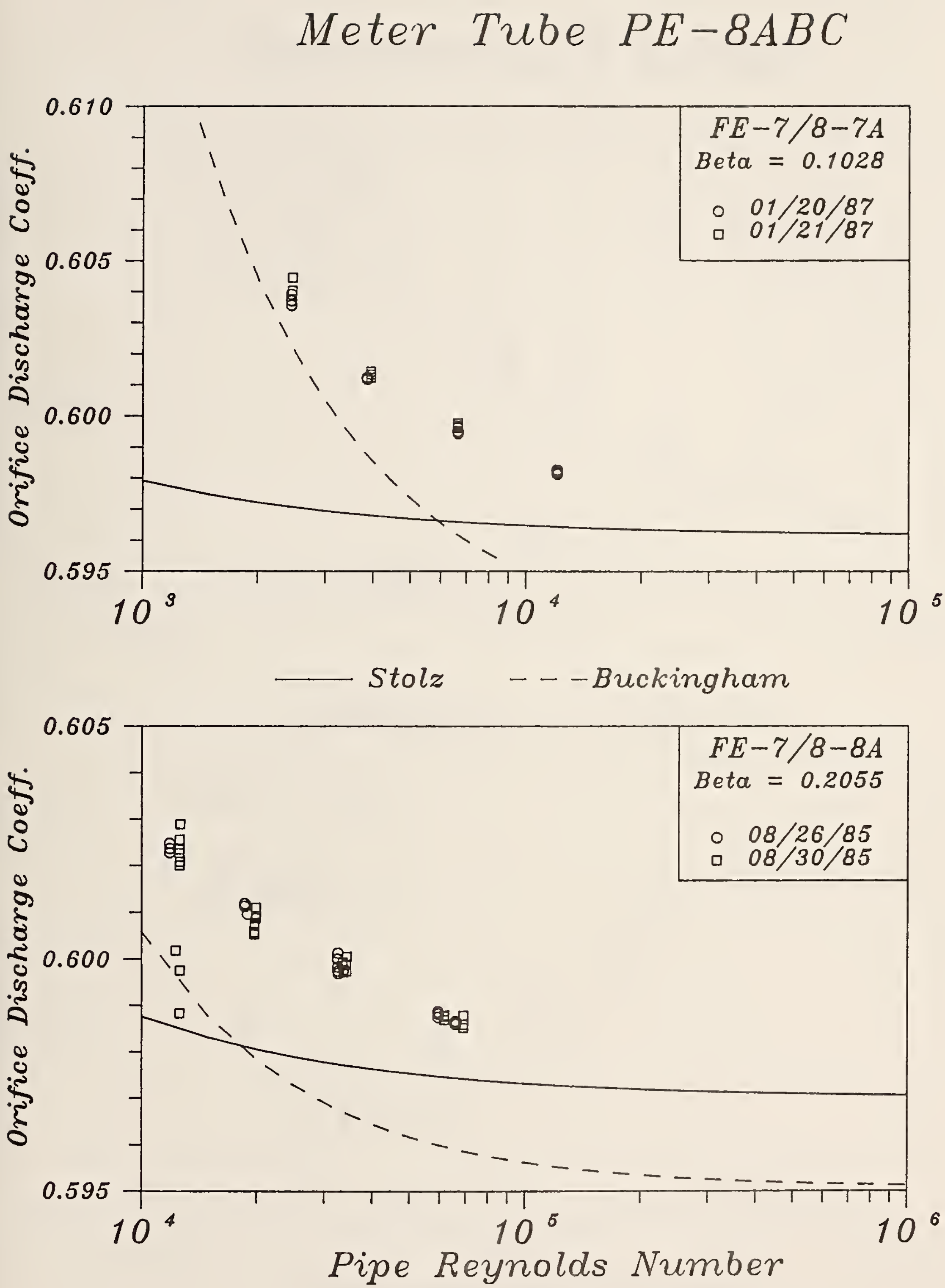


Figure 32A. Discharge Coefficient/Reynolds Number Plots, PE-8ABC 6-Inch Meter Tube, 8 Orifice Plates, Final Data Base

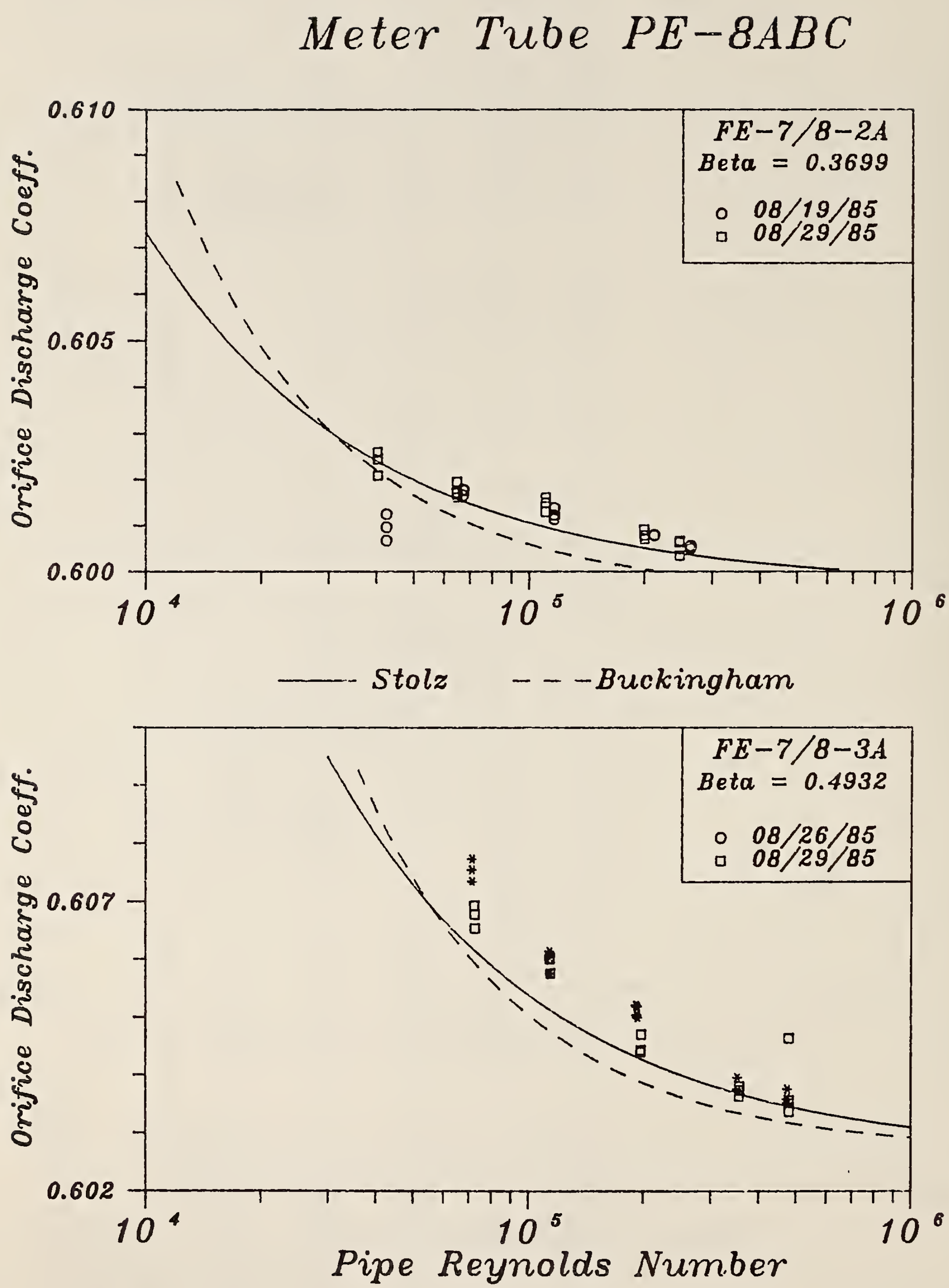


Figure 32B. Discharge Coefficient/Reynolds Number Plots, PE-8ABC 6-Inch Meter Tube, 7 Orifice Plates, Final Data Base

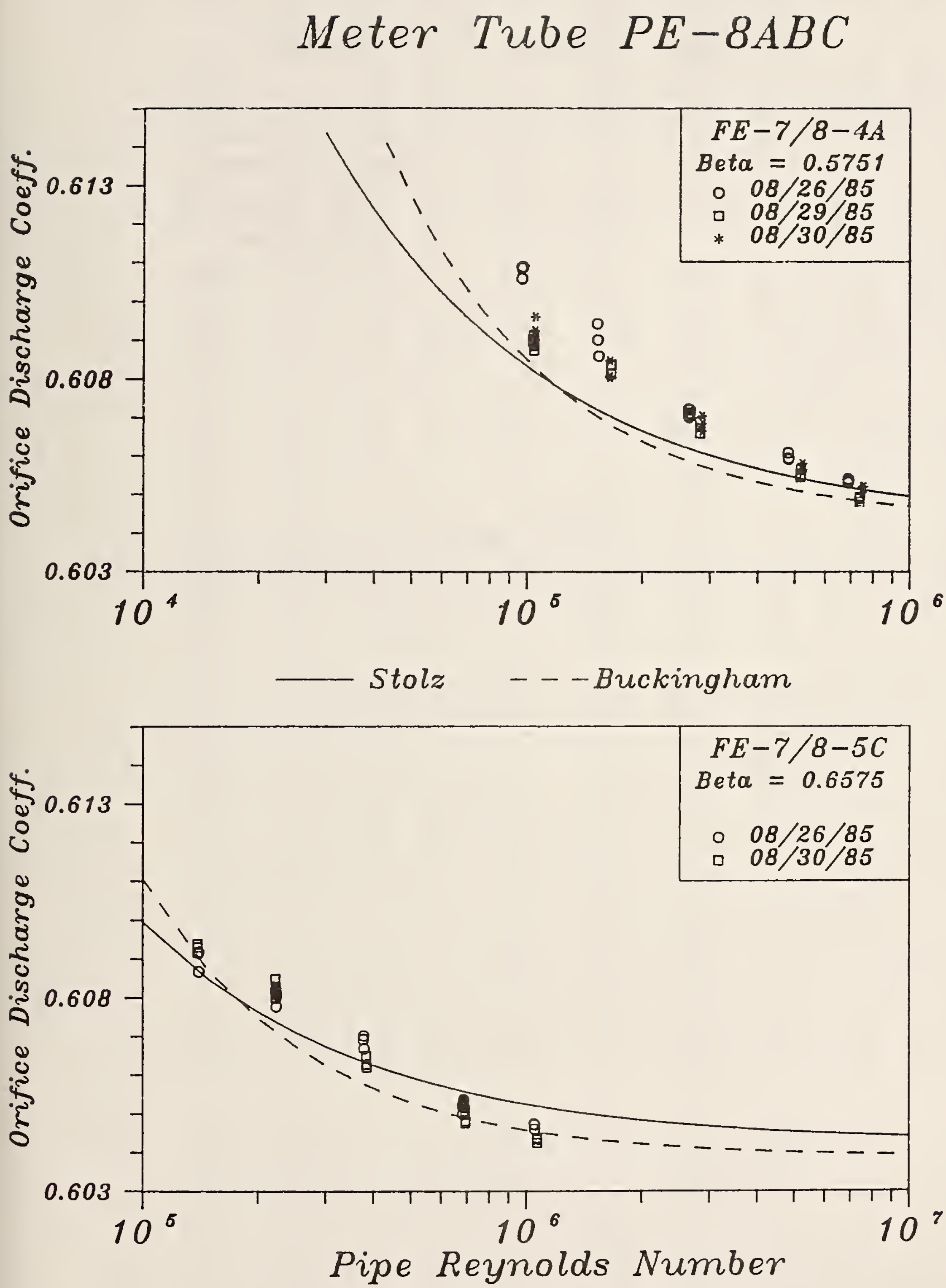


Figure 32C. Discharge Coefficient/Reynolds Number Plots, PE-8ABC 6-Inch Meter Tube, 7 Orifice Plates, Final Data Base

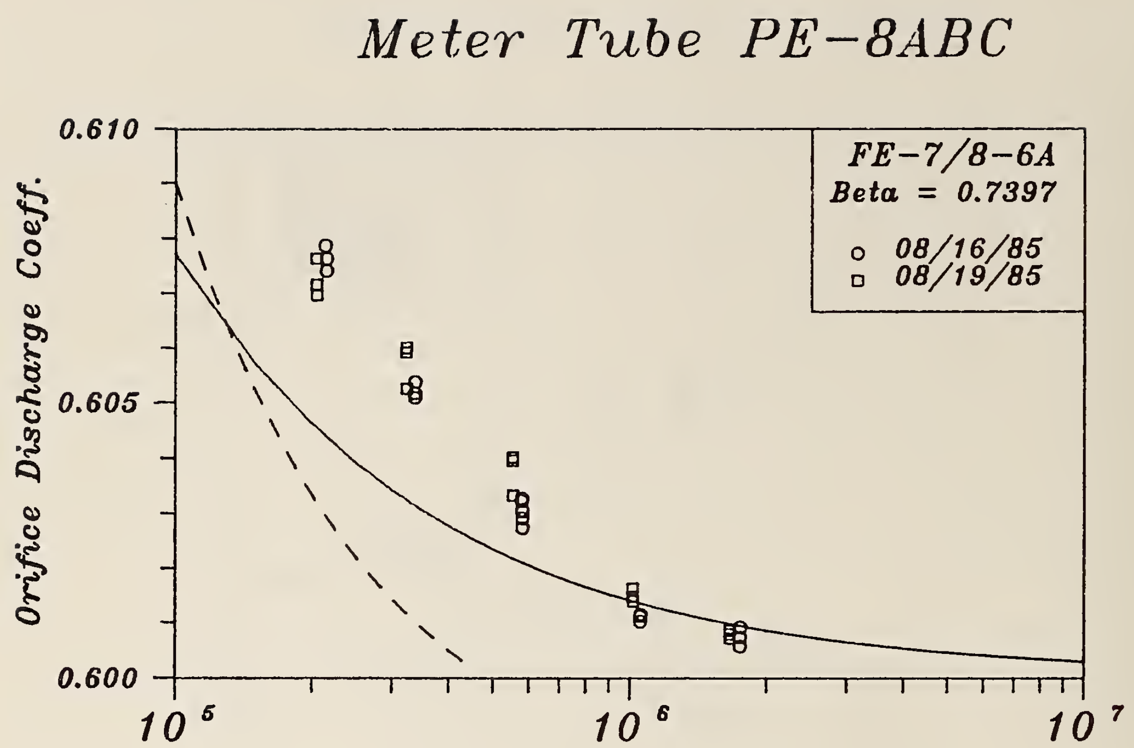


Figure 32D. Discharge Coefficient/Reynolds Number Plots, PE-8ABC 6-Inch Meter Tube, 7 Orifice Plates, Final Data Base

Table 46A. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-1B Diameter 1.9983 Inches, Beta Ratio = 0.19822

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	106.87	24.43	17.194	147	0	3.0248	0.0025	3.0141	0.0022	3.0139	0.0024	0.5971	0.0015	0.0007	0.5981	0.0004	0.0007	0.5981	0.0004	0.0007	42997
2	#	107.56	24.45	17.199	148	5	3.0289	0.0016	3.0199	0.0015	3.0217	0.0020	0.5968	0.0015	0.0007	0.5977	0.0004	0.0007	0.5975	0.0004	0.0007	43027
3	#	107.48	24.48	17.197	148	2	3.0290	0.0011	3.0194	0.0011	3.0206	0.0015	0.5967	0.0015	0.0007	0.5977	0.0004	0.0007	0.5976	0.0004	0.0007	43053
4	#	44.494	24.53	41.706	61	0	17.884	0.0116	17.826	0.0190	17.828	0.0239	0.5956	0.0005	0.0003	0.5966	0.0005	0.0003	0.5965	0.0005	0.0003	104531
5	#	45.244	24.54	41.726	62	0	17.900	0.0209	17.863	0.0300	17.872	0.0195	0.5956	0.0006	0.0003	0.5962	0.0006	0.0003	0.5961	0.0005	0.0003	104606
6	#	45.206	24.55	41.699	62	1	17.874	0.0228	17.811	0.0175	17.820	0.0182	0.5957	0.0006	0.0003	0.5967	0.0005	0.0003	0.5966	0.0005	0.0003	104561
7	#	56.678	24.58	31.280	78	0	10.046	0.0132	10.015	0.0150	10.015	0.0142	0.5960	0.0007	0.0003	0.5969	0.0005	0.0003	0.5969	0.0005	0.0003	78489
8	#	57.071	24.60	31.320	78	0	10.076	0.0118	10.048	0.0142	10.046	0.0134	0.5959	0.0006	0.0003	0.5967	0.0005	0.0003	0.5968	0.0005	0.0003	78627
9	#	57.346	24.61	31.331	79	0	10.080	0.0132	10.052	0.0141	10.043	0.0143	0.5960	0.0007	0.0003	0.5968	0.0005	0.0003	0.5971	0.0005	0.0003	78671
10	#	300.08	24.60	6.2932	149	1	0.4057	0.0002	0.4049	0.0002	0.4048	0.0003	0.5967	0.0112	0.0037	0.5973	0.0024	0.0037	0.5974	0.0024	0.0037	15799
11	#	301.94	24.63	6.2865	150	1	0.4046	0.0003	0.4035	0.0003	0.4034	0.0003	0.5969	0.0112	0.0037	0.5977	0.0024	0.0037	0.5977	0.0024	0.0037	15793
12	#	300.15	24.66	6.2830	149	0	0.4039	0.0003	0.4026	0.0003	0.4026	0.0003	0.5971	0.0112	0.0037	0.5980	0.0024	0.0037	0.5981	0.0024	0.0037	15795
13	#	178.37	25.18	9.977	200	1	1.0177	0.0004	1.0136	0.0005	1.0142	0.0007	0.5973	0.0045	0.0016	0.5985	0.0010	0.0016	0.5983	0.0010	0.0016	25380
14	#	188.69	25.22	9.982	200	5	1.0204	0.0006	1.0163	0.0007	1.0172	0.0007	0.5968	0.0044	0.0016	0.5981	0.0010	0.0016	0.5978	0.0010	0.0016	25417
15	#	190.76	25.26	9.976	200	2	1.0167	0.0009	1.0130	0.0007	1.0134	0.0012	0.5976	0.0045	0.0016	0.5987	0.0010	0.0016	0.5985	0.0010	0.0016	25425
16	$	300.10	29.82	6.2762	149	1	0.4012	0.0005	0.4010	0.0007	0.4012	0.0006	0.5987	0.0026	0.0038	0.5989	0.0028	0.0038	0.5988	0.0026	0.0038	17685
17	$	300.34	29.86	6.2536	149	0	0.3982	0.0002	0.3976	0.0002	0.3981	0.0002	0.5989	0.0026	0.0038	0.5993	0.0027	0.0038	0.5989	0.0026	0.0038	17636
18	$	301.18	29.82	6.2301	153	0	0.3952	0.0001	0.3946	0.0001	0.3949	0.0001	0.5988	0.0027	0.0038	0.5993	0.0028	0.0038	0.5990	0.0026	0.0038	17555
19	$	301.69	29.90	6.3175	150	0	0.4074	0.0003	0.4063	0.0003	0.4077	0.0003	0.5981	0.0026	0.0037	0.5989	0.0027	0.0037	0.5978	0.0025	0.0037	17832
20	$	301.95	29.95	6.3120	150	2	0.4067	0.0002	0.4055	0.0003	0.4069	0.0003	0.5981	0.0026	0.0037	0.5990	0.0027	0.0037	0.5980	0.0025	0.0037	17835
21	$	301.64	29.97	6.3086	151	0	0.4061	0.0002	0.4046	0.0002	0.4061	0.0002	0.5982	0.0026	0.0037	0.5993	0.0027	0.0037	0.5982	0.0025	0.0037	17833
22	$	168.70	30.07	10.026	200	0	1.0280	0.0004	1.0264	0.0004	1.0277	0.0006	0.5976	0.0010	0.0016	0.5980	0.0011	0.0016	0.5976	0.0010	0.0016	28403
23	$	174.28	30.09	10.021	200	2	1.0255	0.0007	1.0241	0.0007	1.0254	0.0008	0.5980	0.0011	0.0016	0.5984	0.0011	0.0016	0.5980	0.0010	0.0016	28399
24	$	173.60	30.12	10.020	200	2	1.0267	0.0005	1.0246	0.0007	1.0264	0.0006	0.5976	0.0010	0.0016	0.5982	0.0011	0.0016	0.5977	0.0010	0.0016	28416
25	$	104.67	30.19	17.226	139	0	3.0309	0.0015	3.0293	0.0023	3.0328	0.0019	0.5979	0.0004	0.0007	0.5981	0.0005	0.0007	0.5977	0.0004	0.0007	48924
26	$	105.28	30.21	17.220	144	0	3.0353	0.0012	3.0327	0.0018	3.0341	0.0019	0.5973	0.0004	0.0007	0.5975	0.0004	0.0007	0.5974	0.0004	0.0007	48926
27	$	105.13	30.23	17.211	146	7	3.0311	0.0015	3.0293	0.0022	3.0318	0.0018	0.5974	0.0004	0.0007	0.5976	0.0005	0.0007	0.5973	0.0004	0.0007	48922
28	$	56.721	30.30	31.385	79	0	10.093	0.0089	10.093	0.0118	10.095	0.0123	0.5970	0.0004	0.0003	0.5970	0.0005	0.0003	0.5969	0.0005	0.0003	89345
29	$	57.715	30.31	31.572	77	0	10.222	0.0133	10.224	0.0139	10.221	0.0132	0.5967	0.0005	0.0003	0.5967	0.0005	0.0003	0.5968	0.0005	0.0003	89895
30	$	57.507	30.33	31.236	80	0	9.999	0.0072	9.995	0.0116	9.995	0.0127	0.5969	0.0004	0.0003	0.5971	0.0005	0.0003	0.5971	0.0005	0.0003	88978

[Test Run Date Codes # - 11/06/85 $ - 11/12/85]

Table 46A. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-1B Diameter 1.9983 Inches, Beta Ratio = 0.19822

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
32	#	45.340	30.38	41.444	63	0	17.642	0.0083	17.633	0.0122	17.635	0.0092	0.5963	0.0004	0.0003	0.5964	0.0004	0.0003	0.5964	0.0004	0.0003	118179
33	#	44.658	30.39	41.465	62	0	17.659	0.0145	17.661	0.0223	17.657	0.0266	0.5963	0.0004	0.0003	0.5963	0.0005	0.0003	0.5963	0.0006	0.0003	118264
34	#	44.645	30.41	41.470	62	0	17.635	0.0270	17.639	0.0359	17.639	0.0335	0.5968	0.0006	0.0003	0.5967	0.0007	0.0003	0.5967	0.0007	0.0003	118328
35	$	301.30	29.51	6.2928	150	1	0.4038	0.0002	0.4031	0.0002	0.4036	0.0002	0.5983	0.0028	0.0037	0.5989	0.0026	0.0037	0.5985	0.0026	0.0037	17615
36	$	299.44	29.54	6.2885	149	1	0.4023	0.0002	0.4019	0.0002	0.4025	0.0002	0.5991	0.0028	0.0038	0.5994	0.0026	0.0038	0.5989	0.0026	0.0038	17614
37	$	300.61	29.56	6.2909	150	0	0.4028	0.0003	0.4022	0.0002	0.4027	0.0002	0.5989	0.0028	0.0038	0.5994	0.0026	0.0038	0.5990	0.0026	0.0038	17628
38	$	166.67	29.61	9.922	200	22	1.0026	0.0011	1.0003	0.0010	1.0011	0.0011	0.5988	0.0012	0.0016	0.5995	0.0011	0.0016	0.5992	0.0011	0.0016	27834
39	$	167.80	29.62	9.906	200	0	1.0019	0.0005	1.0006	0.0005	1.0016	0.0005	0.5980	0.0011	0.0016	0.5984	0.0011	0.0016	0.5981	0.0011	0.0016	27794
40	$	171.75	29.63	9.905	200	1	1.0022	0.0003	1.0007	0.0004	1.0014	0.0004	0.5979	0.0011	0.0016	0.5983	0.0010	0.0016	0.5981	0.0011	0.0016	27797
41	$	124.58	29.63	14.808	172	0	2.2429	0.0007	2.2413	0.0008	2.2416	0.0011	0.5975	0.0005	0.0008	0.5977	0.0005	0.0008	0.5976	0.0005	0.0008	41557
42	$	125.04	29.63	14.809	171	0	2.2437	0.0007	2.2420	0.0008	2.2433	0.0009	0.5974	0.0005	0.0008	0.5976	0.0005	0.0008	0.5975	0.0005	0.0008	41559
43	$	125.18	29.63	14.805	168	0	2.2421	0.0008	2.2399	0.0010	2.2413	0.0010	0.5975	0.0005	0.0008	0.5978	0.0005	0.0008	0.5976	0.0005	0.0008	41549

[Test Run Date Codes # - 11/12/85 $ - 11/13/85]

Table 46B. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-2B Diameter 3.7480 Inches, Beta Ratio = 0.37178

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
22 #	83.927	28.87	22.564	115	0	0.4079	0.0003	0.4069	0.0004	0.4091	0.0003	0.6015	0.0027	0.0037	0.6021	0.0024	0.0037	0.6006	0.0022	0.0037	62296
23 #	84.128	28.91	22.592	117	0	0.4088	0.0004	0.4080	0.0004	0.4100	0.0004	0.6015	0.0027	0.0037	0.6021	0.0024	0.0037	0.6007	0.0022	0.0037	62427
24 #	83.235	28.95	22.640	116	0	0.4115	0.0006	0.4107	0.0005	0.4122	0.0004	0.6008	0.0027	0.0036	0.6014	0.0024	0.0036	0.6003	0.0022	0.0036	62615
25 #	53.436	29.05	36.650	74	0	1.0792	0.0012	1.0776	0.0009	1.0790	0.0018	0.6006	0.0011	0.0015	0.6010	0.0010	0.0015	0.6007	0.0010	0.0015	101580
26 #	52.802	29.07	36.662	73	0	1.0794	0.0005	1.0789	0.0008	1.0790	0.0013	0.6007	0.0011	0.0015	0.6009	0.0010	0.0015	0.6008	0.0010	0.0015	101656
27 #	53.515	29.09	36.712	74	0	1.0811	0.0014	1.0799	0.0014	1.0816	0.0018	0.6011	0.0011	0.0015	0.6014	0.0010	0.0015	0.6009	0.0010	0.0015	101839
28 #	161.15	29.17	35.410	200	0	1.0058	0.0006	1.0044	0.0007	1.0060	0.0009	0.6011	0.0011	0.0016	0.6015	0.0010	0.0016	0.6010	0.0010	0.0016	98397
29 #	161.50	29.20	35.634	200	1	1.0193	0.0006	1.0180	0.0008	1.0199	0.0007	0.6009	0.0011	0.0015	0.6013	0.0010	0.0015	0.6007	0.0009	0.0015	99083
30 #	161.41	29.25	35.763	200	1	1.0263	0.0008	1.0249	0.0008	1.0272	0.0006	0.6010	0.0011	0.0015	0.6014	0.0010	0.0015	0.6007	0.0009	0.0015	99550
31 #	99.87	29.32	61.448	138	1	3.0329	0.0020	3.0316	0.0025	3.0334	0.0021	0.6007	0.0004	0.0006	0.6008	0.0004	0.0006	0.6006	0.0004	0.0006	171303
32 #	99.279	29.33	61.357	137	0	3.0190	0.0024	3.0161	0.0026	3.0208	0.0018	0.6012	0.0005	0.0006	0.6015	0.0004	0.0006	0.6010	0.0004	0.0006	171085
33 #	99.94	29.37	61.386	138	1	3.0238	0.0020	3.0229	0.0015	3.0265	0.0018	0.6010	0.0004	0.0006	0.6011	0.0004	0.0006	0.6007	0.0004	0.0006	171312
34 #	53.945	29.44	111.72	75	0	10.044	0.0036	10.046	0.0041	10.046	0.0046	0.6002	0.0002	0.0003	0.6001	0.0002	0.0003	0.6001	0.0002	0.0003	312266
35 #	53.430	29.47	111.68	74	0	10.035	0.0066	10.034	0.0074	10.035	0.0119	0.6002	0.0003	0.0003	0.6002	0.0003	0.0003	0.6002	0.0004	0.0003	312335
36 #	53.460	29.48	111.66	74	0	10.025	0.0047	10.027	0.0051	10.035	0.0068	0.6004	0.0002	0.0003	0.6004	0.0002	0.0003	0.6001	0.0003	0.0003	312360
37 #	35.810	29.57	167.50	50	0	22.607	0.0180	22.598	0.0140	22.602	0.0130	0.5998	0.0003	0.0002	0.5999	0.0003	0.0002	0.5998	0.0003	0.0002	469463
38 #	35.283	29.59	168.01	49		22.736	0.0168	22.741	0.0165	22.752	0.0105	0.5999	0.0003	0.0002	0.5998	0.0003	0.0002	0.5997	0.0002	0.0002	471096
39 #	35.422	29.59	168.13	49		22.740	0.0269	22.747	0.0276	22.763	0.0119	0.6002	0.0004	0.0002	0.6001	0.0004	0.0002	0.5999	0.0003	0.0002	471424
40 $	52.775	29.86	35.670	71	1	1.0202	0.0007	1.0202	0.0007	1.0200	0.0011	0.6013	0.0011	0.0015	0.6013	0.0010	0.0015	0.6013	0.0010	0.0015	100597
41 $	52.535	29.88	35.738	73	0	1.0238	0.0006	1.0235	0.0011	1.0223	0.0007	0.6013	0.0011	0.0015	0.6014	0.0010	0.0015	0.6018	0.0010	0.0015	100830
42 $	53.245	29.89	35.755	74	0	1.0244	0.0011	1.0233	0.0010	1.0233	0.0009	0.6015	0.0011	0.0015	0.6018	0.0010	0.0015	0.6018	0.0010	0.0015	100901
43 $	83.900	29.92	22.371	117	1	0.4016	0.0003	0.4012	0.0004	0.3997	0.0004	0.6010	0.0026	0.0037	0.6014	0.0024	0.0037	0.6024	0.0024	0.0037	63171
44 $	84.761	29.94	22.414	118	0	0.4028	0.0003	0.4018	0.0003	0.4004	0.0005	0.6012	0.0026	0.0037	0.6020	0.0024	0.0037	0.6031	0.0024	0.0037	63319
45 $	84.742	29.97	22.414	118	0	0.4022	0.0005	0.4013	0.0005	0.4002	0.0004	0.6017	0.0026	0.0037	0.6024	0.0024	0.0037	0.6033	0.0024	0.0037	63361
46 $	161.65	30.05	35.548	200	1	1.0122	0.0006	1.0111	0.0007	1.0096	0.0004	0.6016	0.0011	0.0016	0.6019	0.0010	0.0016	0.6023	0.0010	0.0016	100658
47 $	161.81	30.08	35.587	200	0	1.0156	0.0005	1.0138	0.0006	1.0112	0.0007	0.6012	0.0011	0.0016	0.6018	0.0010	0.0016	0.6025	0.0010	0.0015	100834
48 $	161.86	30.08	35.627	200	0	1.0165	0.0006	1.0143	0.0007	1.0138	0.0005	0.6016	0.0011	0.0016	0.6023	0.0010	0.0016	0.6024	0.0010	0.0015	100946
49 $	35.676	30.12	167.91	50	1	22.706	0.0105	22.700	0.0157	22.697	0.0234	0.6000	0.0002	0.0002	0.6001	0.0003	0.0002	0.6001	0.0004	0.0002	476183
50 $	35.414	30.10	168.66	49	0	22.900	0.0255	22.893	0.0189	22.916	0.0309	0.6001	0.0004	0.0002	0.6002	0.0003	0.0002	0.5999	0.0005	0.0002	478098
51 $	35.784	30.07	167.10	50	0	22.468	0.0359	22.465	0.0475	22.442	0.0332	0.6002	0.0005	0.0002	0.6003	0.0007	0.0002	0.6006	0.0005	0.0002	473380

[Test Run Date Codes # - 11/07/85 $ - 11/08/85]

Table 46B. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-2B Diameter 3.7480 Inches, Beta Ratio = 0.37178

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
52	#	99.200	30.04	62.142	138	0	3.1006	0.0016	3.0997	0.0019	3.0981	0.0023	0.6009	0.0004	0.0006	0.6010	0.0004	0.0006	0.6011	0.0004	0.0006	175927
53	#	99.86	30.06	61.787	139	0	3.0676	0.0014	3.0646	0.0018	3.0626	0.0016	0.6006	0.0004	0.0006	0.6009	0.0004	0.0006	0.6011	0.0004	0.0006	174996
54	#	99.213	30.08	61.833	138	1	3.0705	0.0022	3.0695	0.0019	3.0668	0.0031	0.6008	0.0004	0.0006	0.6009	0.0004	0.0006	0.6011	0.0005	0.0006	175199
55	#	53.575	30.11	112.11	75	0	10.114	0.0118	10.112	0.0119	10.104	0.0097	0.6002	0.0004	0.0003	0.6002	0.0004	0.0003	0.6005	0.0003	0.0003	317859
56	#	53.776	30.12	112.02	75	0	10.101	0.0078	10.098	0.0107	10.089	0.0102	0.6001	0.0003	0.0003	0.6002	0.0004	0.0003	0.6004	0.0003	0.0003	317672
57	#	53.314	30.13	111.42	73	0	9.970	0.0119	9.971	0.0104	9.971	0.0147	0.6008	0.0004	0.0003	0.6008	0.0004	0.0003	0.6007	0.0005	0.0003	316028

[Test Run Date Codes # - 11/08/85]

Table 46C. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-3B Diameter 4.9976 Inches, Beta Ratio = 0.49573

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
						Differential Pressure (psid)						Discharge Coefficients									
1 #	30.133	26.24	203.69	43	0	9.999	0.0079	9.998	0.0189	9.993	0.0124	0.6035	0.0003	0.0003	0.6035	0.0006	0.0003	0.6037	0.0004	0.0003	530722
2 #	30.358	26.27	204.11	41	0	10.034	0.0094	10.041	0.0113	10.032	0.0145	0.6037	0.0004	0.0003	0.6034	0.0004	0.0003	0.6037	0.0005	0.0003	532170
3 #	30.629	26.28	204.09	43	0	10.036	0.0112	10.040	0.0245	10.036	0.0164	0.6035	0.0004	0.0003	0.6034	0.0008	0.0003	0.6035	0.0006	0.0003	532227
4 #	93.918	26.32	64.646	131	0	1.0034	0.0006	1.0025	0.0007	1.0002	0.0012	0.6046	0.0011	0.0016	0.6049	0.0010	0.0016	0.6056	0.0010	0.0016	168739
5 #	94.868	26.36	64.642	132	0	0.9998	0.0009	0.9990	0.0011	1.0007	0.0008	0.6057	0.0012	0.0016	0.6059	0.0010	0.0016	0.6054	0.0010	0.0016	168881
6 #	94.811	26.39	64.628	132	0	1.0015	0.0012	1.0005	0.0010	0.9998	0.0007	0.6050	0.0012	0.0016	0.6053	0.0010	0.0016	0.6055	0.0010	0.0016	168957
7 #	53.683	26.47	112.07	75	0	3.0161	0.0039	3.0125	0.0036	3.0164	0.0019	0.6046	0.0006	0.0006	0.6050	0.0005	0.0006	0.6046	0.0004	0.0006	293521
8 #	53.788	26.49	112.41	75	0	3.0342	0.0019	3.0307	0.0027	3.0351	0.0031	0.6046	0.0004	0.0006	0.6050	0.0004	0.0006	0.6045	0.0005	0.0006	294541
9 #	53.759	26.52	112.23	75	0	3.0254	0.0035	3.0252	0.0037	3.0231	0.0029	0.6045	0.0005	0.0006	0.6045	0.0005	0.0006	0.6048	0.0004	0.0006	294267
10 #	149.54	26.57	40.759	186	1	0.3975	0.0004	0.3961	0.0003	0.3964	0.0002	0.6057	0.0028	0.0038	0.6068	0.0025	0.0038	0.6065	0.0023	0.0038	106985
11 #	149.48	26.64	40.744	185	1	0.3974	0.0003	0.3957	0.0003	0.3960	0.0003	0.6055	0.0028	0.0038	0.6068	0.0025	0.0038	0.6066	0.0023	0.0038	107113
12 #	149.62	26.68	40.731	186	0	0.3972	0.0003	0.3953	0.0004	0.3957	0.0004	0.6055	0.0028	0.0038	0.6069	0.0025	0.0038	0.6067	0.0023	0.0038	107174
13 #	199.74	26.81	203.89	165	0	10.045	0.0054	10.038	0.0056	10.039	0.0050	0.6027	0.0002	0.0003	0.6029	0.0002	0.0003	0.6029	0.0002	0.0003	538043
14 #	200.72	26.83	203.70	166	0	10.016	0.0062	10.015	0.0035	10.028	0.0047	0.6031	0.0002	0.0003	0.6031	0.0002	0.0003	0.6027	0.0002	0.0003	537792
15 #	199.66	26.86	203.97	165	0	10.049	0.0072	10.044	0.0061	10.043	0.0083	0.6028	0.0003	0.0003	0.6030	0.0002	0.0003	0.6030	0.0003	0.0003	538845
16 #	134.39	26.93	333.54	183	0	26.896	0.0096	26.903	0.0083	26.908	0.0067	0.6026	0.0002	0.0002	0.6025	0.0001	0.0002	0.6024	0.0001	0.0002	882519
17 #	135.04	26.96	333.80	179	0	26.939	0.0109	26.947	0.0074	26.946	0.0095	0.6025	0.0002	0.0002	0.6025	0.0001	0.0002	0.6025	0.0002	0.0002	883804
18 #	135.71	26.99	333.85	182	0	26.968	0.0093	26.957	0.0122	26.955	0.0114	0.6023	0.0002	0.0002	0.6024	0.0002	0.0002	0.6025	0.0002	0.0002	884519
19 $	28.925	28.63	204.34	40	1	10.079	0.0098	10.074	0.0109	10.094	0.0195	0.6031	0.0004	0.0003	0.6033	0.0004	0.0003	0.6027	0.0006	0.0003	561230
20 $	29.426	28.64	203.58	41	0	10.008	0.0092	10.007	0.0114	10.001	0.0068	0.6031	0.0004	0.0003	0.6031	0.0004	0.0003	0.6032	0.0003	0.0003	559265
21 $	29.330	28.66	203.69	41	0	10.015	0.0098	10.006	0.0129	10.008	0.0098	0.6032	0.0004	0.0003	0.6034	0.0005	0.0003	0.6034	0.0004	0.0003	559799
22 $	94.726	28.69	65.461	131	1	1.0283	0.0008	1.0284	0.0010	1.0282	0.0007	0.6049	0.0011	0.0015	0.6049	0.0011	0.0015	0.6050	0.0010	0.0015	180026
23 $	94.945	28.73	65.471	131	0	1.0288	0.0012	1.0287	0.0012	1.0283	0.0013	0.6049	0.0011	0.0015	0.6049	0.0011	0.0015	0.6050	0.0011	0.0015	180208
24 $	94.919	28.76	65.447	131	0	1.0273	0.0008	1.0270	0.0008	1.0278	0.0008	0.6051	0.0011	0.0015	0.6052	0.0011	0.0015	0.6049	0.0010	0.0015	180259
25 $	149.99	28.82	40.991	186	0	0.4032	0.0003	0.4027	0.0004	0.4022	0.0004	0.6049	0.0026	0.0037	0.6053	0.0027	0.0037	0.6057	0.0026	0.0037	113047
26 $	149.69	28.89	41.262	186	0	0.4080	0.0002	0.4072	0.0003	0.4074	0.0003	0.6053	0.0026	0.0037	0.6059	0.0027	0.0037	0.6058	0.0025	0.0037	113968
27 $	149.79	28.93	40.241	186	0	0.3880	0.0003	0.3871	0.0003	0.3875	0.0003	0.6054	0.0027	0.0039	0.6061	0.0029	0.0039	0.6058	0.0027	0.0039	111244
28 $	53.704	29.00	111.79	73	0	3.0074	0.0020	3.0066	0.0023	3.0069	0.0026	0.6041	0.0004	0.0006	0.6042	0.0005	0.0006	0.6041	0.0005	0.0006	309501
29 $	54.016	29.01	111.77	73	0	3.0093	0.0024	3.0047	0.0021	3.0060	0.0024	0.6038	0.0005	0.0006	0.6042	0.0005	0.0006	0.6041	0.0004	0.0006	309512
30 $	54.016	29.03	111.77	75	0	3.0077	0.0027	3.0041	0.0031	3.0045	0.0019	0.6040	0.0005	0.0006	0.6043	0.0005	0.0006	0.6043	0.0004	0.0006	309662

[Test Run Date Codes # - 11/07/85 $ - 11/12/85]

Table 46C. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-3B Diameter 4.9976 Inches, Beta Ratio = 0.49573

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	200.53	29.11	203.69	166	1	10.031	0.0084	10.029	0.0071	10.031	0.0051	0.6027	0.0003	0.0003	0.6028	0.0003	0.0003	0.6027	0.0002	0.0003	565283
32	#	199.64	29.13	203.64	165	1	10.025	0.0089	10.025	0.0072	10.022	0.0052	0.6027	0.0003	0.0003	0.6027	0.0003	0.0003	0.6028	0.0002	0.0003	565396
34	#	199.76	29.22	203.42	165	0	10.003	0.0069	10.005	0.0077	10.009	0.0070	0.6027	0.0003	0.0003	0.6027	0.0003	0.0003	0.6026	0.0003	0.0003	565880
35	#	134.45	29.26	332.71	184	0	26.807	0.0129	26.817	0.0113	26.807	0.0104	0.6022	0.0002	0.0002	0.6021	0.0002	0.0002	0.6022	0.0002	0.0002	926327
36	#	134.76	29.26	332.85	180	1	26.832	0.0108	26.828	0.0136	26.828	0.0115	0.6022	0.0002	0.0002	0.6022	0.0002	0.0002	0.6022	0.0002	0.0002	926716
37	#	135.08	29.29	333.41	185	0	26.917	0.0153	26.909	0.0157	26.916	0.0108	0.6022	0.0002	0.0002	0.6023	0.0002	0.0002	0.6023	0.0002	0.0002	928866

[Test Run Date Codes # - 11/12/85]

Table 46D. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-4B Diameter 5.7488 Inches, Beta Ratio = 0.57025

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	110.00	25.44	55.269	148	0	0.3969	0.0005	0.3953	0.0005	0.3967	0.0003	0.6059	0.0116	0.0038	0.6071	0.0025	0.0038	0.6061	0.0025	0.0038	141430
2	#	109.70	25.48	55.706	147	3	0.4020	0.0003	0.4004	0.0004	0.4029	0.0005	0.6068	0.0115	0.0037	0.6080	0.0025	0.0038	0.6061	0.0024	0.0037	142680
3	#	109.32	25.53	55.693	150	0	0.4028	0.0003	0.4009	0.0003	0.4027	0.0003	0.6060	0.0114	0.0037	0.6075	0.0025	0.0038	0.6061	0.0024	0.0037	142807
4	#	70.217	25.61	88.501	97	0	1.0186	0.0008	1.0144	0.0009	1.0185	0.0006	0.6056	0.0045	0.0015	0.6069	0.0010	0.0016	0.6057	0.0010	0.0015	227345
5	#	69.742	25.63	88.796	93	0	1.0269	0.0012	1.0236	0.0017	1.0249	0.0013	0.6052	0.0045	0.0015	0.6062	0.0011	0.0015	0.6058	0.0010	0.0015	228206
6	#	69.632	25.65	88.771	96	0	1.0258	0.0011	1.0210	0.0011	1.0243	0.0008	0.6053	0.0045	0.0015	0.6068	0.0010	0.0015	0.6058	0.0010	0.0015	228245
7	#	40.336	25.70	152.19	56	0	3.0229	0.0042	3.0144	0.0049	3.0204	0.0043	0.6046	0.0016	0.0006	0.6054	0.0006	0.0006	0.6048	0.0006	0.0006	391739
8	#	39.826	25.72	151.95	55	0	3.0146	0.0035	3.0037	0.0045	3.0060	0.0025	0.6044	0.0016	0.0006	0.6055	0.0006	0.0006	0.6053	0.0005	0.0006	391296
9	#	39.836	25.73	151.74	54	0	3.0073	0.0018	2.9969	0.0010	2.9973	0.0026	0.6044	0.0015	0.0006	0.6054	0.0004	0.0006	0.6054	0.0005	0.0006	390864
10	#	299.63	25.88	152.59	149	0	3.0473	0.0036	3.0361	0.0030	3.0369	0.0018	0.6037	0.0016	0.0006	0.6048	0.0005	0.0006	0.6047	0.0004	0.0006	394361
11	#	301.36	25.93	152.47	150	0	3.0418	0.0024	3.0314	0.0016	3.0332	0.0020	0.6038	0.0015	0.0006	0.6048	0.0004	0.0006	0.6047	0.0004	0.0006	394510
12	#	300.42	26.00	152.40	149	0	3.0409	0.0025	3.0310	0.0017	3.0311	0.0018	0.6036	0.0015	0.0006	0.6046	0.0004	0.0006	0.6046	0.0004	0.0006	394960
13	#	149.41	26.07	276.61	185	0	10.040	0.0051	10.015	0.0045	10.014	0.0048	0.6030	0.0005	0.0003	0.6037	0.0002	0.0003	0.6037	0.0002	0.0003	717972
14	#	149.93	26.09	277.08	186	0	10.081	0.0070	10.049	0.0070	10.050	0.0060	0.6028	0.0005	0.0003	0.6037	0.0003	0.0003	0.6037	0.0002	0.0003	719505
15	#	150.00	26.14	276.95	186	0	10.073	0.0060	10.041	0.0071	10.039	0.0044	0.6027	0.0005	0.0003	0.6037	0.0003	0.0003	0.6037	0.0002	0.0003	719987
16	#	99.51	26.25	460.61	137	0	27.890	0.0154	27.804	0.0165	27.825	0.0130	0.6024	0.0003	0.0002	0.6034	0.0002	0.0002	0.6031	0.0002	0.0002	1200405
17	#	100.39	26.30	460.33	135	0	27.862	0.0144	27.779	0.0112	27.789	0.0144	0.6024	0.0003	0.0002	0.6033	0.0002	0.0002	0.6032	0.0002	0.0002	1201025
18	#	99.493	26.34	460.42	137	0	27.883	0.0149	27.791	0.0146	27.801	0.0149	0.6022	0.0003	0.0002	0.6032	0.0002	0.0002	0.6031	0.0002	0.0002	1202319
19	$	99.89	27.52	461.15	139	0	27.907	0.0130	27.900	0.0121	27.932	0.0120	0.6030	0.0002	0.0002	0.6031	0.0002	0.0002	0.6028	0.0002	0.0002	1236197
20	$	100.08	27.56	461.94	139	0	27.998	0.0140	27.995	0.0134	28.011	0.0125	0.6031	0.0002	0.0002	0.6031	0.0002	0.0002	0.6029	0.0002	0.0002	1239400
21	$	99.86	27.65	462.06	139	0	28.017	0.0112	28.014	0.0128	28.037	0.0157	0.6030	0.0002	0.0002	0.6031	0.0002	0.0002	0.6028	0.0002	0.0002	1242200
22	$	149.39	27.74	276.85	185	1	10.051	0.0041	10.047	0.0057	10.038	0.0069	0.6033	0.0002	0.0003	0.6034	0.0002	0.0003	0.6036	0.0003	0.0003	745758
23	$	149.93	27.77	276.27	186	0	9.999	0.0052	9.996	0.0060	9.999	0.0088	0.6036	0.0002	0.0003	0.6036	0.0002	0.0003	0.6036	0.0003	0.0003	744687
24	$	150.03	27.80	276.21	186	0	9.988	0.0046	9.989	0.0053	9.990	0.0076	0.6037	0.0002	0.0003	0.6037	0.0002	0.0003	0.6037	0.0003	0.0003	744999
25	$	299.63	27.88	151.74	149	0	3.0056	0.0027	3.0055	0.0031	3.0039	0.0037	0.6046	0.0005	0.0007	0.6046	0.0005	0.0007	0.6048	0.0005	0.0007	409987
26	$	300.05	27.93	151.54	151	0	2.9955	0.0024	2.9953	0.0018	2.9957	0.0024	0.6049	0.0004	0.0007	0.6049	0.0004	0.0007	0.6049	0.0004	0.0007	409920
27	$	299.24	28.02	151.39	149	0	2.9878	0.0027	2.9891	0.0026	2.9898	0.0020	0.6050	0.0005	0.0007	0.6049	0.0005	0.0007	0.6048	0.0004	0.0007	410299
31	$	35.181	28.15	152.69	54	0	3.0435	0.0023	3.0406	0.0016	3.0406	0.0055	0.6047	0.0005	0.0006	0.6049	0.0004	0.0006	0.6049	0.0007	0.0006	415012
32	$	40.053	28.18	152.62	55	0	3.0369	0.0058	3.0348	0.0060	3.0340	0.0053	0.6051	0.0007	0.0006	0.6053	0.0007	0.0006	0.6053	0.0007	0.0006	415102
33	$	39.605	28.20	152.88	55	0	3.0424	0.0020	3.0440	0.0019	3.0415	0.0038	0.6055	0.0004	0.0006	0.6053	0.0004	0.0006	0.6056	0.0005	0.0006	415970

[Test Run Date Codes # - 11/06/85 $ - 11/12/85]

Table 46D. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-4B Diameter 5.7488 Inches, Beta Ratio = 0.57025

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34	#	69.512	28.28	88.358	93	0	1.0140	0.0009	1.0130	0.0009	1.0108	0.0017	0.6062	0.0011	0.0015	0.6065	0.0011	0.0016	0.6072	0.0012	0.0015	240839
35	#	69.433	28.31	88.284	96	0	1.0135	0.0007	1.0119	0.0006	1.0100	0.0011	0.6058	0.0011	0.0015	0.6063	0.0011	0.0016	0.6069	0.0011	0.0015	240795
36	#	69.514	28.34	88.247	96	0	1.0111	0.0009	1.0103	0.0012	1.0086	0.0006	0.6063	0.0011	0.0016	0.6065	0.0012	0.0016	0.6071	0.0010	0.0016	240850
37	#	109.08	28.41	55.978	151	0	0.4055	0.0003	0.4047	0.0003	0.4048	0.0003	0.6073	0.0026	0.0037	0.6079	0.0027	0.0037	0.6078	0.0026	0.0037	153013
38	#	109.32	28.46	56.050	151	0	0.4080	0.0004	0.4070	0.0004	0.4061	0.0004	0.6062	0.0026	0.0037	0.6070	0.0027	0.0037	0.6077	0.0026	0.0037	153375
39	#	110.00	28.49	56.106	152	1	0.4081	0.0003	0.4071	0.0003	0.4062	0.0005	0.6068	0.0026	0.0037	0.6075	0.0027	0.0037	0.6082	0.0026	0.0037	153628

[Test Run Date Codes # - 11/12/85]

Table 46E. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-5B Diameter 6.6239 Inches, Beta Ratio = 0.65705

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	114.52	29.55	383.78	158	0	9.991	0.0115	9.990	0.0110	9.996	0.0107	0.6027	0.0004	0.0003	0.6028	0.0004	0.0003	0.6026	0.0004	0.0003	1075178
2 #	114.86	29.54	384.28	159	0	10.011	0.0097	10.013	0.0100	10.014	0.0062	0.6029	0.0003	0.0003	0.6028	0.0003	0.0003	0.6028	0.0002	0.0003	1076339
3 #	114.93	29.56	383.96	153	0	10.007	0.0060	10.007	0.0063	10.002	0.0082	0.6026	0.0002	0:0003	0.6026	0.0002	0.0003	0.6027	0.0003	0.0003	1075931
4 #	189.99	29.62	210.67	192	0	2.9971	0.0037	2.9975	0.0034	3.0029	0.0031	0.6041	0.0005	0.0007	0.6041	0.0005	0.0007	0.6035	0.0005	0.0007	591079
5 #	190.15	29.66	210.96	197	0	3.0042	0.0028	3.0040	0.0019	3.0074	0.0023	0.6042	0.0005	0.0007	0.6042	0.0004	0.0007	0.6039	0.0004	0.0007	592398
6 #	190.02	29.70	210.79	193	0	3.0027	0.0027	3.0026	0.0024	3.0017	0.0025	0.6039	0.0005	0.0007	0.6039	0.0004	0.0007	0.6040	0.0004	0.0007	592445
7 #	69.777	29.82	640.57	97	0	27.923	0.0174	27.925	0.0175	27.969	0.0150	0.6018	0.0002	0.0002	0.6018	0.0002	0.0002	0.6013	0.0002	0.0002	1804990
8 #	70.075	29.88	641.16	97	0	28.006	0.0168	27.996	0.0148	28.003	0.0123	0.6015	0.0002	0.0002	0.6016	0.0002	0.0002	0.6015	0.0002	0.0002	1808958
9 #	69.490	29.95	640.86	96	0	27.956	0.0153	27.937	0.0184	27.981	0.0205	0.6017	0.0002	0.0002	0.6019	0.0002	0.0002	0.6015	0.0003	0.0002	1810818
10 #	321.13	30.06	123.02	159	0	1.0193	0.0011	1.0197	0.0007	1.0173	0.0007	0.6049	0.0012	0.0016	0.6048	0.0010	0.0016	0.6055	0.0009	0.0016	348409
11 #	320.61	30.12	122.58	159	0	1.0119	0.0011	1.0122	0.0009	1.0092	0.0010	0.6050	0.0012	0.0016	0.6049	0.0010	0.0016	0.6058	0.0010	0.0016	347626
12 #	320.84	30.17	122.91	159	0	1.0175	0.0011	1.0171	0.0009	1.0150	0.0006	0.6049	0.0011	0.0016	0.6051	0.0010	0.0016	0.6057	0.0009	0.0016	348929
13 #	47.998	30.21	123.33	67	0	1.0232	0.0026	1.0245	0.0023	1.0181	0.0009	0.6053	0.0013	0.0015	0.6049	0.0012	0.0015	0.6068	0.0010	0.0015	350430
14 #	47.778	30.23	123.34	65	0	1.0241	0.0016	1.0240	0.0020	1.0197	0.0014	0.6051	0.0012	0.0015	0.6051	0.0011	0.0015	0.6064	0.0010	0.0015	350599
15 #	47.723	30.24	123.38	66	0	1.0220	0.0015	1.0218	0.0021	1.0220	0.0010	0.6059	0.0012	0.0015	0.6060	0.0012	0.0015	0.6059	0.0010	0.0015	350776
16 #	76.350	30.28	78.171	106	0	0.4090	0.0005	0.4098	0.0005	0.4082	0.0007	0.6069	0.0028	0.0037	0.6062	0.0024	0.0037	0.6074	0.0023	0.0037	222437
17 #	76.733	30.29	78.727	104	0	0.4155	0.0004	0.4156	0.0005	0.4151	0.0006	0.6063	0.0027	0.0036	0.6063	0.0024	0.0036	0.6066	0.0023	0.0036	224065
18 #	76.671	30.31	79.301	106	0	0.4221	0.0005	0.4221	0.0007	0.4204	0.0003	0.6060	0.0027	0.0036	0.6060	0.0024	0.0036	0.6072	0.0022	0.0036	225796
19 $	77.052	29.34	77.766	107	0	0.4053	0.0003	0.4055	0.0004	0.4031	0.0005	0.6064	0.0026	0.0037	0.6062	0.0027	0.0037	0.6080	0.0026	0.0037	216886
20 $	76.625	29.38	77.774	104	1	0.4049	0.0004	0.4050	0.0005	0.4032	0.0003	0.6067	0.0026	0.0037	0.6067	0.0027	0.0037	0.6080	0.0026	0.0037	217096
21 $	77.099	29.41	77.784	103	0	0.4049	0.0004	0.4052	0.0004	0.4037	0.0003	0.6068	0.0026	0.0037	0.6066	0.0027	0.0037	0.6077	0.0026	0.0037	217264
22 $	47.198	29.46	123.78	65	0	1.0291	0.0012	1.0285	0.0024	1.0286	0.0010	0.6057	0.0011	0.0015	0.6059	0.0013	0.0015	0.6058	0.0011	0.0015	346095
23 $	47.964	29.48	123.49	65	0	1.0274	0.0014	1.0265	0.0014	1.0228	0.0010	0.6048	0.0011	0.0015	0.6051	0.0012	0.0015	0.6062	0.0011	0.0015	345446
24 $	47.649	29.51	123.33	66	0	1.0222	0.0032	1.0217	0.0023	1.0219	0.0014	0.6056	0.0014	0.0015	0.6057	0.0013	0.0015	0.6056	0.0011	0.0015	345225
25 $	69.482	29.62	640.05	93	0	27.900	0.0188	27.874	0.0175	27.944	0.0198	0.6016	0.0002	0.0002	0.6018	0.0002	0.0002	0.6011	0.0003	0.0002	1795817
26 $	69.833	29.67	640.60	97	0	27.934	0.0472	27.930	0.0557	28.007	0.0713	0.6017	0.0005	0.0002	0.6017	0.0006	0.0002	0.6009	0.0008	0.0002	1799301
27 $	70.106	29.71	641.40	97	0	28.023	0.0433	28.028	0.0518	28.090	0.0583	0.6015	0.0005	0.0002	0.6015	0.0006	0.0002	0.6008	0.0006	0.0002	1803096
28 $	115.08	29.76	382.59	159	0	9.941	0.0069	9.938	0.0095	9.952	0.0068	0.6024	0.0003	0.0003	0.6025	0.0003	0.0003	0.6021	0.0003	0.0003	1076676
29 $	114.81	29.78	382.48	159	0	9.935	0.0064	9.933	0.0091	9.942	0.0089	0.6024	0.0003	0.0003	0.6025	0.0003	0.0003	0.6022	0.0003	0.0003	1076827
30 $	115.09	29.80	382.73	160	0	9.942	0.0079	9.947	0.0070	9.957	0.0075	0.6026	0.0003	0.0003	0.6025	0.0003	0.0003	0.6021	0.0003	0.0003	1078004

[Test Run Date Codes # - 11/07/85 $ - 11/12/85]

Table 46E. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-5B Diameter 6.6239 Inches, Beta Ratio = 0.65705

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	190.40	29.86	210.32	188	0	2.9916	0.0024	2.9910	0.0021	2.9945	0.0030	0.6037	0.0005	0.0007	0.6037	0.0004	0.0007	0.6034	0.0005	0.0007	593146
32 #	189.83	29.90	210.18	188	0	2.9831	0.0019	2.9849	0.0020	2.9929	0.0022	0.6041	0.0004	0.0007	0.6040	0.0004	0.0007	0.6031	0.0004	0.0007	593266
33 #	189.76	29.93	210.16	194	0	2.9831	0.0018	2.9839	0.0019	2.9891	0.0019	0.6041	0.0004	0.0007	0.6040	0.0004	0.0007	0.6035	0.0004	0.0007	593572

[Test Run Date Codes # - 11/12/85]

Table 46F. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-6B Diameter 7.4997 Inches, Beta Ratio = 0.74393

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
24 #	34.229	27.14	168.52	49	0	1.0112	0.0021	1.0090	0.0015	1.0129	0.0019	0.5991	0.0013	0.0015	0.5997	0.0011	0.0015	0.5986	0.0011	0.0015	447976
25 #	34.429	27.17	168.63	48	0	1.0115	0.0025	1.0103	0.0026	1.0113	0.0022	0.5994	0.0013	0.0015	0.5997	0.0012	0.0015	0.5994	0.0011	0.0015	448560
26 #	34.520	27.20	168.54	48	0	1.0096	0.0019	1.0075	0.0020	1.0082	0.0019	0.5997	0.0013	0.0015	0.6003	0.0011	0.0016	0.6001	0.0011	0.0015	448625
27 #	58.069	27.24	105.86	81	0	0.3959	0.0008	0.3945	0.0012	0.3967	0.0007	0.6015	0.0029	0.0038	0.6025	0.0026	0.0038	0.6009	0.0024	0.0038	282037
28 #	57.748	27.25	104.97	80	0	0.3895	0.0009	0.3877	0.0008	0.3887	0.0009	0.6013	0.0029	0.0038	0.6027	0.0026	0.0039	0.6019	0.0024	0.0038	279724
29 #	58.179	27.29	104.43	80	0	0.3858	0.0007	0.3837	0.0006	0.3856	0.0005	0.6011	0.0029	0.0039	0.6027	0.0026	0.0039	0.6012	0.0024	0.0039	278533
30 #	44.835	27.53	875.90	62	0	27.739	0.0130	27.729	0.0192	27.790	0.0180	0.5945	0.0002	0.0002	0.5947	0.0003	0.0002	0.5940	0.0003	0.0002	2348539
31 #	44.928	27.61	874.96	62	0	27.720	0.0239	27.707	0.0239	27.765	0.0251	0.5941	0.0003	0.0002	0.5943	0.0003	0.0002	0.5936	0.0003	0.0002	2350158
32 #	45.146	27.70	874.22	61	0	27.599	0.0183	27.602	0.0114	27.684	0.0184	0.5949	0.0003	0.0002	0.5949	0.0002	0.0002	0.5940	0.0003	0.0002	2352818
33 #	85.472	28.25	526.72	118	0	9.994	0.0114	9.990	0.0088	10.009	0.0072	0.5957	0.0004	0.0003	0.5958	0.0003	0.0003	0.5953	0.0003	0.0003	1434749
34 #	84.763	28.29	526.12	117	0	9.955	0.0109	9.967	0.0131	9.978	0.0071	0.5962	0.0004	0.0003	0.5958	0.0004	0.0003	0.5955	0.0003	0.0003	1434355
35 #	85.057	28.36	525.89	115	0	9.941	0.0144	9.950	0.0104	9.967	0.0051	0.5964	0.0005	0.0003	0.5961	0.0003	0.0003	0.5956	0.0002	0.0003	1435929
36 #	155.07	28.46	292.04	192	0	3.0552	0.0020	3.0517	0.0018	3.0576	0.0019	0.5974	0.0004	0.0006	0.5977	0.0004	0.0006	0.5971	0.0004	0.0006	799141
37 #	155.14	28.52	294.48	192	0	3.1075	0.0037	3.1018	0.0040	3.1088	0.0027	0.5973	0.0005	0.0006	0.5978	0.0005	0.0006	0.5972	0.0004	0.0006	806877
38 #	154.92	28.59	290.72	192	0	3.0263	0.0031	3.0246	0.0039	3.0276	0.0032	0.5975	0.0005	0.0006	0.5977	0.0005	0.0007	0.5974	0.0005	0.0006	797767
39 #	249.69	28.72	166.24	155	0	0.9858	0.0013	0.9836	0.0014	0.9837	0.0014	0.5987	0.0012	0.0016	0.5994	0.0011	0.0016	0.5993	0.0010	0.0016	457485
40 #	250.06	28.82	166.55	155	0	0.9864	0.0014	0.9852	0.0013	0.9875	0.0012	0.5996	0.0012	0.0016	0.6000	0.0011	0.0016	0.5992	0.0010	0.0016	459310
41 #	249.89	28.90	165.35	155	0	0.9739	0.0011	0.9711	0.0009	0.9737	0.0009	0.5991	0.0012	0.0017	0.6000	0.0010	0.0017	0.5992	0.0010	0.0017	456804
44 $	56.825	30.17	107.43	80	0	0.4072	0.0007	0.4069	0.0007	0.4065	0.0008	0.6021	0.0026	0.0037	0.6023	0.0024	0.0037	0.6025	0.0024	0.0037	304989
45 $	57.879	30.18	107.73	81	0	0.4096	0.0008	0.4099	0.0013	0.4101	0.0004	0.6020	0.0026	0.0037	0.6017	0.0025	0.0036	0.6016	0.0024	0.0037	305908
46 $	57.949	30.20	107.83	81	0	0.4114	0.0006	0.4108	0.0006	0.4108	0.0006	0.6011	0.0026	0.0036	0.6016	0.0024	0.0036	0.6016	0.0024	0.0036	306297
47 $	35.327	30.25	169.55	48	0	1.0214	0.0006	1.0203	0.0023	1.0227	0.0016	0.5999	0.0011	0.0015	0.6002	0.0012	0.0015	0.5996	0.0011	0.0015	482138
48 $	35.000	30.26	170.04	49	0	1.0280	0.0032	1.0278	0.0025	1.0275	0.0017	0.5998	0.0014	0.0015	0.5998	0.0012	0.0015	0.5999	0.0011	0.0015	483650
49 $	34.958	30.28	170.22	49	0	1.0306	0.0012	1.0290	0.0010	1.0297	0.0014	0.5996	0.0011	0.0015	0.6001	0.0010	0.0015	0.5999	0.0010	0.0015	484361
50 $	249.68	30.34	170.13	155	0	1.0296	0.0013	1.0298	0.0010	1.0309	0.0010	0.5996	0.0011	0.0016	0.5996	0.0010	0.0016	0.5992	0.0010	0.0016	484732
51 $	250.42	30.36	170.00	155	0	1.0285	0.0014	1.0274	0.0009	1.0293	0.0012	0.5995	0.0011	0.0016	0.5998	0.0010	0.0016	0.5992	0.0010	0.0016	484547
52 $	250.07	30.38	169.93	155	0	1.0276	0.0012	1.0275	0.0008	1.0280	0.0010	0.5995	0.0011	0.0016	0.5995	0.0010	0.0016	0.5994	0.0010	0.0016	484567
53 $	155.06	30.43	294.72	192	0	3.1126	0.0033	3.1150	0.0027	3.1180	0.0022	0.5974	0.0005	0.0006	0.5972	0.0004	0.0006	0.5969	0.0004	0.0006	841305
54 $	155.16	30.42	294.71	192	0	3.1108	0.0025	3.1112	0.0025	3.1177	0.0031	0.5976	0.0004	0.0006	0.5975	0.0004	0.0006	0.5969	0.0004	0.0006	841085
55 $	154.83	30.44	295.78	192	1	3.1393	0.0030	3.1351	0.0034	3.1420	0.0036	0.5970	0.0005	0.0006	0.5974	0.0005	0.0006	0.5967	0.0005	0.0006	844503

[Test Run Date Codes # - 11/07/85 $ - 11/08/85]

Table 46F. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-6B Diameter 7.4997 Inches, Beta Ratio = 0.74393

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
56	#	45.248	30.68	878.58	63	0	27.979	0.0254	27.970	0.0187	28.030	0.0195	0.5940	0.0003	0.0002	0.5941	0.0003	0.0002	0.5935	0.0003	0.0002	2521272
57	#	44.578	30.75	878.23	62	0	27.959	0.0236	27.939	0.0243	27.989	0.0263	0.5940	0.0003	0.0002	0.5942	0.0003	0.0002	0.5937	0.0003	0.0002	2523983
58	#	45.282	30.82	875.45	63	0	27.791	0.0399	27.779	0.0565	27.806	0.0301	0.5939	0.0005	0.0002	0.5940	0.0006	0.0002	0.5937	0.0004	0.0002	2519710
59	#	84.860	30.90	528.00	118	0	10.055	0.0104	10.053	0.0092	10.078	0.0069	0.5955	0.0003	0.0003	0.5956	0.0003	0.0003	0.5948	0.0003	0.0003	1522240
60	#	84.911	30.95	528.42	118	0	10.063	0.0118	10.069	0.0079	10.088	0.0092	0.5958	0.0004	0.0003	0.5956	0.0003	0.0003	0.5950	0.0003	0.0003	1525066
61	#	85.076	31.00	528.56	115	0	10.065	0.0108	10.061	0.0115	10.098	0.0095	0.5959	0.0004	0.0003	0.5960	0.0004	0.0003	0.5949	0.0003	0.0003	1527087

[Test Run Date Codes # - 11/08/85]

Table 46G. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-7B Diameter 0.9995 Inches, Beta Ratio = 0.09914

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	149.41	30.23	2.5330	185	0	1.0370	0.0007	1.0368	0.0006	1.0371	0.0006	0.6013	0.0011	0.0017	0.6013	0.0010	0.0017	0.6013	0.0009	0.0017	7200
2 #	150.21	30.21	2.5204	186	0	1.0273	0.0006	1.0269	0.0004	1.0271	0.0004	0.6011	0.0011	0.0017	0.6012	0.0010	0.0017	0.6012	0.0009	0.0017	7161
3 #	149.93	30.20	2.5169	186	0	1.0249	0.0004	1.0245	0.0003	1.0247	0.0003	0.6010	0.0011	0.0017	0.6011	0.0010	0.0017	0.6010	0.0009	0.0017	7150
4 #	230.21	30.20	1.5872	190	0	0.4048	0.0003	0.4054	0.0002	0.4052	0.0002	0.6031	0.0027	0.0039	0.6026	0.0024	0.0039	0.6028	0.0023	0.0039	4509
5 #	230.38	30.17	1.5808	190	0	0.4015	0.0005	0.4019	0.0002	0.4017	0.0002	0.6031	0.0028	0.0039	0.6028	0.0024	0.0039	0.6029	0.0023	0.0039	4488
6 #	230.35	30.15	1.5783	190	0	0.4001	0.0003	0.4002	0.0001	0.4001	0.0001	0.6032	0.0028	0.0039	0.6030	0.0024	0.0039	0.6031	0.0023	0.0039	4479
7 #	84.484	30.26	4.3156	117	1	3.0161	0.0014	3.0146	0.0016	3.0170	0.0013	0.6007	0.0004	0.0008	0.6008	0.0004	0.0008	0.6006	0.0004	0.0008	12275
8 #	84.785	30.39	4.3089	117	1	3.0060	0.0011	3.0046	0.0016	3.0065	0.0013	0.6008	0.0004	0.0008	0.6009	0.0004	0.0008	0.6007	0.0004	0.0008	12290
9 #	84.784	30.42	4.3035	117	0	3.0015	0.0014	2.9990	0.0014	3.0013	0.0011	0.6005	0.0004	0.0008	0.6007	0.0004	0.0008	0.6005	0.0004	0.0008	12282
11 #	39.748	30.64	9.3183	54	0	14.123	0.0100	14.124	0.0138	14.121	0.0136	0.5994	0.0005	0.0004	0.5994	0.0005	0.0004	0.5994	0.0005	0.0004	26718
12 #	40.753	30.65	9.3280	55	0	14.151	0.0134	14.145	0.0186	14.147	0.0189	0.5994	0.0005	0.0004	0.5996	0.0006	0.0004	0.5995	0.0006	0.0004	26752
13 #	39.733	30.67	9.3185	55	0	14.127	0.0145	14.126	0.0221	14.127	0.0256	0.5993	0.0005	0.0004	0.5994	0.0006	0.0004	0.5993	0.0007	0.0004	26736
13 $	54.491	29.81	6.7020	76	2	7.2975	0.0013	7.2964	0.0019	7.2961	0.0026	0.5997	0.0003	0.0005	0.5997	0.0003	0.0005	0.5997	0.0003	0.0005	18881
14 $	55.088	29.84	6.6982	74	2	7.2815	0.0026	7.2810	0.0022	7.2821	0.0029	0.6000	0.0003	0.0005	0.6000	0.0003	0.0005	0.6000	0.0003	0.0005	18882
15 $	54.563	29.84	6.6953	76	1	7.2789	0.0011	7.2774	0.0016	7.2770	0.0021	0.5998	0.0003	0.0005	0.5999	0.0003	0.0005	0.5999	0.0003	0.0005	18874
16 $	150.21	29.79	2.4602	186	5	0.9775	0.0008	0.9766	0.0012	0.9788	0.0014	0.6015	0.0011	0.0018	0.6018	0.0012	0.0018	0.6011	0.0011	0.0018	6928
17 $	150.06	29.77	2.4824	186	0	0.9969	0.0003	0.9959	0.0003	0.9973	0.0002	0.6010	0.0011	0.0018	0.6013	0.0011	0.0018	0.6008	0.0010	0.0018	6987
18 $	150.20	29.73	2.4758	186	2	0.9915	0.0004	0.9901	0.0004	0.9910	0.0004	0.6010	0.0011	0.0018	0.6014	0.0011	0.0018	0.6011	0.0010	0.0018	6963
19 $	230.21	29.67	1.5766	190	0	0.4014	0.0003	0.4004	0.0001	0.4014	0.0001	0.6015	0.0026	0.0039	0.6023	0.0027	0.0039	0.6015	0.0025	0.0039	4428
20 $	230.42	29.61	1.5703	190	0	0.3977	0.0002	0.3969	0.0001	0.3979	0.0001	0.6018	0.0027	0.0039	0.6025	0.0028	0.0040	0.6017	0.0026	0.0039	4405
21 $	230.45	29.58	1.5708	190	0	0.3980	0.0002	0.3971	0.0002	0.3981	0.0002	0.6019	0.0026	0.0039	0.6025	0.0028	0.0039	0.6017	0.0026	0.0039	4404
22 $	84.836	29.58	4.3273	118	0	3.0335	0.0019	3.0322	0.0023	3.0333	0.0026	0.6005	0.0004	0.0008	0.6007	0.0005	0.0008	0.6005	0.0005	0.0008	12131
23 $	84.874	29.68	4.3223	118	0	3.0270	0.0011	3.0257	0.0012	3.0270	0.0015	0.6005	0.0004	0.0008	0.6006	0.0004	0.0008	0.6005	0.0004	0.0008	12143
24 $	84.869	29.70	4.3194	115	2	3.0235	0.0005	3.0220	0.0008	3.0230	0.0011	0.6004	0.0004	0.0008	0.6006	0.0004	0.0008	0.6005	0.0004	0.0008	12140
25 $	271.23	29.76	6.7635	168	0	7.4377	0.0011	7.4358	0.0010	7.4359	0.0012	0.5994	0.0002	0.0005	0.5995	0.0002	0.0005	0.5995	0.0002	0.0005	19034
26 $	271.31	29.76	6.7686	168	1	7.4488	0.0013	7.4471	0.0009	7.4477	0.0007	0.5995	0.0002	0.0005	0.5995	0.0002	0.0005	0.5995	0.0002	0.0005	19048
27 $	271.09	29.76	6.7682	168	1	7.4477	0.0014	7.4459	0.0011	7.4464	0.0011	0.5995	0.0002	0.0005	0.5995	0.0002	0.0005	0.5995	0.0002	0.0005	19047
28 $	269.65	29.77	6.7775	167	0	7.4676	0.0056	7.4676	0.0024	7.4684	0.0025	0.5995	0.0003	0.0005	0.5995	0.0002	0.0005	0.5995	0.0002	0.0005	19077
29 $	271.36	29.84	6.7739	168	0	7.4544	0.0050	7.4553	0.0040	7.4557	0.0040	0.5997	0.0003	0.0005	0.5997	0.0002	0.0005	0.5997	0.0002	0.0005	19096
30 $	271.04	29.88	6.7465	168	0	7.3986	0.0053	7.3978	0.0031	7.3987	0.0034	0.5995	0.0003	0.0005	0.5996	0.0002	0.0005	0.5995	0.0002	0.0005	19035

[Test Run Date Codes # - 11/07/85 $ - 11/12/85]

Table 46G. Orifice Discharge Coefficient Values - Meter Tube PE-9

Meter Tube PE-9ABC Diameter 10.0812 Inches -- Orifice Plate FE-9/0-7B Diameter 0.9995 Inches, Beta Ratio = 0.09914

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	199.80	29.96	9.1063	165	0	13.518	0.0085	13.507	0.0061	13.508	0.0070	0.5987	0.0002	0.0004	0.5989	0.0002	0.0004	0.5989	0.0002	0.0004	25736
32	#	200.95	29.97	9.0970	166	0	13.470	0.0110	13.477	0.0087	13.478	0.0083	0.5991	0.0003	0.0004	0.5990	0.0002	0.0004	0.5990	0.0002	0.0004	25716
33	#	200.60	29.99	9.0795	166	0	13.415	0.0136	13.429	0.0093	13.429	0.0096	0.5992	0.0003	0.0004	0.5989	0.0002	0.0004	0.5989	0.0002	0.0004	25677

[Test Run Date Codes # - 11/12/85]

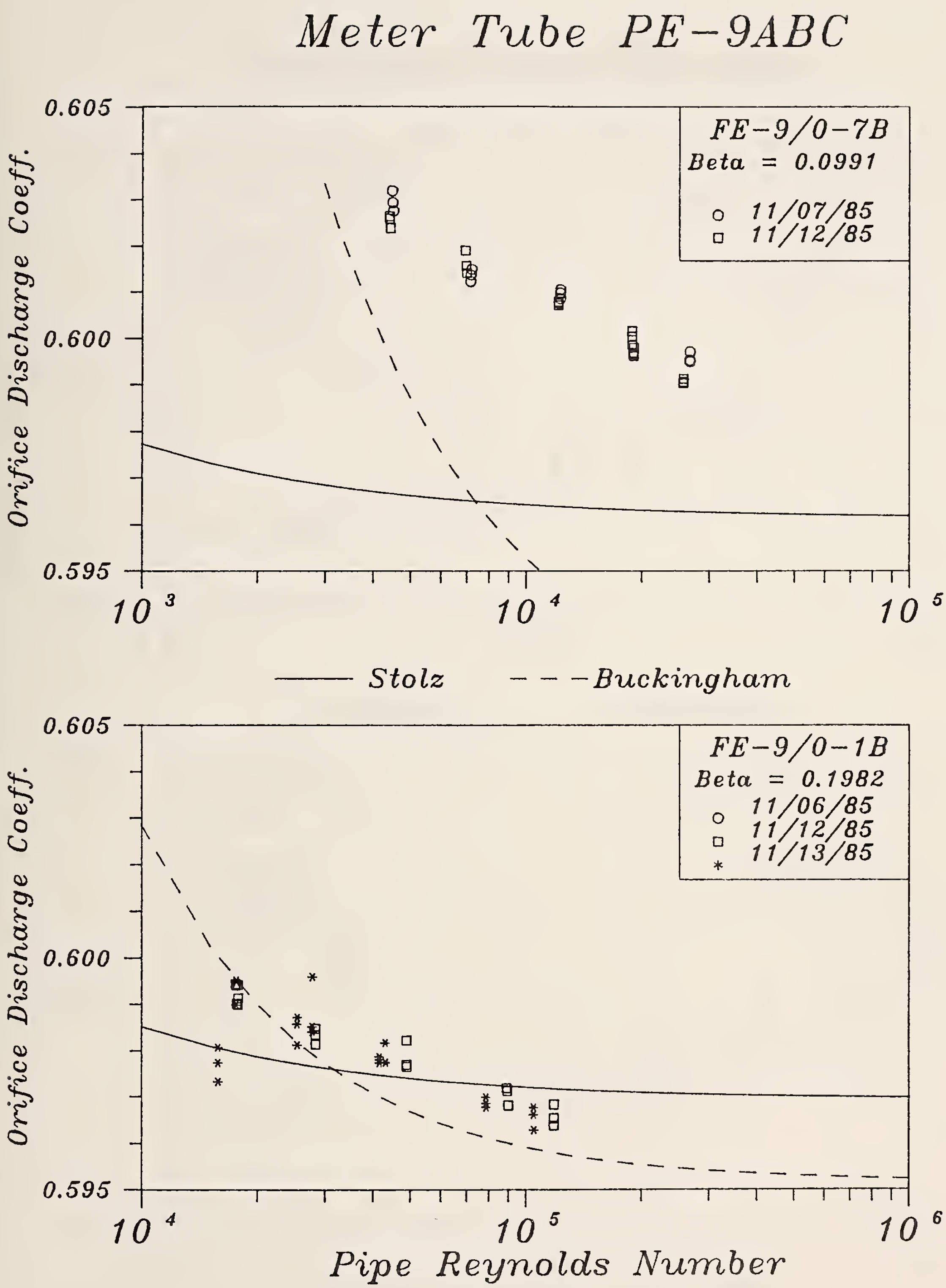


Figure 33A. Discharge Coefficient/Reynolds Number Plots, PE-9ABC 10-Inch Meter Tube, 8 Orifice Plates, Final Data Base

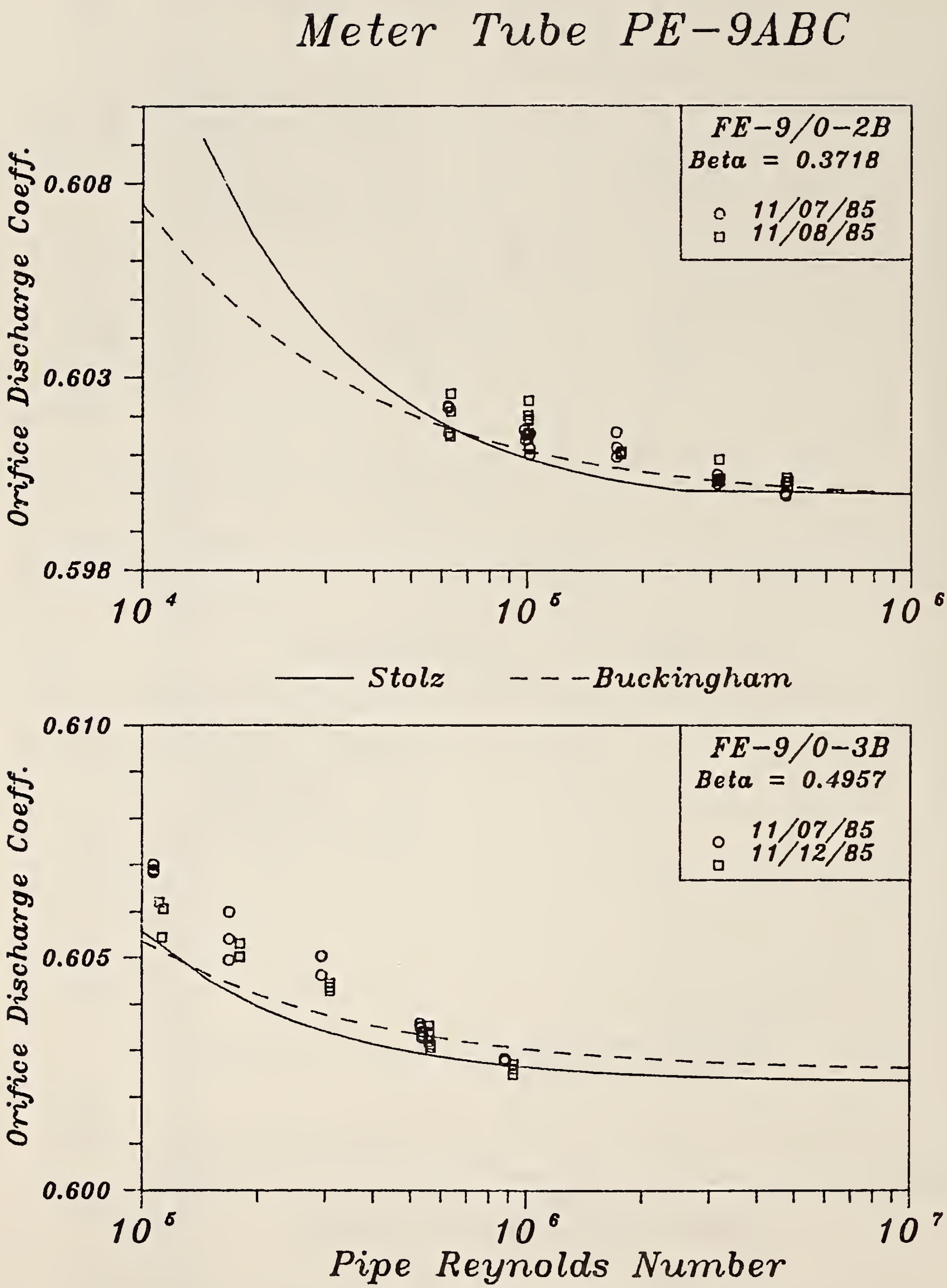


Figure 33B. Discharge Coefficient/Reynolds Number Plots, PE-9ABC 10-Inch Meter Tube, 7 Orifice Plates, Final Data Base

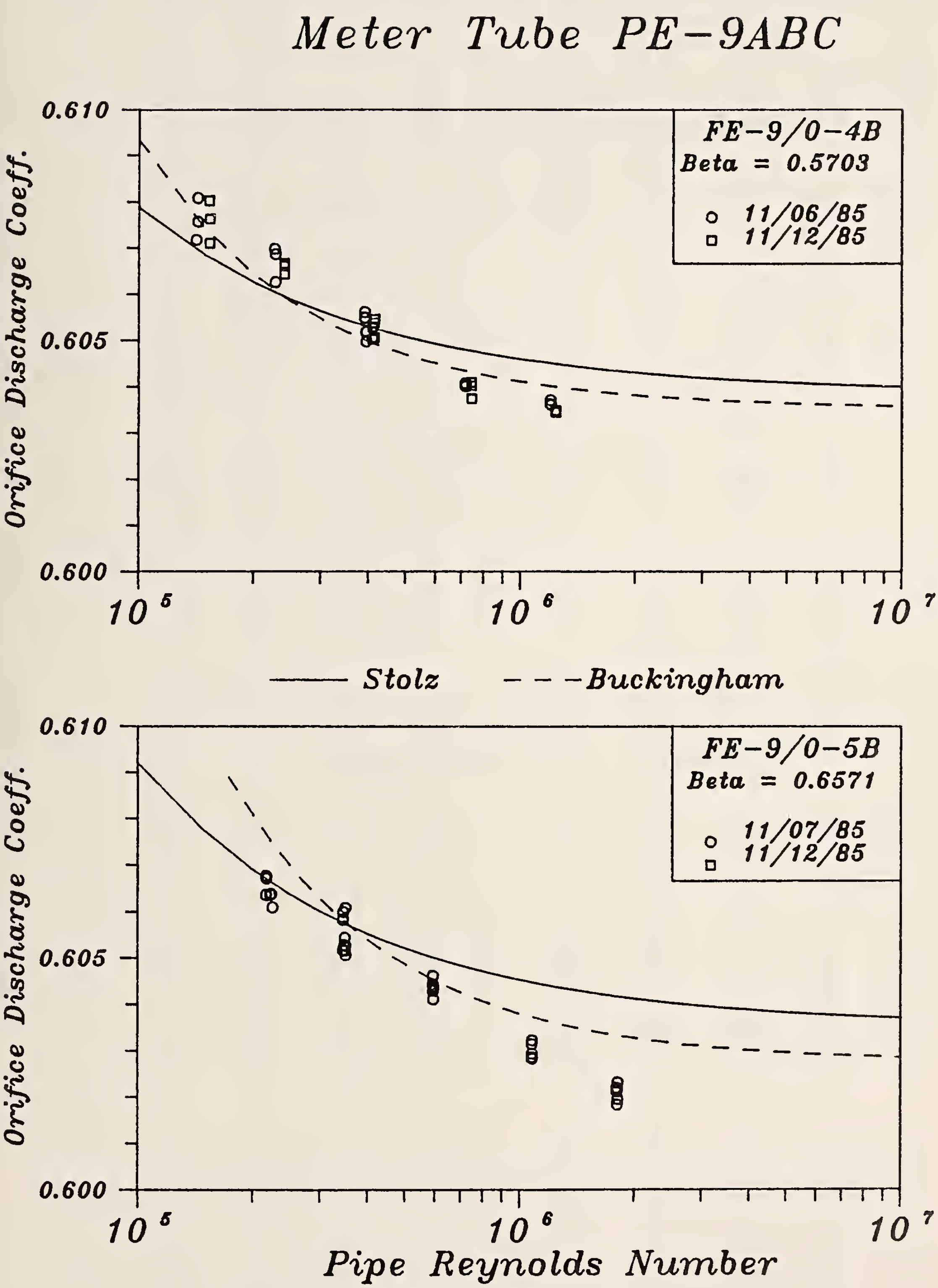


Figure 33C. Discharge Coefficient/Reynolds Number Plots, PE-9ABC 10-Inch Meter Tube, 7 Orifice Plates, Final Data Base

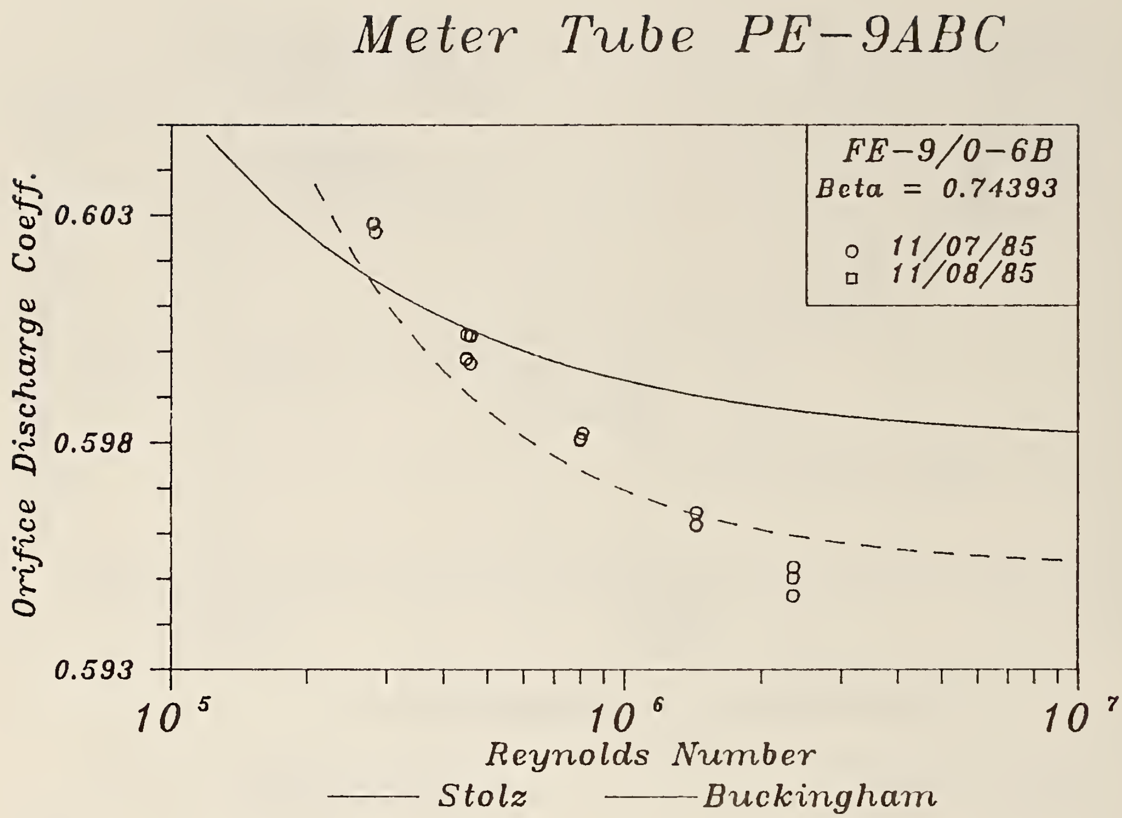


Figure 33D. Discharge Coefficient/Reynolds Number Plots, PE-9ABC
10-Inch Meter Tube, 7 Orifice Plates, Final Data Base

Table 47A. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-1A Diameter 1.9987 Inches, Beta Ratio = 0.19939

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	105.19	31.43	17.173	143	0	2.9992	0.0019	2.9975	0.0023	3.0013	0.0025	0.5991	0.0004	0.0007	0.5992	0.0004	0.0007	0.5988	0.0004	0.0007	50348
2	#	104.58	31.45	17.149	143	0	2.9959	0.0010	2.9941	0.0012	2.9943	0.0015	0.5986	0.0004	0.0007	0.5988	0.0004	0.0007	0.5987	0.0004	0.0007	50300
3	#	105.61	31.45	17.144	145	1	2.9933	0.0014	2.9907	0.0018	2.9918	0.0018	0.5986	0.0004	0.0007	0.5989	0.0004	0.0007	0.5988	0.0004	0.0007	50285
4	#	44.415	31.54	41.161	61	0	17.293	0.0187	17.303	0.0190	17.315	0.0128	0.5980	0.0005	0.0003	0.5978	0.0005	0.0003	0.5976	0.0004	0.0003	120955
5	#	45.207	31.54	41.922	62	0	17.963	0.0249	17.967	0.0225	17.962	0.0204	0.5976	0.0005	0.0003	0.5975	0.0005	0.0003	0.5976	0.0005	0.0003	123192
6	#	45.242	31.55	41.902	62	0	17.905	0.0278	17.907	0.0288	17.903	0.0316	0.5983	0.0006	0.0003	0.5982	0.0006	0.0003	0.5983	0.0006	0.0003	123160
7	#	188.85	31.52	10.033	200	6	1.0247	0.0007	1.0259	0.0008	1.0248	0.0007	0.5988	0.0010	0.0016	0.5984	0.0009	0.0016	0.5988	0.0009	0.0016	29472
8	#	187.20	31.54	10.091	200	12	1.0358	0.0008	1.0361	0.0007	1.0350	0.0008	0.5990	0.0010	0.0016	0.5989	0.0009	0.0016	0.5993	0.0009	0.0016	29654
9	#	190.25	31.56	10.091	194	1	1.0381	0.0003	1.0381	0.0004	1.0360	0.0005	0.5983	0.0009	0.0016	0.5983	0.0009	0.0016	0.5989	0.0009	0.0016	29665
10	#	300.09	31.52	6.3610	149	0	0.4123	0.0003	0.4124	0.0003	0.4118	0.0003	0.5985	0.0023	0.0037	0.5984	0.0023	0.0037	0.5988	0.0022	0.0037	18685
11	#	301.81	31.57	6.3782	150	2	0.4144	0.0003	0.4143	0.0002	0.4136	0.0003	0.5986	0.0023	0.0037	0.5987	0.0022	0.0037	0.5992	0.0021	0.0036	18755
12	#	301.62	31.60	6.3881	150	0	0.4150	0.0004	0.4150	0.0005	0.4144	0.0004	0.5991	0.0023	0.0036	0.5991	0.0023	0.0036	0.5995	0.0022	0.0036	18796
13	#	56.643	31.72	31.272	78	0	9.981	0.0060	9.982	0.0059	9.985	0.0069	0.5980	0.0003	0.0003	0.5980	0.0003	0.0003	0.5979	0.0004	0.0003	92242
14	#	57.384	31.73	31.305	79	0	9.985	0.0167	9.988	0.0178	9.991	0.0104	0.5985	0.0006	0.0003	0.5984	0.0006	0.0003	0.5983	0.0004	0.0003	92357
15	#	57.394	31.73	31.283	79	0	9.987	0.0089	9.985	0.0101	9.987	0.0158	0.5981	0.0004	0.0003	0.5981	0.0004	0.0003	0.5981	0.0006	0.0003	92295
16	#	140.09	31.69	13.020	191	1	1.7265	0.0007	1.7264	0.0008	1.7269	0.0007	0.5986	0.0006	0.0010	0.5987	0.0006	0.0010	0.5986	0.0006	0.0010	38380
17	#	140.06	31.69	12.961	192	0	1.7095	0.0005	1.7091	0.0007	1.7087	0.0007	0.5989	0.0006	0.0010	0.5989	0.0006	0.0010	0.5990	0.0006	0.0010	38206
18	#	140.12	31.68	12.922	192	11	1.6975	0.0015	1.6974	0.0016	1.6976	0.0014	0.5992	0.0006	0.0010	0.5992	0.0006	0.0010	0.5992	0.0006	0.0010	38085
19	#	300.10	31.64	6.3416	149	1	0.4084	0.0002	0.4086	0.0002	0.4081	0.0002	0.5995	0.0024	0.0037	0.5994	0.0023	0.0037	0.5997	0.0022	0.0037	18674
20	#	301.77	31.63	6.3376	150	2	0.4082	0.0002	0.4079	0.0002	0.4074	0.0001	0.5993	0.0024	0.0037	0.5995	0.0023	0.0037	0.5999	0.0022	0.0037	18659
21	#	301.96	31.61	6.3277	150	1	0.4064	0.0002	0.4062	0.0002	0.4059	0.0002	0.5997	0.0024	0.0037	0.5998	0.0023	0.0037	0.6000	0.0022	0.0037	18622
22	#	186.05	31.60	9.950	200	2	1.0069	0.0005	1.0064	0.0005	1.0063	0.0004	0.5991	0.0010	0.0016	0.5992	0.0009	0.0016	0.5993	0.0009	0.0016	29277
23	#	190.69	31.63	9.955	196	2	1.0084	0.0003	1.0081	0.0003	1.0071	0.0003	0.5989	0.0010	0.0016	0.5990	0.0009	0.0016	0.5993	0.0009	0.0016	29308
24	#	190.93	31.60	9.956	199	0	1.0079	0.0004	1.0078	0.0004	1.0072	0.0003	0.5991	0.0010	0.0016	0.5992	0.0009	0.0016	0.5993	0.0009	0.0016	29294
25	$	301.27	29.48	6.3250	140	0	0.4054	0.0002	0.4054	0.0002	0.4053	0.0002	0.6000	0.0024	0.0037	0.6000	0.0024	0.0037	0.6001	0.0023	0.0037	17794
26	$	301.45	29.60	6.3067	140	2	0.4032	0.0001	0.4029	0.0002	0.4024	0.0002	0.5999	0.0024	0.0038	0.6001	0.0024	0.0038	0.6005	0.0023	0.0037	17788
27	$	301.24	29.60	6.3075	140	0	0.4034	0.0001	0.4029	0.0001	0.4025	0.0002	0.5998	0.0024	0.0038	0.6002	0.0024	0.0038	0.6005	0.0023	0.0037	17790
28	$	168.29	29.63	9.975	200	0	1.0103	0.0004	1.0092	0.0005	1.0092	0.0005	0.5994	0.0010	0.0016	0.5997	0.0010	0.0016	0.5997	0.0009	0.0016	28153
29	$	177.45	29.63	9.967	200	1	1.0090	0.0004	1.0078	0.0004	1.0076	0.0005	0.5993	0.0010	0.0016	0.5997	0.0010	0.0016	0.5997	0.0009	0.0016	28129
30	$	176.02	29.62	9.964	200	3	1.0087	0.0004	1.0076	0.0003	1.0073	0.0004	0.5992	0.0010	0.0016	0.5995	0.0010	0.0016	0.5996	0.0009	0.0016	28114

[Test Run Date Codes # - 11/14/85 $ - 11/18/85]

Table 47A. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-1A Diameter 1.9987 Inches, Beta Ratio = 0.19939

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	105.25	29.90	17.203	143	5	3.0084	0.0032	3.0080	0.0026	3.0088	0.0033	0.5991	0.0005	0.0007	0.5991	0.0004	0.0007	0.5990	0.0005	0.0007	48833
32	#	105.81	29.93	17.210	147	0	3.0105	0.0016	3.0085	0.0022	3.0094	0.0022	0.5991	0.0004	0.0007	0.5993	0.0004	0.0007	0.5992	0.0004	0.0007	48886
33	#	105.67	29.95	17.222	147	0	3.0167	0.0019	3.0145	0.0021	3.0167	0.0033	0.5989	0.0004	0.0007	0.5991	0.0004	0.0007	0.5989	0.0005	0.0007	48940
34	#	56.865	30.22	31.387	79	0	10.047	0.0083	10.047	0.0071	10.049	0.0060	0.5981	0.0004	0.0003	0.5981	0.0004	0.0003	0.5981	0.0003	0.0003	89706
35	#	57.563	30.23	31.690	80	2	10.222	0.0182	10.234	0.0167	10.234	0.0150	0.5987	0.0006	0.0003	0.5984	0.0006	0.0003	0.5984	0.0005	0.0003	90591
36	#	57.451	30.25	31.759	80	0	10.290	0.0165	10.288	0.0172	10.288	0.0152	0.5980	0.0006	0.0003	0.5981	0.0006	0.0003	0.5981	0.0005	0.0003	90826
37	#	44.646	30.29	41.114	62	0	17.260	0.0249	17.262	0.0271	17.270	0.0340	0.5978	0.0006	0.0003	0.5978	0.0006	0.0003	0.5976	0.0007	0.0003	117682
38	#	45.668	30.31	41.082	62	0	17.212	0.0163	17.210	0.0235	17.228	0.0246	0.5982	0.0005	0.0003	0.5982	0.0005	0.0003	0.5979	0.0006	0.0003	117640
39	#	45.333	30.31	41.070	63	0	17.181	0.0209	17.193	0.0184	17.198	0.0227	0.5985	0.0005	0.0003	0.5983	0.0005	0.0003	0.5982	0.0005	0.0003	117604

[Test Run Date Codes # - 11/18/85]

Table 47B. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-2A Diameter 3.7480 Inches, Beta Ratio = 0.37390

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	99.487	28.78	62.407	135	0	3.1190	0.0026	3.1163	0.0031	3.1128	0.0029	0.6014	0.0004	0.0006	0.6017	0.0004	0.0006	0.6020	0.0004	0.0006	172938
2	#	99.51	28.80	62.809	137	0	3.1584	0.0024	3.1575	0.0026	3.1574	0.0025	0.6015	0.0004	0.0006	0.6016	0.0004	0.0006	0.6016	0.0004	0.0006	174128
3	#	99.71	28.81	61.996	136	0	3.0780	0.0015	3.0752	0.0019	3.0734	0.0019	0.6014	0.0004	0.0006	0.6017	0.0004	0.0006	0.6019	0.0004	0.0006	171912
7	#	35.461	28.83	167.37	49	0	22.481	0.0203	22.474	0.0285	22.472	0.0276	0.6008	0.0003	0.0002	0.6009	0.0004	0.0002	0.6009	0.0004	0.0002	464310
8	#	35.846	28.85	167.73	50	0	22.588	0.0371	22.578	0.0332	22.585	0.0566	0.6007	0.0005	0.0002	0.6008	0.0005	0.0002	0.6007	0.0008	0.0002	465518
9	#	35.361	28.87	167.60	49	0	22.572	0.0342	22.564	0.0323	22.566	0.0266	0.6004	0.0005	0.0002	0.6005	0.0005	0.0002	0.6005	0.0004	0.0002	465351
13	#	161.41	29.06	36.152	200	0	1.0451	0.0006	1.0454	0.0007	1.0431	0.0009	0.6019	0.0010	0.0015	0.6018	0.0009	0.0015	0.6025	0.0009	0.0015	100790
14	#	161.30	29.10	36.236	200	0	1.0501	0.0009	1.0499	0.0010	1.0488	0.0010	0.6019	0.0010	0.0015	0.6019	0.0009	0.0015	0.6022	0.0009	0.0015	101113
15	#	161.57	29.13	36.276	200	3	1.0517	0.0013	1.0519	0.0013	1.0512	0.0016	0.6021	0.0010	0.0015	0.6020	0.0010	0.0015	0.6022	0.0010	0.0015	101288
16	#	54.296	29.16	111.65	76	0	10.001	0.0126	9.999	0.0134	9.999	0.0119	0.6009	0.0004	0.0003	0.6010	0.0004	0.0003	0.6010	0.0004	0.0003	311949
17	#	53.807	29.16	111.79	75	0	10.025	0.0071	10.025	0.0026	10.026	0.0052	0.6009	0.0003	0.0003	0.6009	0.0002	0.0003	0.6009	0.0002	0.0003	312330
18	#	53.804	29.16	111.92	75	0	10.041	0.0151	10.033	0.0157	10.050	0.0071	0.6011	0.0005	0.0003	0.6014	0.0005	0.0003	0.6009	0.0003	0.0003	312693
19	#	52.647	29.18	35.730	73	0	1.0209	0.0009	1.0198	0.0012	1.0187	0.0006	0.6019	0.0010	0.0015	0.6022	0.0010	0.0015	0.6025	0.0009	0.0015	99873
20	#	52.673	29.19	35.729	73	0	1.0219	0.0007	1.0210	0.0011	1.0209	0.0009	0.6016	0.0010	0.0015	0.6018	0.0010	0.0015	0.6019	0.0010	0.0015	99891
21	#	52.639	29.21	35.714	73	0	1.0198	0.0011	1.0186	0.0011	1.0186	0.0008	0.6019	0.0010	0.0015	0.6023	0.0010	0.0015	0.6023	0.0010	0.0015	99891
25	#	84.210	29.33	22.753	115	0	0.4144	0.0003	0.4132	0.0004	0.4120	0.0003	0.6016	0.0023	0.0036	0.6025	0.0023	0.0036	0.6033	0.0022	0.0036	63805
26	#	84.658	29.36	22.757	118	0	0.4144	0.0004	0.4133	0.0004	0.4121	0.0004	0.6017	0.0023	0.0036	0.6025	0.0023	0.0036	0.6034	0.0022	0.0036	63856
27	#	83.931	29.39	22.766	117	0	0.4148	0.0002	0.4136	0.0003	0.4126	0.0003	0.6017	0.0023	0.0036	0.6025	0.0023	0.0036	0.6033	0.0022	0.0036	63922
29	$	53.218	31.55	35.320	74	0	0.9977	0.0010	0.9978	0.0009	0.9987	0.0009	0.6020	0.0012	0.0016	0.6020	0.0010	0.0016	0.6017	0.0010	0.0016	103814
30	$	53.283	31.56	35.346	74	0	0.9979	0.0007	0.9980	0.0009	0.9986	0.0009	0.6024	0.0012	0.0016	0.6024	0.0010	0.0016	0.6022	0.0010	0.0016	103913
31	$	83.964	31.57	22.427	113	2	0.4024	0.0003	0.4025	0.0003	0.4022	0.0006	0.6019	0.0028	0.0037	0.6019	0.0024	0.0037	0.6021	0.0023	0.0037	65944
32	$	84.517	31.59	22.262	115	2	0.3956	0.0005	0.3956	0.0006	0.3958	0.0003	0.6026	0.0028	0.0038	0.6026	0.0025	0.0038	0.6025	0.0023	0.0038	65486
33	$	84.118	31.62	22.253	117	1	0.3951	0.0005	0.3950	0.0004	0.3958	0.0004	0.6027	0.0028	0.0038	0.6028	0.0024	0.0038	0.6022	0.0023	0.0038	65502
34	$	53.718	31.68	111.60	73	0	10.004	0.0108	10.007	0.0088	10.010	0.0084	0.6007	0.0004	0.0003	0.6006	0.0003	0.0003	0.6005	0.0003	0.0003	328900
35	$	53.750	31.69	111.54	75	0	9.996	0.0065	9.996	0.0072	9.991	0.0074	0.6006	0.0003	0.0003	0.6006	0.0003	0.0003	0.6008	0.0003	0.0003	328789
36	$	53.707	31.69	111.57	75	0	9.989	0.0091	9.993	0.0068	9.993	0.0058	0.6010	0.0003	0.0003	0.6009	0.0003	0.0003	0.6009	0.0002	0.0003	328883
37	$	34.875	31.70	166.48	47	0	22.250	0.0361	22.254	0.0331	22.233	0.0351	0.6009	0.0005	0.0002	0.6008	0.0005	0.0002	0.6011	0.0005	0.0002	490847
38	$	35.656	31.67	166.48	50	0	22.283	0.0107	22.266	0.0195	22.263	0.0229	0.6005	0.0002	0.0002	0.6007	0.0003	0.0002	0.6007	0.0004	0.0002	490559
39	$	36.009	31.67	166.53	48	0	22.281	0.0192	22.264	0.0149	22.278	0.0170	0.6007	0.0003	0.0002	0.6009	0.0003	0.0002	0.6007	0.0003	0.0002	490698
40	$	99.004	31.65	61.399	138	3	3.0216	0.0028	3.0222	0.0026	3.0210	0.0016	0.6014	0.0005	0.0006	0.6013	0.0004	0.0006	0.6014	0.0004	0.0006	180843

[Test Run Date Codes # - 11/14/85 $ - 11/19/85]

Table 47B. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-2A Diameter 3.7480 Inches, Beta Ratio = 0.37390

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
41 #	99.89	31.66	61.517	139	1	3.0344	0.0013	3.0345	0.0013	3.0313	0.0018	0.6013	0.0004	0.0006	0.6012	0.0004	0.0006	0.6016	0.0004	0.0006	181227
42 #	99.79	31.69	61.593	139	1	3.0380	0.0012	3.0391	0.0012	3.0362	0.0014	0.6016	0.0004	0.0006	0.6015	0.0004	0.0006	0.6018	0.0004	0.0006	181565

[Test Run Date Codes # - 11/19/85]

Table 47C. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-3A Diameter 4.9985 Inches, Beta Ratio = 0.49864

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	200.58	31.64	203.84	166	0	10.034	0.0041	10.036	0.0042	10.031	0.0035	0.6026	0.0002	0.0003	0.6025	0.0002	0.0003	0.6026	0.0002	0.0003	600250
2	#	200.72	31.66	203.67	166	4	10.023	0.0062	10.015	0.0048	10.009	0.0047	0.6024	0.0002	0.0003	0.6026	0.0002	0.0003	0.6028	0.0002	0.0003	600008
3	#	199.55	31.70	204.06	165	0	10.058	0.0052	10.054	0.0050	10.055	0.0044	0.6025	0.0002	0.0003	0.6026	0.0002	0.0003	0.6026	0.0002	0.0003	601659
4	#	134.83	31.72	329.25	179	0	26.202	0.0095	26.204	0.0119	26.189	0.0141	0.6023	0.0002	0.0002	0.6023	0.0002	0.0002	0.6024	0.0002	0.0002	971175
5	#	134.63	31.74	330.88	183	0	26.461	0.0116	26.448	0.0093	26.436	0.0116	0.6023	0.0002	0.0002	0.6025	0.0002	0.0002	0.6026	0.0002	0.0002	976382
6	#	135.23	31.76	330.72	185	0	26.423	0.0088	26.423	0.0083	26.407	0.0093	0.6025	0.0002	0.0002	0.6024	0.0001	0.0002	0.6026	0.0002	0.0002	976327
7	#	53.983	31.79	111.75	75	0	3.0031	0.0017	3.0040	0.0022	3.0037	0.0019	0.6038	0.0004	0.0006	0.6037	0.0004	0.0006	0.6038	0.0004	0.0006	330102
8	#	54.342	31.82	111.69	75	0	3.0030	0.0030	3.0031	0.0051	2.9986	0.0020	0.6035	0.0005	0.0006	0.6035	0.0006	0.0006	0.6040	0.0004	0.0006	330148
9	#	53.640	31.84	111.30	74	0	2.9769	0.0023	2.9754	0.0019	2.9803	0.0018	0.6041	0.0004	0.0006	0.6042	0.0004	0.0006	0.6037	0.0004	0.0006	329126
10	#	29.220	31.90	202.90	41	0	9.933	0.0078	9.937	0.0117	9.917	0.0101	0.6028	0.0003	0.0003	0.6027	0.0004	0.0003	0.6033	0.0004	0.0003	600738
11	#	29.435	31.91	202.92	41	0	9.929	0.0113	9.931	0.0095	9.922	0.0082	0.6030	0.0004	0.0003	0.6030	0.0004	0.0003	0.6032	0.0004	0.0003	600915
12	#	29.268	31.93	202.95	41	0	9.917	0.0053	9.929	0.0091	9.929	0.0099	0.6035	0.0003	0.0003	0.6031	0.0004	0.0003	0.6031	0.0004	0.0003	601254
13	#	94.668	31.95	64.054	131	0	0.9856	0.0009	0.9855	0.0008	0.9853	0.0011	0.6042	0.0010	0.0016	0.6042	0.0010	0.0016	0.6043	0.0010	0.0016	189844
14	#	94.547	31.99	64.168	130	0	0.9890	0.0006	0.9883	0.0007	0.9884	0.0008	0.6042	0.0010	0.0016	0.6044	0.0010	0.0016	0.6044	0.0009	0.0016	190338
15	#	94.202	32.02	64.184	130	1	0.9884	0.0006	0.9879	0.0008	0.9878	0.0009	0.6045	0.0010	0.0016	0.6047	0.0010	0.0016	0.6047	0.0010	0.0016	190506
16	#	149.94	32.08	41.283	186	1	0.4086	0.0004	0.4088	0.0005	0.4079	0.0003	0.6048	0.0024	0.0037	0.6047	0.0023	0.0037	0.6053	0.0022	0.0037	122686
17	#	149.79	32.14	41.227	186	0	0.4081	0.0003	0.4083	0.0003	0.4069	0.0003	0.6043	0.0024	0.0037	0.6042	0.0023	0.0037	0.6052	0.0022	0.0037	122672
18	#	150.34	32.19	41.192	186	1	0.4072	0.0002	0.4071	0.0003	0.4062	0.0003	0.6045	0.0024	0.0037	0.6045	0.0023	0.0037	0.6052	0.0022	0.0037	122693
19	$	95.245	32.18	64.335	133	0	0.9929	0.0008	0.9922	0.0009	0.9916	0.0006	0.6046	0.0011	0.0016	0.6048	0.0011	0.0016	0.6050	0.0010	0.0016	191588
20	$	94.710	32.21	64.212	132	0	0.9896	0.0011	0.9885	0.0010	0.9887	0.0008	0.6045	0.0011	0.0016	0.6048	0.0011	0.0016	0.6047	0.0010	0.0016	191339
21	$	94.813	32.24	64.052	132	0	0.9852	0.0008	0.9836	0.0009	0.9846	0.0004	0.6043	0.0011	0.0016	0.6048	0.0011	0.0016	0.6045	0.0010	0.0016	190983
22	$	29.708	32.29	203.75	42	0	10.019	0.0066	10.010	0.0045	10.014	0.0100	0.6028	0.0003	0.0003	0.6031	0.0003	0.0003	0.6030	0.0004	0.0003	608151
23	$	29.845	32.30	203.42	42	0	9.974	0.0081	9.973	0.0116	9.963	0.0067	0.6032	0.0004	0.0003	0.6032	0.0004	0.0003	0.6035	0.0003	0.0003	607296
24	$	29.740	32.31	203.48	42	0	9.982	0.0052	9.984	0.0030	9.981	0.0069	0.6031	0.0003	0.0003	0.6031	0.0003	0.0003	0.6032	0.0003	0.0003	607599
25	$	52.885	32.32	110.92	74	0	2.9543	0.0024	2.9547	0.0021	2.9551	0.0036	0.6043	0.0005	0.0006	0.6043	0.0004	0.0006	0.6042	0.0005	0.0006	331274
26	$	53.581	32.35	110.70	73	0	2.9439	0.0039	2.9422	0.0030	2.9464	0.0015	0.6042	0.0006	0.0006	0.6044	0.0005	0.0006	0.6040	0.0004	0.0006	330835
27	$	53.894	32.38	110.77	75	0	2.9508	0.0029	2.9499	0.0027	2.9496	0.0034	0.6038	0.0005	0.0006	0.6039	0.0005	0.0006	0.6040	0.0005	0.0006	331227
28	$	149.91	32.42	40.629	186	0	0.3956	0.0002	0.3951	0.0003	0.3954	0.0003	0.6050	0.0027	0.0038	0.6053	0.0026	0.0038	0.6051	0.0025	0.0038	121593
29	$	149.84	32.47	40.557	186	0	0.3937	0.0003	0.3929	0.0003	0.3937	0.0005	0.6053	0.0027	0.0038	0.6059	0.0026	0.0038	0.6053	0.0025	0.0038	121505
30	$	149.87	32.53	40.832	186	0	0.3995	0.0004	0.3986	0.0004	0.3996	0.0004	0.6050	0.0027	0.0038	0.6057	0.0026	0.0038	0.6049	0.0024	0.0038	122479

[Test Run Date Codes # - 11/14/85 $ - 11/15/85]

Table 47C. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-3A Diameter 4.9985 Inches, Beta Ratio = 0.49864

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	134.77	32.55	332.92	181	0	26.802	0.0078	26.801	0.0107	26.788	0.0148	0.6022	0.0001	0.0002	0.6022	0.0002	0.0002	0.6024	0.0002	0.0002	999044
32	#	134.95	32.55	332.82	187	0	26.780	0.0159	26.775	0.0162	26.756	0.0102	0.6023	0.0002	0.0002	0.6023	0.0002	0.0002	0.6026	0.0002	0.0002	998734
33	#	134.73	32.54	332.89	184	0	26.780	0.0123	26.782	0.0140	26.776	0.0107	0.6024	0.0002	0.0002	0.6024	0.0002	0.0002	0.6025	0.0002	0.0002	998744
34	$	148.85	32.33	41.276	185	0	0.4082	0.0003	0.4074	0.0003	0.4077	0.0003	0.6050	0.0027	0.0037	0.6056	0.0024	0.0037	0.6053	0.0023	0.0037	123302
35	$	149.92	32.37	41.333	186	0	0.4089	0.0004	0.4082	0.0004	0.4088	0.0003	0.6053	0.0027	0.0037	0.6058	0.0024	0.0037	0.6054	0.0023	0.0037	123572
36	$	150.03	32.39	41.353	186	1	0.4092	0.0001	0.4083	0.0003	0.4085	0.0003	0.6054	0.0027	0.0037	0.6060	0.0024	0.0037	0.6059	0.0023	0.0037	123684
37	$	94.511	32.45	65.202	132	0	1.0206	0.0008	1.0188	0.0006	1.0200	0.0004	0.6044	0.0011	0.0015	0.6049	0.0010	0.0015	0.6046	0.0009	0.0015	195256
38	$	94.914	32.47	65.200	127	0	1.0197	0.0005	1.0184	0.0007	1.0184	0.0005	0.6046	0.0011	0.0015	0.6050	0.0010	0.0015	0.6050	0.0009	0.0015	195330
39	$	94.792	32.47	65.196	132	0	1.0199	0.0006	1.0182	0.0006	1.0188	0.0005	0.6045	0.0011	0.0015	0.6051	0.0010	0.0015	0.6049	0.0009	0.0015	195318
40	$	53.547	32.50	112.45	75	0	3.0393	0.0020	3.0376	0.0029	3.0403	0.0024	0.6041	0.0004	0.0006	0.6042	0.0005	0.0006	0.6040	0.0004	0.0006	337108
41	$	53.392	32.50	112.50	72	0	3.0418	0.0015	3.0404	0.0025	3.0430	0.0024	0.6041	0.0004	0.0006	0.6042	0.0004	0.0006	0.6039	0.0004	0.0006	337240
42	$	53.810	32.50	112.54	75	0	3.0453	0.0018	3.0438	0.0016	3.0469	0.0022	0.6040	0.0004	0.0006	0.6041	0.0004	0.0006	0.6038	0.0004	0.0006	337378

[Test Run Date Codes # - 11/15/85 $ - 11/19/85]

Table 47D. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-4A Diameter 5.7488 Inches, Beta Ratio = 0.57349

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	39.395	29.36	153.81	55	0	3.0722	0.0023	3.0703	0.0018	3.0674	0.0025	0.6055	0.0004	0.0006	0.6057	0.0004	0.0006	0.6060	0.0004	0.0006	431605
2 #	39.500	29.39	154.92	55	0	3.1179	0.0027	3.1156	0.0038	3.1141	0.0024	0.6054	0.0005	0.0006	0.6056	0.0005	0.0006	0.6058	0.0004	0.0006	435003
3 #	39.760	29.41	155.21	55	0	3.1261	0.0066	3.1264	0.0047	3.1251	0.0038	0.6057	0.0007	0.0006	0.6057	0.0006	0.0006	0.6058	0.0005	0.0006	435993
4 #	109.25	29.45	56.077	148	0	0.4060	0.0002	0.4062	0.0002	0.4045	0.0005	0.6072	0.0024	0.0037	0.6071	0.0023	0.0037	0.6084	0.0022	0.0037	157657
5 #	109.85	29.50	56.111	149	0	0.4065	0.0003	0.4066	0.0005	0.4061	0.0003	0.6073	0.0024	0.0037	0.6072	0.0023	0.0037	0.6075	0.0022	0.0037	157923
6 #	109.57	29.54	56.011	152	0	0.4046	0.0005	0.4047	0.0005	0.4042	0.0004	0.6076	0.0024	0.0037	0.6076	0.0023	0.0037	0.6079	0.0022	0.0037	157777
7 #	69.093	29.62	88.942	96	0	1.0201	0.0012	1.0206	0.0013	1.0216	0.0014	0.6076	0.0010	0.0015	0.6075	0.0010	0.0015	0.6072	0.0010	0.0015	250969
8 #	69.738	29.64	89.355	93	0	1.0327	0.0012	1.0324	0.0011	1.0309	0.0010	0.6067	0.0010	0.0015	0.6068	0.0010	0.0015	0.6072	0.0009	0.0015	252242
9 #	69.390	29.66	89.644	96	0	1.0384	0.0011	1.0383	0.0011	1.0375	0.0010	0.6070	0.0010	0.0015	0.6071	0.0010	0.0015	0.6073	0.0009	0.0015	253167
10 #	300.02	29.75	155.23	149	0	3.1348	0.0041	3.1312	0.0030	3.1282	0.0039	0.6050	0.0005	0.0006	0.6053	0.0004	0.0006	0.6056	0.0005	0.0006	439238
11 #	300.07	29.78	152.72	149	0	3.0328	0.0036	3.0310	0.0021	3.0278	0.0016	0.6051	0.0005	0.0006	0.6053	0.0004	0.0007	0.6056	0.0004	0.0007	432399
12 #	299.67	29.81	152.44	149	0	3.0148	0.0021	3.0171	0.0013	3.0159	0.0017	0.6058	0.0004	0.0007	0.6056	0.0004	0.0007	0.6057	0.0004	0.0007	431884
13 #	99.79	30.07	462.26	138	0	27.904	0.0164	27.908	0.0213	27.864	0.0170	0.6039	0.0002	0.0002	0.6038	0.0003	0.0002	0.6043	0.0002	0.0002	1316963
14 #	99.69	30.12	462.56	138	0	27.929	0.0163	27.931	0.0172	27.905	0.0133	0.6040	0.0002	0.0002	0.6040	0.0002	0.0002	0.6042	0.0002	0.0002	1319200
15 #	100.18	30.18	462.57	136	0	27.950	0.0181	27.944	0.0192	27.904	0.0206	0.6038	0.0002	0.0002	0.6038	0.0002	0.0002	0.6043	0.0003	0.0002	1320923
16 #	149.44	30.24	276.98	185	0	10.004	0.0046	10.007	0.0043	9.995	0.0059	0.6043	0.0002	0.0003	0.6042	0.0002	0.0003	0.6046	0.0002	0.0003	791973
17 #	149.88	30.27	277.24	186	0	10.019	0.0079	10.022	0.0107	10.013	0.0108	0.6044	0.0003	0.0003	0.6043	0.0004	0.0003	0.6046	0.0004	0.0003	793202
18 #	149.84	30.30	277.72	186	0	10.058	0.0043	10.060	0.0052	10.045	0.0066	0.6043	0.0002	0.0003	0.6042	0.0002	0.0003	0.6047	0.0002	0.0003	795076
22 $	109.45	30.45	55.809	153	0	0.4019	0.0004	0.4013	0.0004	0.4011	0.0003	0.6075	0.0024	0.0037	0.6080	0.0025	0.0038	0.6081	0.0024	0.0037	160284
23 $	110.64	30.54	55.584	154	0	0.4033	0.0003	0.4026	0.0003	0.4022	0.0004	0.6040	0.0024	0.0037	0.6046	0.0025	0.0037	0.6048	0.0023	0.0037	159943
24 $	109.50	30.57	55.831	148	0	0.4025	0.0003	0.4018	0.0005	0.4016	0.0006	0.6073	0.0024	0.0037	0.6078	0.0025	0.0037	0.6080	0.0024	0.0037	160754
25 $	39.878	30.77	152.82	56	0	3.0322	0.0023	3.0307	0.0031	3.0329	0.0025	0.6057	0.0004	0.0006	0.6058	0.0005	0.0006	0.6056	0.0004	0.0006	441890
26 $	40.045	30.78	153.41	56	0	3.0568	0.0022	3.0554	0.0040	3.0528	0.0034	0.6056	0.0004	0.0006	0.6057	0.0005	0.0006	0.6059	0.0005	0.0006	443689
27 $	40.156	30.79	154.25	56	0	3.0840	0.0022	3.0837	0.0029	3.0852	0.0047	0.6062	0.0004	0.0006	0.6062	0.0005	0.0006	0.6060	0.0006	0.0006	446208
28 $	69.199	30.86	88.020	93	0	1.0013	0.0011	0.9999	0.0011	1.0022	0.0010	0.6070	0.0010	0.0016	0.6075	0.0011	0.0016	0.6068	0.0010	0.0016	254994
29 $	69.644	30.88	89.024	97	1	1.0256	0.0012	1.0238	0.0008	1.0250	0.0013	0.6067	0.0010	0.0015	0.6072	0.0010	0.0015	0.6069	0.0010	0.0015	258012
30 $	69.464	30.92	88.966	96	0	1.0241	0.0010	1.0220	0.0015	1.0212	0.0009	0.6067	0.0010	0.0015	0.6073	0.0011	0.0015	0.6076	0.0010	0.0015	258062
31 @	70.070	30.71	87.668	98	0	0.9922	0.0011	0.9908	0.0011	0.9943	0.0014	0.6074	0.0012	0.0016	0.6078	0.0010	0.0016	0.6067	0.0010	0.0016	253171
32 @	69.588	30.75	87.148	97	0	0.9818	0.0008	0.9807	0.0007	0.9819	0.0011	0.6070	0.0012	0.0016	0.6073	0.0010	0.0016	0.6069	0.0010	0.0016	251882
33 @	70.222	30.76	87.021	98	0	0.9786	0.0014	0.9770	0.0012	0.9788	0.0013	0.6071	0.0012	0.0016	0.6076	0.0011	0.0016	0.6070	0.0010	0.0016	251570

[Test Run Date Codes # - 11/14/85 $ - 11/18/85 @ - 11/19/85]

Table 47D. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-4A Diameter 5.7488 Inches, Beta Ratio = 0.57349

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34 #	109.63	30.82	56.105	153	0	0.4053	0.0003	0.4045	0.0003	0.4056	0.0004	0.6082	0.0028	0.0037	0.6088	0.0024	0.0037	0.6080	0.0023	0.0037	162398
35 #	109.65	30.86	56.171	153	0	0.4064	0.0003	0.4057	0.0004	0.4061	0.0004	0.6081	0.0028	0.0037	0.6086	0.0024	0.0037	0.6083	0.0023	0.0037	162728
36 #	109.33	30.91	56.154	146	0	0.4068	0.0002	0.4054	0.0004	0.4063	0.0003	0.6076	0.0028	0.0037	0.6086	0.0024	0.0037	0.6080	0.0023	0.0037	162849
37 #	39.651	31.00	153.22	54	0	3.0433	0.0059	3.0423	0.0033	3.0428	0.0015	0.6061	0.0007	0.0006	0.6062	0.0005	0.0006	0.6062	0.0004	0.0006	445176
38 #	39.468	31.01	153.30	55	0	3.0441	0.0026	3.0436	0.0025	3.0538	0.0033	0.6064	0.0005	0.0006	0.6064	0.0004	0.0006	0.6054	0.0005	0.0006	445528
39 #	39.358	31.03	153.11	55	0	3.0472	0.0030	3.0440	0.0043	3.0388	0.0048	0.6053	0.0005	0.0006	0.6056	0.0006	0.0006	0.6062	0.0006	0.0006	445145
40 #	100.03	31.11	463.10	136	0	28.010	0.0244	28.001	0.0345	27.978	0.0292	0.6039	0.0003	0.0002	0.6040	0.0004	0.0002	0.6042	0.0003	0.0002	1348678
41 #	100.54	31.14	461.52	138	0	27.802	0.0163	27.810	0.0205	27.776	0.0156	0.6041	0.0002	0.0002	0.6040	0.0003	0.0002	0.6044	0.0002	0.0002	1344924
42 #	99.83	31.16	460.96	139	0	27.740	0.0208	27.729	0.0188	27.728	0.0214	0.6040	0.0003	0.0002	0.6041	0.0002	0.0002	0.6041	0.0003	0.0002	1343839
43 #	150.21	31.29	275.78	186	0	9.917	0.0080	9.917	0.0080	9.915	0.0072	0.6044	0.0003	0.0003	0.6044	0.0003	0.0003	0.6045	0.0003	0.0003	806181
44 #	149.82	31.34	277.42	186	0	10.039	0.0063	10.039	0.0069	10.036	0.0085	0.6043	0.0003	0.0003	0.6043	0.0003	0.0003	0.6044	0.0003	0.0003	811839
45 #	149.95	31.42	277.39	186	0	10.029	0.0044	10.029	0.0049	10.027	0.0080	0.6045	0.0002	0.0003	0.6045	0.0002	0.0003	0.6046	0.0003	0.0003	813094
46 #	109.16	31.47	55.464	153	0	0.3964	0.0003	0.3949	0.0003	0.3952	0.0004	0.6080	0.0028	0.0038	0.6092	0.0024	0.0038	0.6089	0.0024	0.0038	162750
47 #	109.58	31.48	55.831	153	0	0.4022	0.0004	0.4002	0.0004	0.4008	0.0003	0.6076	0.0028	0.0037	0.6091	0.0024	0.0038	0.6087	0.0023	0.0037	163861
48 #	109.06	31.50	56.227	152	1	0.4082	0.0002	0.4056	0.0003	0.4067	0.0003	0.6074	0.0028	0.0037	0.6093	0.0024	0.0037	0.6085	0.0023	0.0037	165091
49 $	39.929	32.48	151.71	56	0	2.9949	0.0022	2.9951	0.0016	2.9905	0.0014	0.6051	0.0005	0.0006	0.6051	0.0004	0.0006	0.6056	0.0004	0.0006	454589
50 $	39.455	32.50	151.33	55	0	2.9785	0.0014	2.9799	0.0013	2.9754	0.0028	0.6052	0.0004	0.0006	0.6051	0.0004	0.0006	0.6056	0.0005	0.0006	453636
51 $	40.163	32.50	152.62	56	0	3.0304	0.0018	3.0289	0.0026	3.0263	0.0040	0.6052	0.0004	0.0006	0.6053	0.0005	0.0006	0.6056	0.0005	0.0006	457510
52 $	69.491	32.51	87.496	97	0	0.9915	0.0009	0.9911	0.0012	0.9924	0.0015	0.6065	0.0011	0.0016	0.6067	0.0011	0.0016	0.6063	0.0011	0.0016	262343
53 $	70.259	32.52	87.477	98	0	0.9930	0.0006	0.9924	0.0007	0.9911	0.0012	0.6059	0.0011	0.0016	0.6061	0.0010	0.0016	0.6065	0.0011	0.0016	262340
54 $	69.667	32.54	88.060	97	0	1.0038	0.0011	1.0037	0.0009	1.0045	0.0008	0.6067	0.0011	0.0016	0.6067	0.0011	0.0016	0.6065	0.0010	0.0016	264196
55 $	110.17	32.55	55.736	154	0	0.4012	0.0004	0.4007	0.0004	0.4000	0.0004	0.6074	0.0026	0.0037	0.6077	0.0025	0.0038	0.6083	0.0025	0.0037	167253
56 $	109.43	32.57	55.770	146	0	0.4022	0.0003	0.4015	0.0004	0.4001	0.0006	0.6070	0.0026	0.0037	0.6075	0.0025	0.0037	0.6086	0.0025	0.0037	167423
57 $	109.18	32.64	56.203	148	0	0.4082	0.0002	0.4074	0.0003	0.4065	0.0004	0.6072	0.0026	0.0037	0.6078	0.0025	0.0037	0.6085	0.0024	0.0037	168969
58 $	110.28	32.67	56.541	154	0	0.4127	0.0004	0.4122	0.0004	0.4122	0.0003	0.6075	0.0026	0.0036	0.6079	0.0025	0.0037	0.6079	0.0024	0.0036	170090
59 $	109.46	32.71	56.838	153	2	0.4178	0.0004	0.4173	0.0004	0.4166	0.0004	0.6070	0.0025	0.0036	0.6073	0.0024	0.0036	0.6079	0.0024	0.0036	171122
60 $	109.60	32.75	56.952	153	2	0.4185	0.0003	0.4180	0.0004	0.4176	0.0003	0.6077	0.0025	0.0036	0.6080	0.0024	0.0036	0.6083	0.0024	0.0036	171608
61 $	299.99	32.82	151.10	149	0	2.9664	0.0025	2.9661	0.0032	2.9687	0.0028	0.6056	0.0005	0.0007	0.6056	0.0005	0.0007	0.6054	0.0005	0.0007	455947
62 $	300.41	32.83	151.81	149	0	2.9968	0.0023	2.9952	0.0029	2.9970	0.0021	0.6054	0.0004	0.0007	0.6055	0.0005	0.0007	0.6053	0.0004	0.0007	458187
63 $	299.83	32.86	151.60	149	0	2.9888	0.0028	2.9886	0.0017	2.9884	0.0012	0.6053	0.0005	0.0007	0.6054	0.0004	0.0007	0.6054	0.0004	0.0007	457841

[Test Run Date Codes # - 11/19/85 $ - 11/20/85]

Table 47D. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-4A Diameter 5.7488 Inches, Beta Ratio = 0.57349

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
64	#	150.21	32.87	276.87	186	0	9.995	0.0082	9.996	0.0101	9.997	0.0082	0.6045	0.0003	0.0003	0.6045	0.0003	0.0003	0.6045	0.0003	0.0003	836318
65	#	150.05	32.88	276.29	186	0	9.956	0.0056	9.957	0.0059	9.956	0.0072	0.6044	0.0002	0.0003	0.6044	0.0002	0.0003	0.6044	0.0003	0.0003	834733
66	#	150.20	32.90	277.28	186	0	10.027	0.0043	10.029	0.0056	10.025	0.0062	0.6045	0.0002	0.0003	0.6044	0.0002	0.0003	0.6045	0.0002	0.0003	838082
67	#	99.82	33.01	462.08	136	0	27.888	0.0134	27.889	0.0131	27.880	0.0132	0.6040	0.0002	0.0002	0.6040	0.0002	0.0002	0.6041	0.0002	0.0002	1399794
68	#	99.77	33.06	462.05	139	0	27.886	0.0182	27.873	0.0154	27.885	0.0104	0.6040	0.0002	0.0002	0.6041	0.0002	0.0002	0.6040	0.0002	0.0002	1401113
69	#	99.247	33.12	461.79	136	0	27.866	0.0164	27.855	0.0164	27.861	0.0138	0.6039	0.0002	0.0002	0.6040	0.0002	0.0002	0.6039	0.0002	0.0002	1402056

[Test Run Date Codes # - 11/20/85]

Table 47E. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-5A Diameter 6.6241 Inches, Beta Ratio = 0.66081

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	47.536	31.53	123.53	66	0	1.0171	0.0013	1.0177	0.0017	1.0162	0.0016	0.6066	0.0011	0.0015	0.6064	0.0011	0.0015	0.6068	0.0011	0.0015	362938
2 #	47.964	31.54	123.57	67	0	1.0185	0.0016	1.0175	0.0016	1.0170	0.0017	0.6063	0.0012	0.0015	0.6066	0.0011	0.0015	0.6068	0.0011	0.0015	363118
3 #	47.946	31.56	123.53	67	0	1.0189	0.0012	1.0175	0.0021	1.0180	0.0018	0.6060	0.0011	0.0015	0.6064	0.0012	0.0015	0.6063	0.0011	0.0015	363157
4 #	77.157	31.64	77.997	108	0	0.4049	0.0005	0.4041	0.0006	0.4030	0.0008	0.6070	0.0027	0.0037	0.6076	0.0026	0.0037	0.6084	0.0025	0.0037	229682
5 #	76.644	31.66	78.056	107	0	0.4058	0.0006	0.4051	0.0005	0.4028	0.0004	0.6068	0.0027	0.0037	0.6073	0.0026	0.0037	0.6091	0.0024	0.0037	229951
6 #	77.315	31.69	78.090	108	0	0.4053	0.0004	0.4046	0.0004	0.4035	0.0006	0.6074	0.0027	0.0037	0.6080	0.0026	0.0037	0.6088	0.0025	0.0037	230195
7 #	320.73	31.74	125.49	159	0	1.0503	0.0009	1.0492	0.0009	1.0487	0.0007	0.6064	0.0011	0.0016	0.6067	0.0010	0.0016	0.6068	0.0010	0.0016	370299
8 #	320.83	31.78	124.74	159	0	1.0382	0.0013	1.0364	0.0009	1.0376	0.0005	0.6063	0.0011	0.0016	0.6068	0.0010	0.0016	0.6064	0.0010	0.0016	368413
9 #	320.56	31.79	125.82	159	0	1.0569	0.0016	1.0563	0.0010	1.0551	0.0010	0.6061	0.0011	0.0015	0.6062	0.0010	0.0015	0.6066	0.0010	0.0016	371664
10 #	69.676	31.85	638.98	97	0	27.541	0.0340	27.543	0.0360	27.515	0.0309	0.6030	0.0004	0.0002	0.6030	0.0004	0.0002	0.6033	0.0004	0.0002	1889878
11 #	69.667	31.91	640.90	97	0	27.692	0.0440	27.687	0.0539	27.660	0.0712	0.6031	0.0005	0.0002	0.6032	0.0006	0.0002	0.6035	0.0008	0.0002	1897922
12 #	69.697	31.94	640.77	97	0	27.687	0.0513	27.688	0.0491	27.669	0.0399	0.6031	0.0006	0.0002	0.6031	0.0006	0.0002	0.6033	0.0005	0.0002	1898720
13 #	169.87	32.02	211.91	200	0	3.0129	0.0022	3.0122	0.0023	3.0080	0.0026	0.6046	0.0004	0.0007	0.6047	0.0004	0.0007	0.6051	0.0004	0.0007	628975
14 #	180.81	32.03	212.48	200	0	3.0284	0.0023	3.0291	0.0022	3.0253	0.0024	0.6047	0.0004	0.0007	0.6046	0.0004	0.0007	0.6050	0.0004	0.0007	630806
15 #	175.09	32.06	212.83	200	0	3.0422	0.0025	3.0411	0.0030	3.0375	0.0018	0.6043	0.0005	0.0006	0.6044	0.0005	0.0006	0.6048	0.0004	0.0006	632212
16 #	114.25	32.06	385.35	159	0	10.004	0.0085	9.998	0.0076	9.984	0.0089	0.6034	0.0003	0.0003	0.6035	0.0003	0.0003	0.6039	0.0003	0.0003	1144703
17 #	114.43	32.08	385.66	159	0	10.009	0.0076	10.012	0.0088	10.003	0.0102	0.6037	0.0003	0.0003	0.6036	0.0003	0.0003	0.6039	0.0003	0.0003	1146107
18 #	115.06	32.09	384.57	160	0	9.952	0.0071	9.952	0.0068	9.943	0.0083	0.6037	0.0003	0.0003	0.6037	0.0003	0.0003	0.6040	0.0003	0.0003	1143091
19 $	46.813	31.79	122.09	66	0	0.9927	0.0009	0.9920	0.0009	0.9938	0.0012	0.6069	0.0012	0.0016	0.6070	0.0010	0.0016	0.6065	0.0010	0.0016	360655
20 $	47.983	31.81	121.94	67	0	0.9921	0.0009	0.9901	0.0012	0.9915	0.0016	0.6063	0.0012	0.0016	0.6069	0.0011	0.0016	0.6064	0.0011	0.0016	360359
21 $	47.947	31.83	121.93	67	0	0.9904	0.0013	0.9898	0.0019	0.9946	0.0013	0.6068	0.0012	0.0016	0.6069	0.0011	0.0016	0.6055	0.0010	0.0016	360475
22 $	76.424	31.87	77.911	107	0	0.4034	0.0006	0.4023	0.0005	0.4029	0.0005	0.6075	0.0028	0.0037	0.6083	0.0024	0.0037	0.6079	0.0023	0.0037	230529
23 $	76.516	31.90	77.656	107	0	0.4007	0.0006	0.3993	0.0006	0.4001	0.0004	0.6076	0.0028	0.0038	0.6086	0.0024	0.0038	0.6080	0.0023	0.0038	229919
24 $	76.598	31.93	77.475	107	1	0.3989	0.0007	0.3975	0.0008	0.3998	0.0006	0.6075	0.0029	0.0038	0.6086	0.0025	0.0038	0.6068	0.0024	0.0038	229526
25 $	114.40	31.99	385.47	152	0	10.005	0.0084	10.003	0.0075	9.990	0.0084	0.6035	0.0003	0.0003	0.6036	0.0003	0.0003	0.6040	0.0003	0.0003	1143416
26 $	115.17	31.98	385.79	159	0	10.013	0.0093	10.016	0.0108	10.009	0.0086	0.6038	0.0003	0.0003	0.6037	0.0004	0.0003	0.6039	0.0003	0.0003	1144109
27 $	115.18	32.00	385.89	160	0	10.026	0.0099	10.028	0.0078	10.026	0.0104	0.6036	0.0003	0.0003	0.6035	0.0003	0.0003	0.6035	0.0003	0.0003	1144877
28 $	69.654	32.08	638.90	97	0	27.501	0.0718	27.508	0.0838	27.547	0.0585	0.6034	0.0008	0.0002	0.6033	0.0009	0.0002	0.6029	0.0007	0.0002	1898689
29 $	69.927	32.14	643.40	94	0	27.906	0.0367	27.890	0.0437	27.910	0.0250	0.6032	0.0004	0.0002	0.6034	0.0005	0.0002	0.6031	0.0003	0.0002	1914446
30 $	69.944	32.17	642.16	94	0	27.835	0.0545	27.825	0.0589	27.792	0.0508	0.6028	0.0006	0.0002	0.6029	0.0007	0.0002	0.6033	0.0006	0.0002	1911945

[Test Run Date Codes # - 11/15/85 $ - 11/19/85]

Table 47E. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-5A Diameter 6.6241 Inches, Beta Ratio = 0.66081

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	189.62	32.22	211.50	200	0	3.0020	0.0030	3.0040	0.0027	3.0023	0.0028	0.6045	0.0005	0.0007	0.6043	0.0004	0.0007	0.6045	0.0004	0.0007	630352
32 #	189.87	32.26	211.59	189	0	3.0062	0.0022	3.0061	0.0022	3.0058	0.0023	0.6044	0.0005	0.0007	0.6044	0.0004	0.0007	0.6044	0.0004	0.0007	631150
33 #	189.84	32.28	211.60	191	0	3.0075	0.0019	3.0040	0.0024	3.0054	0.0019	0.6043	0.0004	0.0007	0.6046	0.0004	0.0007	0.6045	0.0004	0.0007	631454
34 $	46.935	31.82	122.64	66	0	1.0026	0.0014	1.0019	0.0013	1.0032	0.0019	0.6065	0.0013	0.0016	0.6068	0.0013	0.0016	0.6064	0.0012	0.0016	362499
35 $	47.920	31.83	122.44	67	0	1.0027	0.0012	1.0013	0.0014	0.9982	0.0015	0.6055	0.0012	0.0016	0.6059	0.0013	0.0016	0.6069	0.0012	0.0016	361972
36 $	47.996	31.83	122.48	67	0	1.0010	0.0013	1.0024	0.0018	1.0011	0.0006	0.6062	0.0013	0.0016	0.6058	0.0013	0.0016	0.6062	0.0011	0.0016	362099
37 $	76.433	31.83	77.342	107	1	0.3980	0.0006	0.3973	0.0005	0.3974	0.0003	0.6071	0.0030	0.0038	0.6076	0.0030	0.0038	0.6076	0.0027	0.0038	228656
38 $	76.583	31.84	77.092	107	0	0.3957	0.0004	0.3950	0.0003	0.3945	0.0004	0.6069	0.0030	0.0038	0.6075	0.0030	0.0038	0.6078	0.0027	0.0038	227964
39 $	77.104	31.84	76.877	107	0	0.3923	0.0006	0.3912	0.0006	0.3922	0.0004	0.6079	0.0030	0.0038	0.6087	0.0031	0.0039	0.6079	0.0027	0.0038	227327
40 $	320.75	31.98	124.07	159	0	1.0277	0.0013	1.0265	0.0016	1.0269	0.0019	0.6061	0.0012	0.0016	0.6065	0.0013	0.0016	0.6064	0.0012	0.0016	367955
41 $	320.65	31.99	125.69	159	0	1.0565	0.0011	1.0553	0.0006	1.0531	0.0006	0.6056	0.0012	0.0015	0.6060	0.0011	0.0016	0.6066	0.0010	0.0016	372840
42 $	320.70	31.97	125.89	159	0	1.0590	0.0013	1.0579	0.0009	1.0572	0.0011	0.6058	0.0012	0.0015	0.6061	0.0012	0.0015	0.6064	0.0011	0.0015	373270
43 $	324.78	31.95	123.17	161	0	1.0129	0.0014	1.0111	0.0013	1.0108	0.0016	0.6061	0.0012	0.0016	0.6066	0.0012	0.0016	0.6067	0.0012	0.0016	365039
44 $	324.62	31.94	122.72	161	0	1.0055	0.0011	1.0039	0.0007	1.0042	0.0007	0.6061	0.0012	0.0016	0.6065	0.0012	0.0016	0.6064	0.0011	0.0016	363632
45 $	324.90	31.94	122.78	161	0	1.0066	0.0011	1.0050	0.0006	1.0046	0.0005	0.6060	0.0012	0.0016	0.6065	0.0012	0.0016	0.6066	0.0011	0.0016	363821
46 $	189.25	31.93	209.24	186	0	2.9331	0.0028	2.9352	0.0026	2.9346	0.0034	0.6050	0.0005	0.0007	0.6048	0.0005	0.0007	0.6049	0.0005	0.0007	619882
47 $	190.10	32.03	209.99	194	1	2.9595	0.0020	2.9566	0.0021	2.9587	0.0020	0.6045	0.0005	0.0007	0.6048	0.0005	0.0007	0.6046	0.0004	0.0007	623413
48 $	190.15	32.09	209.23	189	0	2.9354	0.0030	2.9323	0.0023	2.9335	0.0027	0.6048	0.0005	0.0007	0.6051	0.0005	0.0007	0.6050	0.0005	0.0007	621914
49 $	114.41	32.14	386.58	159	0	10.062	0.0096	10.060	0.0104	10.068	0.0074	0.6036	0.0003	0.0003	0.6036	0.0004	0.0003	0.6034	0.0003	0.0003	1150264
50 $	115.13	32.18	384.58	160	0	9.950	0.0069	9.954	0.0081	9.951	0.0083	0.6038	0.0003	0.0003	0.6037	0.0003	0.0003	0.6038	0.0003	0.0003	1145260
51 $	115.10	32.23	385.33	160	0	9.985	0.0111	9.989	0.0115	9.988	0.0091	0.6039	0.0004	0.0003	0.6038	0.0004	0.0003	0.6038	0.0003	0.0003	1148687
52 $	70.424	32.28	631.70	98	0	26.914	0.0161	26.914	0.0185	26.891	0.0198	0.6030	0.0002	0.0002	0.6030	0.0002	0.0002	0.6033	0.0003	0.0002	1885092
53 $	69.582	32.33	629.64	97	0	26.726	0.0232	26.721	0.0239	26.758	0.0287	0.6032	0.0003	0.0002	0.6032	0.0003	0.0002	0.6028	0.0003	0.0002	1880866
54 $	69.631	32.36	628.52	97	0	26.632	0.0149	26.624	0.0186	26.648	0.0119	0.6032	0.0002	0.0002	0.6033	0.0003	0.0002	0.6030	0.0002	0.0002	1878691
55 $	75.911	32.43	78.500	107	1	0.4108	0.0006	0.4090	0.0005	0.4081	0.0006	0.6066	0.0029	0.0037	0.6079	0.0029	0.0037	0.6086	0.0027	0.0036	234981
56 $	76.588	32.46	78.237	107	0	0.4067	0.0005	0.4056	0.0005	0.4041	0.0002	0.6076	0.0029	0.0037	0.6084	0.0029	0.0037	0.6096	0.0027	0.0037	234340
57 $	76.637	32.50	78.266	107	0	0.4076	0.0003	0.4061	0.0003	0.4050	0.0007	0.6072	0.0029	0.0037	0.6083	0.0029	0.0037	0.6091	0.0027	0.0037	234619
58 $	559.94	32.63	78.000	139	4	0.4054	0.0007	0.4040	0.0004	0.4032	0.0004	0.6067	0.0030	0.0038	0.6078	0.0029	0.0038	0.6084	0.0027	0.0038	234450
59 $	560.15	32.70	78.114	139	1	0.4064	0.0006	0.4041	0.0003	0.4034	0.0004	0.6069	0.0029	0.0038	0.6086	0.0029	0.0038	0.6091	0.0027	0.0038	235131
60 $	560.31	32.75	78.102	139	0	0.4059	0.0003	0.4038	0.0002	0.4031	0.0003	0.6071	0.0029	0.0038	0.6087	0.0029	0.0038	0.6093	0.0027	0.0038	235336

[Test Run Date Codes # - 11/19/85 $ - 11/21/85]

Table 47E. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-5A Diameter 6.6241 Inches, Beta Ratio = 0.66081

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
61	#	320.76	32.79	123.83	159	0	1.0231	0.0010	1.0211	0.0005	1.0214	0.0007	0.6064	0.0012	0.0016	0.6070	0.0012	0.0016	0.6069	0.0011	0.0016	373445
62	#	320.60	32.80	124.79	159	0	1.0409	0.0006	1.0381	0.0004	1.0374	0.0004	0.6058	0.0012	0.0016	0.6066	0.0012	0.0016	0.6068	0.0011	0.0016	376403
63	#	320.69	32.83	125.14	159	0	1.0460	0.0011	1.0428	0.0009	1.0422	0.0006	0.6060	0.0012	0.0016	0.6070	0.0012	0.0016	0.6071	0.0011	0.0016	377704

[Test Run Date Codes # - 11/21/85]

Table 47F. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-6A Diameter 7.4996 Inches, Beta Ratio = 0.74815

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	45.007	30.63	883.98	62	0	27.800	0.0204	27.832	0.0221	27.747	0.0164	0.5966	0.0003	0.0002	0.5962	0.0003	0.0002	0.5971	0.0002	0.0002	2548511
2 #	44.972	30.73	887.50	62	0	28.041	0.0189	28.048	0.0193	28.004	0.0252	0.5964	0.0003	0.0002	0.5963	0.0003	0.0002	0.5968	0.0003	0.0002	2564042
3 #	44.939	30.82	886.85	62	0	28.029	0.0211	28.016	0.0263	27.960	0.0352	0.5961	0.0003	0.0002	0.5962	0.0003	0.0002	0.5968	0.0004	0.0002	2567033
4 #	84.791	30.87	531.32	117	0	10.020	0.0104	10.025	0.0087	10.010	0.0098	0.5973	0.0003	0.0003	0.5971	0.0003	0.0003	0.5976	0.0003	0.0003	1539563
5 #	84.857	30.91	531.10	116	0	10.024	0.0070	10.018	0.0079	9.994	0.0092	0.5969	0.0003	0.0003	0.5971	0.0003	0.0003	0.5978	0.0003	0.0003	1540222
6 #	84.679	30.95	530.56	113	0	9.987	0.0080	9.981	0.0066	9.979	0.0094	0.5974	0.0003	0.0003	0.5976	0.0003	0.0003	0.5977	0.0003	0.0003	1539946
7 #	249.69	31.01	168.62	155	0	0.9988	0.0012	0.9986	0.0010	1.0004	0.0011	0.6004	0.0010	0.0016	0.6004	0.0010	0.0016	0.5999	0.0010	0.0016	490026
8 #	249.80	31.05	168.67	155	0	1.0032	0.0012	1.0000	0.0008	0.9996	0.0009	0.5993	0.0010	0.0016	0.6002	0.0010	0.0016	0.6003	0.0009	0.0016	490582
9 #	249.85	31.10	168.66	155	0	0.9995	0.0014	0.9984	0.0011	0.9996	0.0008	0.6003	0.0011	0.0016	0.6007	0.0010	0.0016	0.6003	0.0009	0.0016	491078
10 #	155.09	31.13	289.40	192	0	2.9638	0.0031	2.9615	0.0039	2.9551	0.0028	0.5982	0.0005	0.0007	0.5984	0.0005	0.0007	0.5991	0.0004	0.0007	843162
11 #	155.06	31.14	289.37	192	2	2.9557	0.0023	2.9585	0.0026	2.9559	0.0030	0.5989	0.0004	0.0007	0.5987	0.0004	0.0007	0.5989	0.0004	0.0007	843241
12 #	154.92	31.15	289.59	192	0	2.9660	0.0024	2.9632	0.0024	2.9573	0.0022	0.5984	0.0004	0.0007	0.5986	0.0004	0.0007	0.5992	0.0004	0.0007	844081
13 #	35.028	31.21	168.10	49	0	0.9934	0.0022	0.9921	0.0029	0.9923	0.0041	0.6002	0.0012	0.0016	0.6006	0.0013	0.0016	0.6005	0.0016	0.0016	490595
14 #	34.480	31.23	169.83	48	0	1.0144	0.0021	1.0138	0.0020	1.0121	0.0012	0.6001	0.0012	0.0015	0.6002	0.0011	0.0015	0.6007	0.0010	0.0015	495845
15 #	34.495	31.25	169.88	48	0	1.0158	0.0006	1.0151	0.0017	1.0118	0.0021	0.5998	0.0010	0.0015	0.6000	0.0011	0.0015	0.6010	0.0011	0.0015	496179
16 #	58.308	31.29	107.32	81	0	0.4029	0.0013	0.4017	0.0011	0.4013	0.0006	0.6016	0.0026	0.0037	0.6026	0.0025	0.0037	0.6028	0.0023	0.0037	313723
17 #	56.982	31.32	107.32	79	0	0.4028	0.0012	0.4021	0.0009	0.4015	0.0009	0.6018	0.0026	0.0037	0.6023	0.0024	0.0037	0.6027	0.0023	0.0037	313921
18 #	57.729	31.33	107.12	80	0	0.3995	0.0007	0.3983	0.0007	0.4004	0.0008	0.6031	0.0025	0.0037	0.6040	0.0024	0.0038	0.6024	0.0023	0.0038	313392
34 $	85.563	32.88	527.83	119	0	9.889	0.0127	9.897	0.0149	9.897	0.0076	0.5974	0.0004	0.0003	0.5972	0.0005	0.0003	0.5972	0.0003	0.0003	1594696
35 $	84.892	32.91	527.94	118	0	9.895	0.0112	9.896	0.0123	9.905	0.0122	0.5974	0.0004	0.0003	0.5973	0.0004	0.0003	0.5971	0.0004	0.0003	1596004
36 $	84.922	32.93	528.07	118	0	9.923	0.0155	9.915	0.0158	9.898	0.0086	0.5967	0.0005	0.0003	0.5969	0.0005	0.0003	0.5974	0.0003	0.0003	1597067
37 $	45.316	33.06	885.29	63	0	27.946	0.0327	27.946	0.0243	27.905	0.0114	0.5961	0.0004	0.0002	0.5961	0.0003	0.0002	0.5965	0.0002	0.0002	2684565
38 $	44.827	33.16	886.88	62	0	28.064	0.0335	28.066	0.0327	27.979	0.0369	0.5959	0.0004	0.0002	0.5959	0.0004	0.0002	0.5968	0.0004	0.0002	2694904
39 $	44.613	33.23	884.99	62	0	27.933	0.0242	27.947	0.0210	27.859	0.0151	0.5960	0.0003	0.0002	0.5959	0.0003	0.0002	0.5968	0.0002	0.0002	2693012
40 $	155.08	33.25	288.54	192	0	2.9459	0.0028	2.9467	0.0027	2.9474	0.0025	0.5984	0.0005	0.0007	0.5983	0.0005	0.0007	0.5982	0.0004	0.0007	878367
41 $	154.98	33.27	289.40	192	0	2.9636	0.0026	2.9621	0.0025	2.9640	0.0029	0.5984	0.0005	0.0007	0.5985	0.0004	0.0007	0.5983	0.0005	0.0007	881366
42 $	155.37	33.28	289.59	192	0	2.9670	0.0031	2.9660	0.0035	2.9618	0.0023	0.5984	0.0005	0.0007	0.5985	0.0005	0.0007	0.5990	0.0004	0.0007	882124
43 $	35.044	33.31	170.37	49	0	1.0183	0.0025	1.0190	0.0024	1.0235	0.0021	0.6010	0.0013	0.0015	0.6008	0.0012	0.0015	0.5994	0.0011	0.0015	519291
44 $	34.248	33.32	169.41	48	0	1.0074	0.0014	1.0065	0.0014	1.0098	0.0018	0.6008	0.0012	0.0016	0.6010	0.0011	0.0016	0.6001	0.0011	0.0016	516449
45 $	34.112	33.35	168.82	48	0	0.9995	0.0028	0.9986	0.0018	1.0022	0.0020	0.6011	0.0014	0.0016	0.6013	0.0012	0.0016	0.6003	0.0012	0.0016	514979

[Test Run Date Codes # - 11/14/85 $ - 11/15/85]

Table 47F. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-6A Diameter 7.4996 Inches, Beta Ratio = 0.74815

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
46 #	57.626	33.39	106.72	81	0	0.3990	0.0012	0.3984	0.0009	0.3969	0.0008	0.6014	0.0028	0.0037	0.6018	0.0026	0.0037	0.6030	0.0025	0.0037	325812
47 #	57.687	33.41	106.09	78	0	0.3936	0.0005	0.3926	0.0005	0.3918	0.0005	0.6020	0.0027	0.0038	0.6026	0.0026	0.0038	0.6033	0.0025	0.0038	324014
48 #	57.410	33.43	105.88	80	0	0.3907	0.0008	0.3905	0.0007	0.3909	0.0009	0.6030	0.0028	0.0038	0.6031	0.0027	0.0038	0.6028	0.0026	0.0038	323499

[Test Run Date Codes # - 11/15/85]

Table 47G. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-7A Diameter 1.0001 Inches, Beta Ratio = 0.09977

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	200.60	32.18	9.2459	166	0	14.067	0.0310	14.064	0.0405	14.063	0.0414	0.5954	0.0007	0.0004	0.5954	0.0009	0.0004	0.5954	0.0009	0.0004	27534
2	#	199.70	32.23	9.2171	165	0	13.983	0.0066	13.976	0.0076	13.978	0.0086	0.5952	0.0002	0.0004	0.5954	0.0002	0.0004	0.5954	0.0002	0.0004	27477
3	#	200.64	32.26	9.2197	166	0	13.989	0.0096	13.987	0.0106	13.988	0.0104	0.5953	0.0002	0.0004	0.5953	0.0003	0.0004	0.5953	0.0003	0.0004	27501
4	#	250.14	32.30	7.7975	155	0	10.014	0.0131	10.020	0.0072	10.018	0.0067	0.5951	0.0004	0.0004	0.5949	0.0003	0.0004	0.5949	0.0002	0.0004	23278
5	#	250.15	32.33	7.8146	155	0	10.037	0.0062	10.034	0.0074	10.033	0.0069	0.5957	0.0002	0.0004	0.5958	0.0003	0.0004	0.5958	0.0002	0.0004	23344
6	#	251.58	32.35	7.8040	156	0	10.008	0.0045	10.008	0.0038	10.007	0.0042	0.5957	0.0002	0.0004	0.5958	0.0002	0.0004	0.5958	0.0002	0.0004	23322
7	#	259.90	32.32	7.0420	161	0	8.1427	0.0024	8.1402	0.0022	8.1421	0.0024	0.5960	0.0002	0.0005	0.5961	0.0002	0.0005	0.5960	0.0002	0.0005	21032
8	#	261.25	32.29	7.0093	162	0	8.0668	0.0019	8.0631	0.0016	8.0650	0.0017	0.5960	0.0002	0.0005	0.5961	0.0002	0.0005	0.5960	0.0002	0.0005	20921
9	#	261.46	32.23	7.0016	162	0	8.0471	0.0022	8.0441	0.0019	8.0456	0.0018	0.5961	0.0002	0.0005	0.5962	0.0002	0.0005	0.5961	0.0002	0.0005	20872
10	#	230.20	32.12	1.5818	190	0	0.4067	0.0002	0.4058	0.0002	0.4059	0.0002	0.5990	0.0026	0.0038	0.5997	0.0025	0.0039	0.5996	0.0024	0.0038	4705
11	#	230.36	32.05	1.5788	190	0	0.4045	0.0002	0.4036	0.0001	0.4039	0.0002	0.5995	0.0026	0.0039	0.6002	0.0025	0.0039	0.5999	0.0024	0.0039	4689
12	#	230.20	31.97	1.5800	190	0	0.4061	0.0002	0.4045	0.0002	0.4049	0.0002	0.5988	0.0026	0.0038	0.5999	0.0025	0.0039	0.5996	0.0024	0.0038	4685
13	#	85.108	31.82	4.2843	118	0	2.9990	0.0010	2.9970	0.0012	2.9985	0.0014	0.5974	0.0004	0.0008	0.5976	0.0004	0.0008	0.5975	0.0004	0.0008	12664
14	#	85.641	31.88	4.2110	119	0	2.8973	0.0014	2.8949	0.0017	2.8957	0.0015	0.5974	0.0004	0.0008	0.5977	0.0004	0.0008	0.5976	0.0004	0.0008	12462
15	#	84.926	31.97	4.2107	118	0	2.8960	0.0006	2.8940	0.0008	2.8955	0.0006	0.5975	0.0004	0.0008	0.5977	0.0004	0.0008	0.5976	0.0004	0.0008	12485
16	#	150.21	32.00	2.5009	186	0	1.0174	0.0004	1.0156	0.0003	1.0173	0.0003	0.5988	0.0011	0.0017	0.5993	0.0010	0.0017	0.5988	0.0010	0.0017	7420
17	#	149.92	31.93	2.4975	186	0	1.0163	0.0003	1.0141	0.0003	1.0155	0.0003	0.5983	0.0011	0.0017	0.5989	0.0010	0.0017	0.5985	0.0010	0.0017	7399
18	#	150.23	31.89	2.4976	186	0	1.0155	0.0003	1.0132	0.0004	1.0147	0.0004	0.5985	0.0011	0.0017	0.5992	0.0010	0.0017	0.5988	0.0010	0.0017	7393
19	$	49.750	31.21	7.8233	69	0	10.037	0.0019	10.037	0.0032	10.036	0.0022	0.5963	0.0003	0.0004	0.5963	0.0003	0.0004	0.5963	0.0003	0.0004	22831
20	$	50.370	31.21	7.8244	70	0	10.048	0.0043	10.047	0.0041	10.047	0.0028	0.5960	0.0004	0.0004	0.5961	0.0004	0.0004	0.5960	0.0003	0.0004	22835
21	$	49.703	31.19	7.8269	69	0	10.051	0.0017	10.051	0.0015	10.049	0.0013	0.5961	0.0003	0.0004	0.5961	0.0003	0.0004	0.5962	0.0003	0.0004	22832
22	$	149.79	31.13	2.5344	186	1	1.0469	0.0003	1.0464	0.0004	1.0470	0.0004	0.5981	0.0009	0.0017	0.5982	0.0010	0.0017	0.5981	0.0009	0.0017	7384
23	$	150.67	31.06	2.5279	187	0	1.0419	0.0002	1.0414	0.0002	1.0415	0.0003	0.5980	0.0009	0.0017	0.5981	0.0010	0.0017	0.5981	0.0009	0.0017	7354
24	$	150.83	31.03	2.5274	187	2	1.0411	0.0002	1.0407	0.0002	1.0410	0.0003	0.5981	0.0009	0.0017	0.5982	0.0010	0.0017	0.5981	0.0009	0.0017	7348
25	$	84.633	31.05	4.3145	117	0	3.0403	0.0009	3.0391	0.0009	3.0401	0.0008	0.5975	0.0004	0.0008	0.5976	0.0004	0.0008	0.5975	0.0004	0.0008	12549
26	$	85.751	31.04	4.3137	119	0	3.0400	0.0007	3.0390	0.0007	3.0392	0.0005	0.5974	0.0004	0.0008	0.5975	0.0004	0.0008	0.5975	0.0004	0.0008	12544
27	$	85.086	31.05	4.3085	115	0	3.0317	0.0020	3.0307	0.0019	3.0316	0.0019	0.5975	0.0004	0.0008	0.5976	0.0004	0.0008	0.5975	0.0004	0.0008	12532
28	$	230.24	31.02	1.5716	190	21	0.3988	0.0004	0.3975	0.0005	0.3980	0.0005	0.6009	0.0024	0.0039	0.6019	0.0025	0.0039	0.6015	0.0024	0.0039	4568
29	$	230.25	30.97	1.5670	190	0	0.3989	0.0005	0.3985	0.0006	0.3989	0.0006	0.5991	0.0024	0.0039	0.5994	0.0025	0.0039	0.5991	0.0024	0.0039	4550
30	$	230.22	30.91	1.5816	190	0	0.4057	0.0003	0.4056	0.0002	0.4060	0.0002	0.5996	0.0024	0.0039	0.5996	0.0024	0.0039	0.5993	0.0023	0.0039	4587

[Test Run Date Codes # - 11/15/85 $ - 11/18/85]

Table 47G. Orifice Discharge Coefficient Values - Meter Tube PE-0

Meter Tube PE-0ABC Diameter 10.0242 Inches -- Orifice Plate FE-9/0-7A Diameter 1.0001 Inches, Beta Ratio = 0.09977

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31	#	150.21	30.83	2.5157	186	1	1.0314	0.0002	1.0312	0.0002	1.0308	0.0002	0.5981	0.0009	0.0017	0.5982	0.0010	0.0017	0.5983	0.0009	0.0017	7283
32	#	150.14	30.85	2.5101	186	6	1.0259	0.0004	1.0256	0.0005	1.0253	0.0006	0.5984	0.0009	0.0017	0.5985	0.0010	0.0017	0.5986	0.0009	0.0017	7270
33	#	150.06	30.85	2.5070	186	0	1.0241	0.0002	1.0240	0.0002	1.0239	0.0002	0.5982	0.0009	0.0017	0.5982	0.0010	0.0017	0.5982	0.0009	0.0017	7261
34	#	245.27	31.08	7.8269	161	9	10.056	0.0034	10.056	0.0022	10.058	0.0017	0.5960	0.0002	0.0004	0.5960	0.0001	0.0004	0.5959	0.0001	0.0004	22780
35	#	245.79	31.08	7.8242	158	4	10.056	0.0023	10.055	0.0016	10.055	0.0017	0.5958	0.0001	0.0004	0.5958	0.0001	0.0004	0.5958	0.0001	0.0004	22772
36	#	245.34	31.09	7.8193	154	5	10.042	0.0015	10.042	0.0014	10.043	0.0013	0.5958	0.0001	0.0004	0.5958	0.0001	0.0004	0.5958	0.0001	0.0004	22762
37	#	199.80	31.10	9.2318	165	0	14.012	0.0156	14.014	0.0155	14.014	0.0161	0.5955	0.0004	0.0004	0.5955	0.0004	0.0004	0.5955	0.0004	0.0004	26880
38	#	200.14	31.14	9.1999	165	0	13.926	0.0203	13.924	0.0222	13.924	0.0205	0.5953	0.0004	0.0004	0.5953	0.0005	0.0004	0.5953	0.0005	0.0004	26809
39	#	200.76	31.17	9.2060	166	1	13.933	0.0121	13.938	0.0115	13.938	0.0107	0.5955	0.0003	0.0004	0.5954	0.0003	0.0004	0.5954	0.0003	0.0004	26844
44	$	150.02	32.24	2.5493	186	2	1.0598	0.0004	1.0590	0.0004	1.0591	0.0005	0.5980	0.0011	0.0017	0.5983	0.0011	0.0017	0.5982	0.0010	0.0017	7601
45	$	149.93	32.31	2.5469	186	2	1.0575	0.0003	1.0566	0.0003	1.0567	0.0004	0.5981	0.0011	0.0017	0.5984	0.0011	0.0017	0.5983	0.0010	0.0017	7605
46	$	149.81	32.35	2.5433	186	0	1.0546	0.0003	1.0539	0.0003	1.0543	0.0003	0.5981	0.0011	0.0017	0.5983	0.0011	0.0017	0.5982	0.0010	0.0017	7601
47	$	230.20	32.33	1.5875	190	7	0.4098	0.0001	0.4092	0.0001	0.4099	0.0001	0.5989	0.0028	0.0038	0.5994	0.0029	0.0038	0.5988	0.0026	0.0038	4742
48	$	230.37	32.31	1.5877	190	8	0.4093	0.0002	0.4086	0.0001	0.4092	0.0001	0.5993	0.0028	0.0038	0.5999	0.0029	0.0038	0.5994	0.0026	0.0038	4741
49	$	230.22	32.25	1.5832	190	15	0.4071	0.0001	0.4065	0.0001	0.4072	0.0002	0.5993	0.0029	0.0038	0.5997	0.0029	0.0038	0.5992	0.0026	0.0038	4722
50	$	84.871	32.24	4.2893	118	0	3.0061	0.0015	3.0046	0.0021	3.0086	0.0019	0.5974	0.0005	0.0008	0.5976	0.0005	0.0008	0.5972	0.0004	0.0008	12789
51	$	84.893	32.32	4.2968	118	0	3.0147	0.0015	3.0131	0.0013	3.0155	0.0014	0.5976	0.0005	0.0008	0.5978	0.0005	0.0008	0.5976	0.0004	0.0008	12833
52	$	84.959	32.37	4.2963	113	0	3.0191	0.0009	3.0177	0.0011	3.0196	0.0012	0.5971	0.0004	0.0008	0.5973	0.0005	0.0008	0.5971	0.0004	0.0008	12845

[Test Run Date Codes # - 11/18/85 $ - 11/21/85]

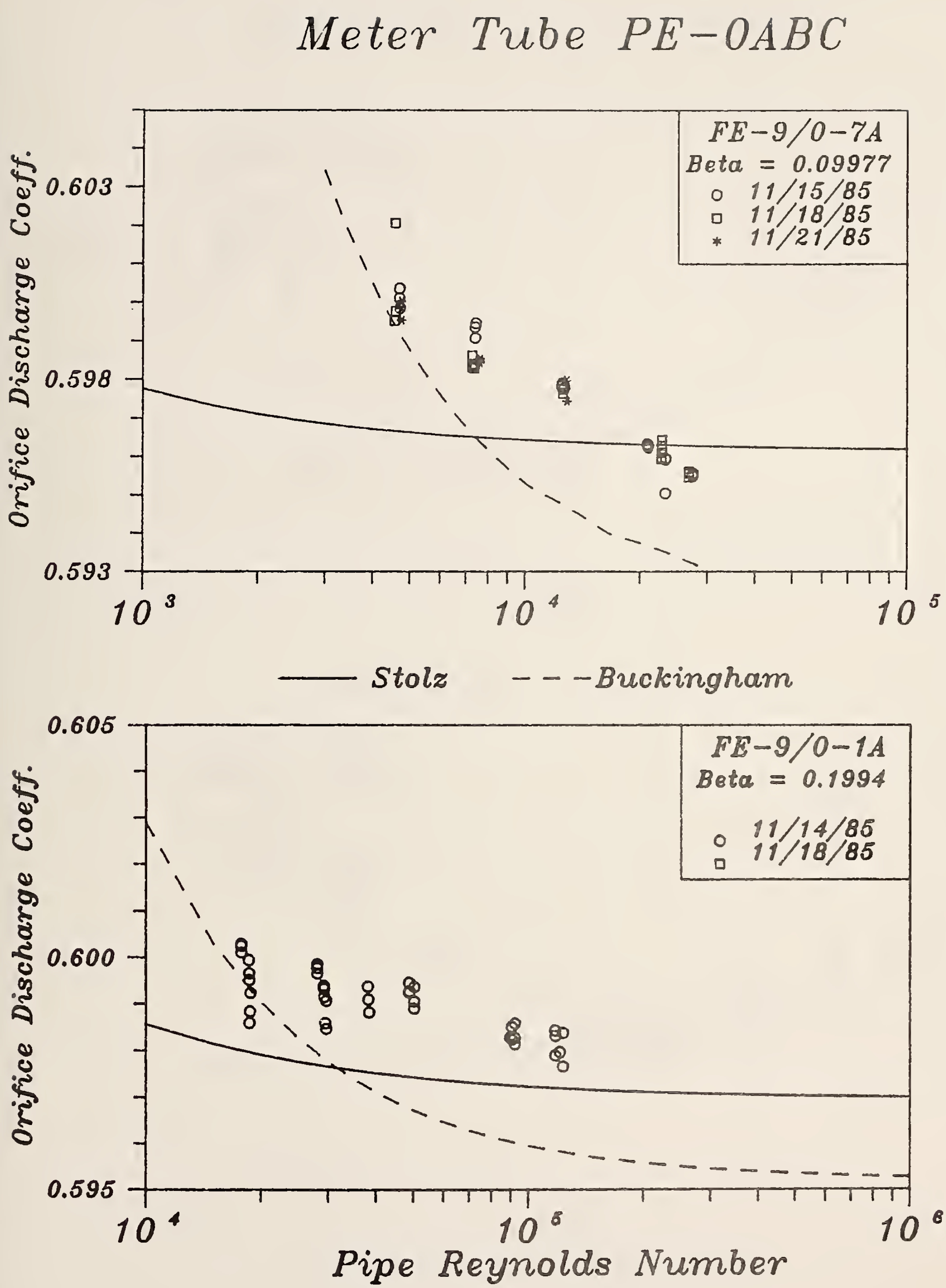


Figure 34A. Discharge Coefficient/Reynolds Number Plots, PE-0ABC 10-Inch Meter Tube, 7 Orifice Plates, Final Data Base

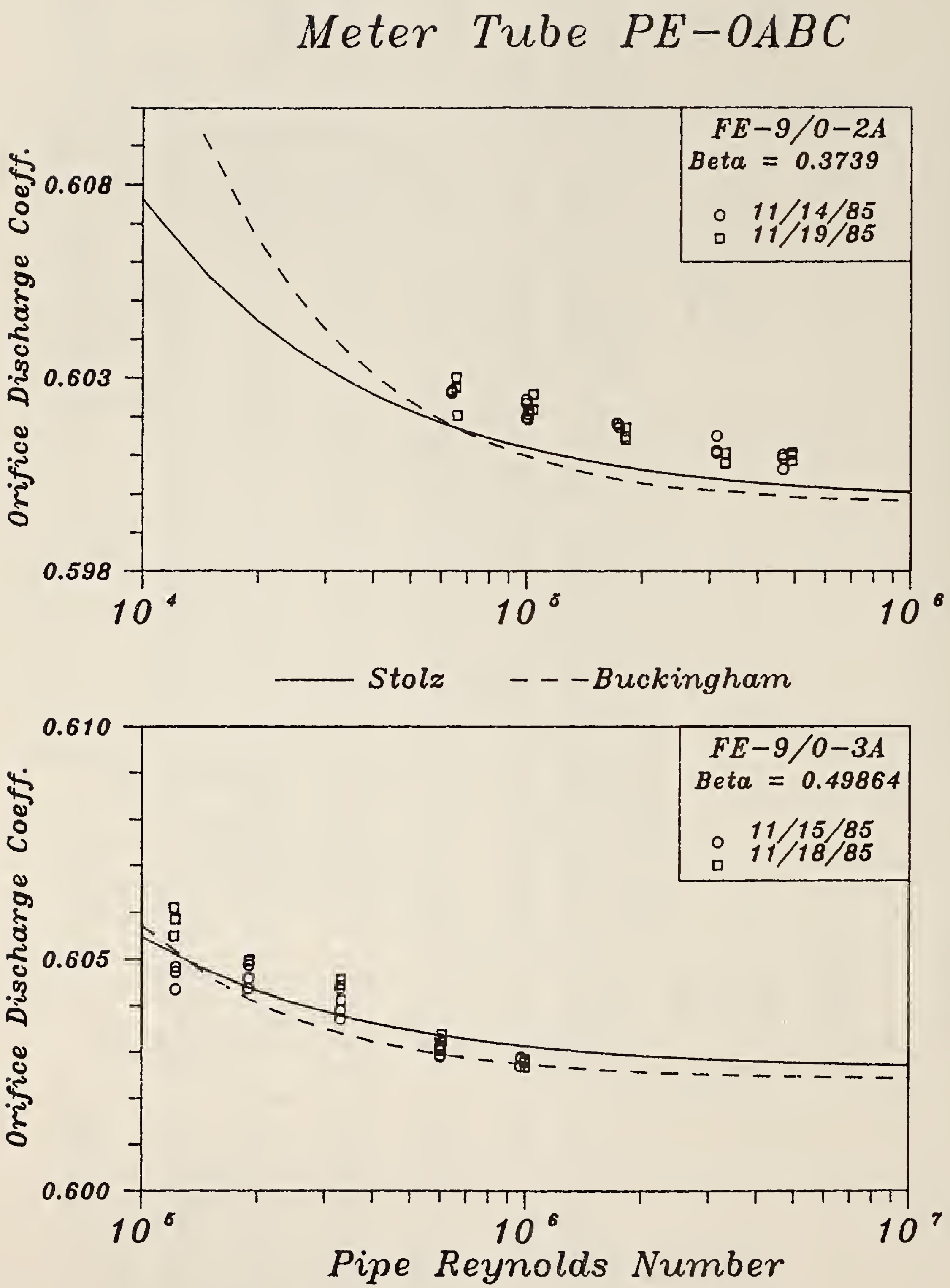


Figure 34B. Discharge Coefficient/Reynolds Number Plots, PE-0ABC 10-Inch Meter Tube, 7 Orifice Plates, Final Data Base

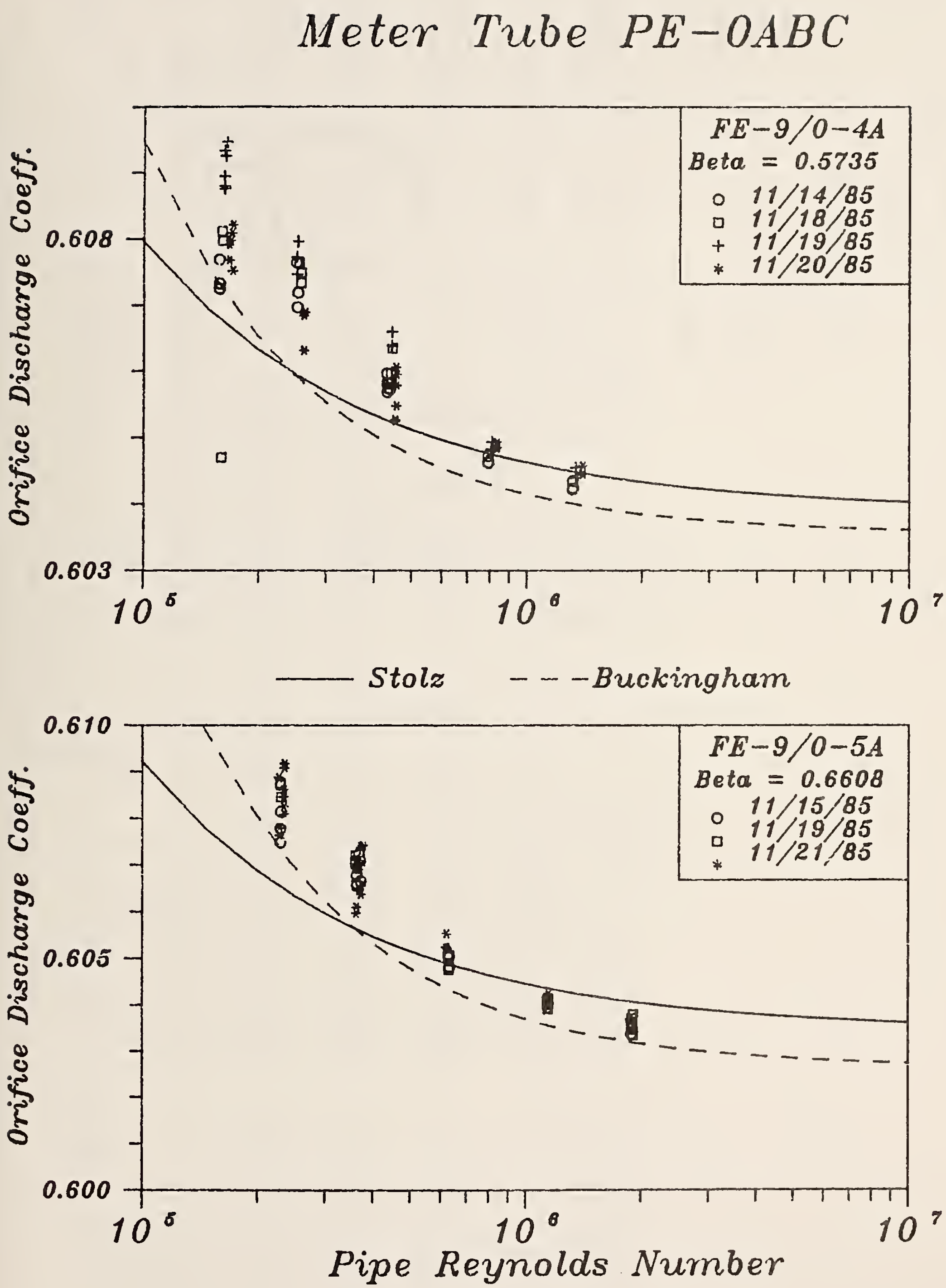


Figure 34C. Discharge Coefficient/Reynolds Number Plots, PE-0ABC
10-Inch Meter Tube, 7 Orifice Plates, Final Data Base

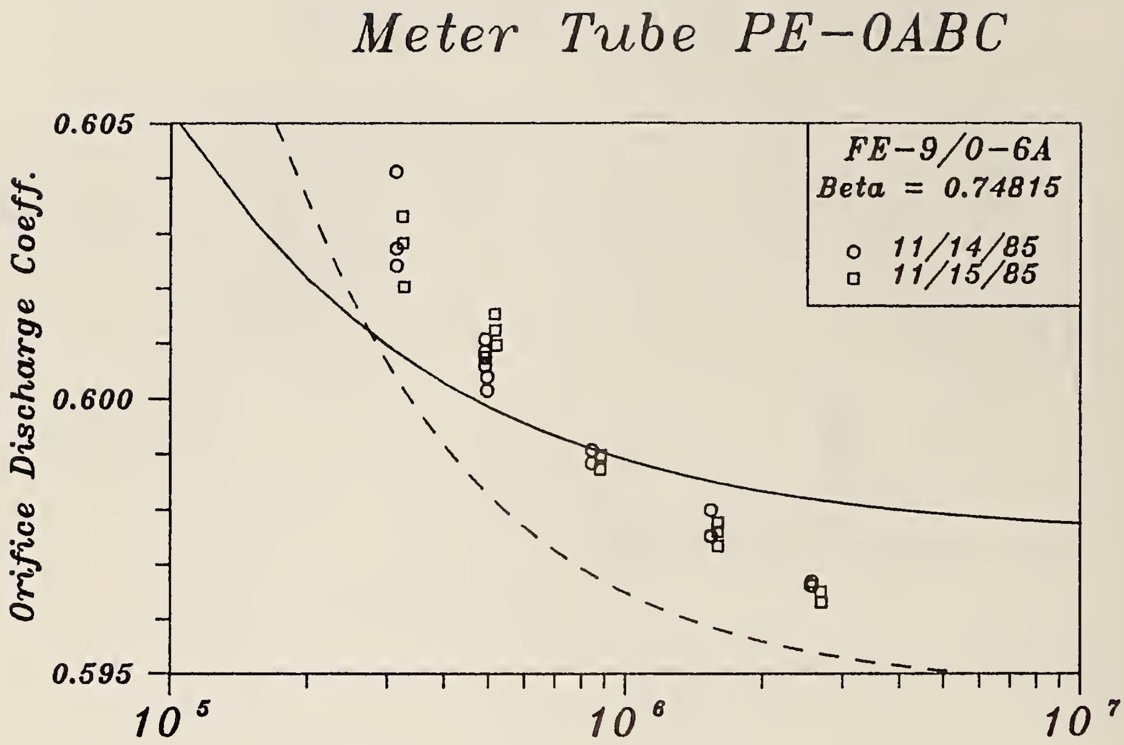


Figure 34D. Discharge Coefficient/Reynolds Number Plots, PE-0ABC
10-Inch Meter Tube, 7 Orifice Plates, Final Data Base

Table 48A. Orifice Discharge Coefficient Values - Meter Tube FE-1

Meter Tube FE-1ABC Diameter 2.0724 Inches -- Orifice Plate FE-1/2-2A Diameter 0.7502 Inches, Beta Ratio = 0.36200

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	84.989	33.33	4.5580	130	0	10.311	0.0153	10.307	0.0168	10.309	0.0164	0.6041	0.0005	0.0005	0.6042	0.0005	0.0005	0.6041	0.0005	0.0005	67226
2 #	84.289	33.34	4.5054	136	0	10.060	0.0212	10.062	0.0249	10.065	0.0240	0.6045	0.0007	0.0005	0.6044	0.0008	0.0005	0.6044	0.0008	0.0005	66463
3 #	85.651	33.36	4.4507	131	2	9.819	0.0363	9.811	0.0409	9.810	0.0390	0.6045	0.0011	0.0005	0.6047	0.0013	0.0005	0.6047	0.0012	0.0005	65683
4 #	251.31	33.32	1.4622	156	0	1.0521	0.0023	1.0519	0.0025	1.0537	0.0024	0.6067	0.0014	0.0018	0.6067	0.0014	0.0018	0.6062	0.0012	0.0018	21562
5 #	249.78	33.33	1.4542	155	0	1.0395	0.0024	1.0392	0.0027	1.0414	0.0026	0.6070	0.0014	0.0018	0.6071	0.0015	0.0018	0.6064	0.0012	0.0018	21448
6 #	251.49	33.36	1.4590	156	0	1.0461	0.0015	1.0457	0.0014	1.0476	0.0014	0.6071	0.0013	0.0018	0.6072	0.0013	0.0018	0.6067	0.0011	0.0018	21532
7 #	144.95	33.43	2.4797	180	0	3.0375	0.0059	3.0378	0.0069	3.0400	0.0069	0.6055	0.0007	0.0009	0.6055	0.0008	0.0009	0.6052	0.0008	0.0009	36648
8 #	144.83	33.45	2.4750	180	0	3.0257	0.0057	3.0256	0.0065	3.0275	0.0065	0.6055	0.0007	0.0009	0.6055	0.0008	0.0009	0.6053	0.0008	0.0009	36593
9 #	145.05	33.47	2.4779	180	0	3.0350	0.0051	3.0337	0.0058	3.0353	0.0059	0.6053	0.0007	0.0009	0.6055	0.0007	0.0009	0.6053	0.0007	0.0009	36651
10 #	271.15	33.39	0.9271	168	0	0.4205	0.0013	0.4206	0.0015	0.4217	0.0015	0.6085	0.0033	0.0039	0.6084	0.0033	0.0039	0.6076	0.0027	0.0039	13690
11 #	269.39	33.42	0.9313	167	0	0.4240	0.0010	0.4242	0.0013	0.4254	0.0012	0.6087	0.0032	0.0038	0.6086	0.0032	0.0038	0.6077	0.0026	0.0039	13761
12 #	271.06	33.43	0.9312	168	0	0.4245	0.0012	0.4239	0.0013	0.4250	0.0012	0.6083	0.0032	0.0038	0.6087	0.0032	0.0038	0.6079	0.0026	0.0038	13762
13 #	249.69	33.67	7.4971	155	0	27.990	0.0137	27.991	0.0106	27.996	0.0113	0.6031	0.0002	0.0004	0.6031	0.0001	0.0004	0.6030	0.0002	0.0004	111342
14 #	251.44	33.69	7.4970	156	0	27.993	0.0141	27.985	0.0161	27.990	0.0163	0.6030	0.0002	0.0004	0.6031	0.0002	0.0004	0.6031	0.0002	0.0004	111386
15 #	251.21	33.71	7.4972	156	0	27.990	0.0093	27.988	0.0110	27.991	0.0126	0.6031	0.0001	0.0004	0.6031	0.0002	0.0004	0.6031	0.0002	0.0004	111434
16 #	400.37	33.75	4.4884	148	6	10.017	0.0291	10.036	0.0292	10.044	0.0289	0.6036	0.0009	0.0005	0.6030	0.0009	0.0005	0.6028	0.0009	0.0005	66767
17 #	401.50	33.79	4.5148	148	0	10.128	0.0193	10.128	0.0212	10.128	0.0233	0.6038	0.0006	0.0005	0.6038	0.0006	0.0005	0.6038	0.0007	0.0005	67215
18 #	401.23	33.83	4.5741	150	4	10.404	0.0350	10.405	0.0400	10.410	0.0410	0.6036	0.0010	0.0005	0.6035	0.0012	0.0005	0.6034	0.0012	0.0005	68153

[Test Run Date Codes # - 07/15/85]

Table 48B. Orifice Discharge Coefficient Values - Meter Tube FE-1

Meter Tube FE-1ABC Diameter 2.0724 Inches -- Orifice Plate FE-1/2-6A Diameter 1.5002 Inches, Beta Ratio = 0.72390

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
2	#	159.73	32.67	11.771	198	0	3.0673	0.0061	3.0638	0.0066	3.0587	0.0062	0.6144	0.0008	0.0008	0.6148	0.0008	0.0008	0.6153	0.0007	0.0008	171272
3	#	160.54	32.70	11.728	199	0	3.0435	0.0048	3.0412	0.0064	3.0376	0.0056	0.6146	0.0007	0.0008	0.6148	0.0008	0.0008	0.6152	0.0007	0.0008	170756
4	#	159.95	32.75	11.688	198	0	3.0217	0.0057	3.0188	0.0075	3.0155	0.0081	0.6147	0.0007	0.0008	0.6150	0.0009	0.0008	0.6153	0.0009	0.0008	170352
5	#	160.20	32.77	11.697	198	0	3.0278	0.0059	3.0252	0.0069	3.0232	0.0074	0.6146	0.0008	0.0008	0.6148	0.0008	0.0008	0.6150	0.0008	0.0008	170559
6	#	160.61	32.79	11.671	199	0	3.0145	0.0047	3.0106	0.0054	3.0065	0.0058	0.6145	0.0007	0.0008	0.6149	0.0007	0.0008	0.6153	0.0007	0.0008	170235
7	#	84.940	32.83	21.204	138	0	10.014	0.0111	10.013	0.0123	9.998	0.0130	0.6126	0.0004	0.0005	0.6126	0.0004	0.0005	0.6131	0.0005	0.0005	309548
8	#	85.081	32.84	21.204	138	0	10.013	0.0123	10.016	0.0133	10.002	0.0130	0.6126	0.0004	0.0005	0.6125	0.0005	0.0005	0.6129	0.0005	0.0005	309615
9	#	84.917	32.86	21.213	130	0	10.026	0.0108	10.025	0.0107	10.010	0.0117	0.6125	0.0004	0.0005	0.6125	0.0004	0.0005	0.6130	0.0004	0.0005	309876
10	#	269.61	32.89	7.0809	167	0	1.1015	0.0030	1.1009	0.0030	1.0987	0.0030	0.6168	0.0015	0.0017	0.6170	0.0015	0.0017	0.6176	0.0013	0.0017	103500
11	#	271.21	32.93	6.9335	168	0	1.0554	0.0022	1.0542	0.0030	1.0533	0.0028	0.6170	0.0014	0.0017	0.6174	0.0016	0.0017	0.6176	0.0013	0.0017	101429
13	#	269.61	32.98	6.9692	167	0	1.0657	0.0023	1.0649	0.0020	1.0639	0.0020	0.6172	0.0014	0.0017	0.6174	0.0014	0.0017	0.6177	0.0012	0.0017	102055
17	#	53.433	33.21	35.243	87	0	27.795	0.0066	27.787	0.0055	27.745	0.0065	0.6112	0.0003	0.0004	0.6112	0.0003	0.0004	0.6117	0.0003	0.0004	518532
18	#	53.186	33.21	35.284	86	0	27.844	0.0083	27.850	0.0067	27.804	0.0078	0.6113	0.0003	0.0004	0.6113	0.0003	0.0004	0.6118	0.0003	0.0004	519134
19	#	53.605	33.22	35.267	85	0	27.830	0.0046	27.824	0.0064	27.784	0.0067	0.6112	0.0003	0.0004	0.6113	0.0003	0.0004	0.6117	0.0003	0.0004	518989
20	#	399.98	33.20	4.2164	150	0	0.3878	0.0015	0.3873	0.0013	0.3873	0.0013	0.6191	0.0036	0.0042	0.6194	0.0036	0.0042	0.6194	0.0029	0.0042	62023
21	#	400.94	33.22	4.3289	151	0	0.4084	0.0009	0.4073	0.0010	0.4072	0.0009	0.6193	0.0033	0.0040	0.6201	0.0034	0.0040	0.6202	0.0027	0.0040	63703
22	#	400.33	33.24	4.3328	151	0	0.4088	0.0009	0.4079	0.0008	0.4078	0.0007	0.6196	0.0033	0.0040	0.6203	0.0033	0.0040	0.6203	0.0026	0.0040	63787

[Test Run Date Codes # - 07/15/85]

Table 48C. Orifice Discharge Coefficient Values - Meter Tube FE-2

Meter Tube FE-2ABC Diameter 2.0716 Inches -- Orifice Plate FE-1/2-2B Diameter 0.7502 Inches, Beta Ratio = 0.36214

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	400.36	34.00	4.4863	148	0	10.030	0.0170	10.031	0.0226	10.023	0.0229	0.6029	0.0005	0.0005	0.6029	0.0007	0.0005	0.6031	0.0007	0.0005	67101
2 #	402.05	34.03	4.5002	147	0	10.090	0.0201	10.088	0.0189	10.079	0.0196	0.6030	0.0006	0.0005	0.6030	0.0006	0.0005	0.6033	0.0006	0.0005	67350
3 #	400.38	34.07	4.5093	148	0	10.125	0.0274	10.130	0.0255	10.121	0.0271	0.6032	0.0008	0.0005	0.6030	0.0008	0.0005	0.6033	0.0008	0.0005	67540
4 #	249.70	34.14	7.4632	155	0	27.813	0.0188	27.814	0.0189	27.792	0.0190	0.6023	0.0002	0.0004	0.6023	0.0002	0.0004	0.6025	0.0002	0.0004	111942
5 #	250.03	34.17	7.4634	155	0	27.824	0.0154	27.812	0.0164	27.794	0.0176	0.6022	0.0002	0.0004	0.6023	0.0002	0.0004	0.6025	0.0002	0.0004	112013
6 #	250.01	34.20	7.4654	155	0	27.831	0.0154	27.827	0.0146	27.812	0.0138	0.6023	0.0002	0.0004	0.6023	0.0002	0.0004	0.6025	0.0002	0.0004	112111
7 #	84.407	34.20	4.4918	137	0	10.042	0.0246	10.046	0.0276	10.038	0.0273	0.6033	0.0008	0.0005	0.6032	0.0009	0.0005	0.6034	0.0009	0.0005	67455
9 #	85.013	34.23	4.4920	138	0	10.034	0.0267	10.038	0.0316	10.027	0.0299	0.6036	0.0008	0.0005	0.6035	0.0010	0.0005	0.6038	0.0009	0.0005	67499
10 #	85.079	34.25	4.5025	138	0	10.090	0.0142	10.093	0.0195	10.082	0.0186	0.6033	0.0005	0.0005	0.6032	0.0006	0.0005	0.6035	0.0006	0.0005	67684
11 #	85.078	34.26	4.4927	138	0	10.052	0.0186	10.052	0.0207	10.042	0.0211	0.6031	0.0006	0.0005	0.6031	0.0007	0.0005	0.6034	0.0007	0.0005	67550
12 #	85.118	34.28	4.4978	138	0	10.075	0.0178	10.070	0.0228	10.060	0.0233	0.6031	0.0006	0.0005	0.6033	0.0007	0.0005	0.6036	0.0007	0.0005	67654
13 #	271.20	34.22	0.9120	168	1	0.4156	0.0017	0.4176	0.0016	0.4156	0.0016	0.6023	0.0027	0.0039	0.6008	0.0028	0.0038	0.6022	0.0026	0.0039	13701
15 #	270.91	34.27	0.9097	168	0	0.4153	0.0016	0.4140	0.0011	0.4128	0.0011	0.6010	0.0027	0.0039	0.6018	0.0027	0.0039	0.6027	0.0024	0.0039	13681
16 #	144.94	34.44	2.4807	180	0	3.0563	0.0048	3.0557	0.0064	3.0524	0.0068	0.6040	0.0006	0.0009	0.6040	0.0007	0.0009	0.6044	0.0008	0.0009	37434
17 #	145.16	34.47	2.4764	180	0	3.0465	0.0057	3.0446	0.0067	3.0418	0.0072	0.6039	0.0007	0.0009	0.6041	0.0008	0.0009	0.6043	0.0008	0.0009	37392
18 #	145.08	34.49	2.4776	180	0	3.0525	0.0074	3.0468	0.0086	3.0432	0.0080	0.6036	0.0008	0.0009	0.6041	0.0009	0.0009	0.6045	0.0009	0.0009	37425
19 #	249.69	34.47	1.4658	155	0	1.0662	0.0026	1.0664	0.0022	1.0633	0.0021	0.6043	0.0012	0.0018	0.6042	0.0012	0.0018	0.6051	0.0011	0.0018	22133
20 #	251.26	34.49	1.4558	156	0	1.0560	0.0036	1.0522	0.0026	1.0494	0.0026	0.6030	0.0014	0.0018	0.6041	0.0013	0.0018	0.6049	0.0012	0.0018	21990
21 #	249.75	34.51	1.4577	155	0	1.0571	0.0023	1.0549	0.0020	1.0523	0.0019	0.6035	0.0012	0.0018	0.6041	0.0012	0.0018	0.6049	0.0011	0.0018	22028
22 #	251.31	34.53	1.4596	156	0	1.0596	0.0030	1.0567	0.0033	1.0539	0.0035	0.6036	0.0013	0.0018	0.6044	0.0014	0.0018	0.6052	0.0014	0.0018	22066

[Test Run Date Codes # - 07/17/85]

Table 48D. Orifice Discharge Coefficient Values - Meter Tube FE-2

Meter Tube FE-2ABC Diameter 2.0716 Inches -- Orifice Plate FE-1/2-6B Diameter 1.5004 Inches, Beta Ratio = 0.72427

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	269.61	33.55	6.8156	167	0	1.0191	0.0020	1.0189	0.0019	1.0178	0.0019	0.6169	0.0012	0.0018	0.6169	0.0012	0.0018	0.6173	0.0011	0.0018	101013
2	#	270.96	33.59	6.8063	168	0	1.0164	0.0024	1.0162	0.0021	1.0150	0.0022	0.6169	0.0012	0.0018	0.6169	0.0013	0.0018	0.6173	0.0012	0.0018	100958
3	#	271.01	33.63	6.7793	168	0	1.0093	0.0022	1.0074	0.0022	1.0063	0.0025	0.6166	0.0012	0.0018	0.6172	0.0013	0.0018	0.6175	0.0012	0.0018	100639
4	#	160.36	33.70	11.610	199	0	2.9832	0.0042	2.9816	0.0055	2.9748	0.0054	0.6142	0.0006	0.0008	0.6143	0.0007	0.0008	0.6150	0.0007	0.0008	172592
5	#	159.83	33.73	11.704	198	0	3.0339	0.0059	3.0297	0.0056	3.0235	0.0061	0.6140	0.0007	0.0008	0.6144	0.0007	0.0008	0.6150	0.0007	0.0008	174098
6	#	160.55	33.75	11.718	199	0	3.0391	0.0071	3.0362	0.0069	3.0295	0.0072	0.6142	0.0008	0.0008	0.6144	0.0008	0.0008	0.6151	0.0008	0.0008	174374
7	#	400.76	33.77	4.3544	152	0	0.4127	0.0009	0.4116	0.0009	0.4117	0.0008	0.6194	0.0026	0.0039	0.6202	0.0027	0.0040	0.6201	0.0024	0.0039	64825
8	#	402.52	33.80	4.3518	152	0	0.4111	0.0010	0.4105	0.0007	0.4109	0.0007	0.6202	0.0026	0.0040	0.6206	0.0027	0.0040	0.6203	0.0024	0.0040	64826
9	#	402.14	33.82	4.3420	152	0	0.4100	0.0009	0.4085	0.0010	0.4089	0.0009	0.6196	0.0026	0.0040	0.6208	0.0028	0.0040	0.6204	0.0025	0.0040	64706
10	#	52.850	33.90	35.253	86	0	27.797	0.0090	27.811	0.0102	27.733	0.0096	0.6110	0.0003	0.0004	0.6108	0.0003	0.0004	0.6117	0.0003	0.0004	526206
11	#	52.723	33.91	35.309	86	0	27.911	0.0109	27.902	0.0106	27.812	0.0086	0.6107	0.0003	0.0004	0.6108	0.0003	0.0004	0.6118	0.0003	0.0004	527155
12	#	53.300	33.92	35.310	87	0	27.910	0.0079	27.903	0.0039	27.813	0.0083	0.6107	0.0003	0.0004	0.6108	0.0003	0.0004	0.6118	0.0003	0.0004	527273
13	#	85.432	33.93	21.180	138	0	9.999	0.0078	10.003	0.0119	9.974	0.0123	0.6120	0.0003	0.0005	0.6119	0.0004	0.0005	0.6128	0.0004	0.0005	316341
14	#	84.707	33.96	21.235	133	0	10.049	0.0087	10.055	0.0103	10.023	0.0101	0.6121	0.0003	0.0005	0.6119	0.0004	0.0005	0.6129	0.0004	0.0005	317352
15	#	85.156	33.98	21.237	138	0	10.064	0.0119	10.061	0.0157	10.026	0.0138	0.6117	0.0004	0.0005	0.6118	0.0005	0.0005	0.6128	0.0005	0.0005	317512

[Test Run Date Codes # - 07/17/85]

Table 48E. Orifice Discharge Coefficient Values - Meter Tube FE-3

Meter Tube FE-3ABC Diameter 3.0733 Inches -- Orifice Plate FE-3/4-2B Diameter 1.1251 Inches, Beta Ratio = 0.36609

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	168.16	34.48	10.036	200	0	10.001	0.0158	10.001	0.0168	10.004	0.0171	0.6003	0.0005	0.0004	0.6003	0.0005	0.0004	0.6002	0.0005	0.0004	102163
2 #	179.74	34.50	10.048	188	0	10.031	0.0139	10.030	0.0146	10.027	0.0168	0.6001	0.0004	0.0004	0.6001	0.0005	0.0004	0.6002	0.0005	0.0004	102330
3 #	180.23	34.52	10.043	181	0	10.016	0.0170	10.016	0.0224	10.020	0.0214	0.6003	0.0005	0.0004	0.6003	0.0007	0.0004	0.6002	0.0007	0.0004	102324
4 #	325.61	34.52	5.5160	160	0	3.0135	0.0043	3.0141	0.0041	3.0144	0.0045	0.6011	0.0005	0.0008	0.6010	0.0005	0.0008	0.6010	0.0006	0.0008	56198
5 #	325.30	34.54	5.5051	160	0	3.0020	0.0050	3.0022	0.0057	3.0022	0.0057	0.6010	0.0006	0.0008	0.6010	0.0007	0.0008	0.6010	0.0007	0.0008	56109
6 #	324.92	34.57	5.5015	160	0	2.9971	0.0049	2.9968	0.0046	2.9955	0.0048	0.6011	0.0006	0.0008	0.6012	0.0006	0.0008	0.6013	0.0006	0.0008	56106
7 #	110.39	34.66	16.755	176	0	27.942	0.0145	27.937	0.0179	27.942	0.0160	0.5996	0.0002	0.0003	0.5996	0.0002	0.0003	0.5996	0.0002	0.0003	171184
8 #	109.98	34.67	16.760	175	0	27.956	0.0098	27.953	0.0122	27.960	0.0122	0.5996	0.0002	0.0003	0.5996	0.0002	0.0003	0.5996	0.0002	0.0003	171267
9 #	110.36	34.68	16.764	170	0	27.972	0.0116	27.970	0.0136	27.973	0.0121	0.5996	0.0002	0.0003	0.5996	0.0002	0.0003	0.5996	0.0002	0.0003	171338
10 #	184.70	34.58	2.0227	182	0	0.4029	0.0007	0.4042	0.0008	0.4023	0.0009	0.6028	0.0024	0.0039	0.6018	0.0027	0.0039	0.6032	0.0024	0.0039	20632
11 #	185.60	34.59	2.0138	181	0	0.3993	0.0006	0.3999	0.0007	0.3984	0.0007	0.6029	0.0024	0.0039	0.6024	0.0027	0.0039	0.6035	0.0024	0.0039	20546
12 #	184.86	34.61	2.0307	180	0	0.4058	0.0015	0.4057	0.0016	0.4042	0.0016	0.6031	0.0026	0.0039	0.6031	0.0028	0.0039	0.6042	0.0026	0.0038	20726
13 #	67.215	34.71	5.5036	107	0	2.9988	0.0068	2.9975	0.0093	2.9973	0.0091	0.6012	0.0008	0.0008	0.6013	0.0010	0.0008	0.6014	0.0010	0.0008	56286
14 #	67.703	34.72	5.5479	108	0	3.0484	0.0065	3.0479	0.0074	3.0470	0.0066	0.6011	0.0008	0.0008	0.6011	0.0008	0.0008	0.6012	0.0008	0.0008	56750
15 #	67.802	34.73	5.5386	108	0	3.0372	0.0098	3.0359	0.0112	3.0350	0.0104	0.6012	0.0010	0.0008	0.6013	0.0012	0.0008	0.6014	0.0011	0.0008	56666
16 #	117.46	34.71	3.1777	183	0	0.9967	0.0021	0.9964	0.0023	0.9961	0.0026	0.6021	0.0012	0.0017	0.6022	0.0013	0.0017	0.6023	0.0012	0.0017	32499
17 #	117.88	34.73	3.1748	184	0	0.9957	0.0027	0.9947	0.0028	0.9940	0.0028	0.6019	0.0013	0.0017	0.6022	0.0014	0.0017	0.6024	0.0013	0.0017	32482
19 #	118.61	34.77	3.2062	184	0	1.0149	0.0024	1.0143	0.0031	1.0139	0.0027	0.6021	0.0012	0.0017	0.6022	0.0014	0.0017	0.6024	0.0012	0.0017	32830
20 #	184.46	34.75	2.0351	180	0	0.4070	0.0012	0.4064	0.0012	0.4057	0.0011	0.6035	0.0025	0.0038	0.6039	0.0027	0.0039	0.6045	0.0024	0.0038	20830
21 #	185.74	34.77	2.0333	180	0	0.4057	0.0009	0.4052	0.0011	0.4048	0.0009	0.6039	0.0025	0.0039	0.6043	0.0027	0.0039	0.6045	0.0024	0.0039	20820
22 #	184.29	34.78	2.0381	177	0	0.4077	0.0007	0.4070	0.0008	0.4065	0.0008	0.6039	0.0024	0.0038	0.6043	0.0026	0.0039	0.6047	0.0023	0.0038	20873

[Test Run Date Codes # - 07/03/85]

Table 48F. Orifice Discharge Coefficient Values - Meter Tube FE-3

Meter Tube FE-3ABC Diameter 3.0733 Inches -- Orifice Plate FE-3/4-68 Diameter 2.2499 Inches, Beta Ratio = 0.73208

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	69.535	34.07	26.506	111	0	3.0595	0.0049	3.0581	0.0053	3.0654	0.0051	0.6106	0.0006	0.0007	0.6108	0.0007	0.0007	0.6100	0.0006	0.0007	267606
2	#	69.395	34.09	26.698	108	0	3.1028	0.0042	3.1001	0.0050	3.1087	0.0045	0.6108	0.0006	0.0007	0.6110	0.0006	0.0007	0.6102	0.0006	0.0007	269655
3	#	69.624	34.11	26.761	111	0	3.1186	0.0034	3.1166	0.0040	3.1231	0.0060	0.6107	0.0005	0.0007	0.6109	0.0006	0.0007	0.6102	0.0007	0.0007	270403
4	#	190.39	34.13	9.775	185	0	0.4102	0.0009	0.4106	0.0011	0.4096	0.0010	0.6151	0.0025	0.0039	0.6148	0.0027	0.0038	0.6155	0.0024	0.0038	98815
5	#	189.84	34.16	10.100	180	0	0.4380	0.0011	0.4395	0.0014	0.4366	0.0013	0.6150	0.0024	0.0036	0.6140	0.0026	0.0036	0.6160	0.0023	0.0036	102158
6	#	190.38	34.18	10.056	179	8	0.4331	0.0012	0.4337	0.0014	0.4324	0.0015	0.6158	0.0024	0.0037	0.6153	0.0027	0.0037	0.6162	0.0024	0.0037	101750
7	#	120.50	34.24	15.307	181	0	1.0114	0.0017	1.0102	0.0021	1.0127	0.0019	0.6133	0.0011	0.0017	0.6137	0.0013	0.0017	0.6130	0.0011	0.0017	155069
8	#	120.07	34.26	15.341	186	0	1.0163	0.0018	1.0157	0.0019	1.0178	0.0016	0.6132	0.0011	0.0017	0.6134	0.0012	0.0017	0.6128	0.0010	0.0017	155481
9	#	120.36	34.28	15.338	180	0	1.0159	0.0014	1.0152	0.0016	1.0172	0.0019	0.6133	0.0011	0.0017	0.6134	0.0012	0.0017	0.6129	0.0011	0.0017	155516
10	#	37.163	34.34	47.931	59	0	10.057	0.0082	10.055	0.0064	10.090	0.0054	0.6091	0.0005	0.0004	0.6091	0.0005	0.0004	0.6081	0.0005	0.0004	486563
11	#	37.166	34.34	48.008	59	0	10.091	0.0066	10.092	0.0068	10.117	0.0044	0.6090	0.0005	0.0004	0.6090	0.0005	0.0004	0.6082	0.0005	0.0004	487346
12	#	38.355	34.35	48.046	61	0	10.106	0.0023	10.105	0.0025	10.131	0.0026	0.6090	0.0004	0.0004	0.6091	0.0004	0.0004	0.6083	0.0004	0.0004	487832
13	#	130.18	34.38	47.789	198	0	9.997	0.0037	9.998	0.0043	10.037	0.0035	0.6091	0.0002	0.0004	0.6090	0.0002	0.0004	0.6079	0.0002	0.0004	485510
14	#	129.59	34.40	47.847	198	0	10.027	0.0037	10.026	0.0035	10.053	0.0032	0.6089	0.0002	0.0004	0.6089	0.0002	0.0004	0.6081	0.0002	0.0004	486300
15	#	129.01	34.42	47.891	195	0	10.050	0.0030	10.048	0.0032	10.077	0.0033	0.6088	0.0002	0.0004	0.6088	0.0002	0.0004	0.6080	0.0002	0.0004	486942
16	#	79.030	34.52	79.706	127	0	27.925	0.0050	27.926	0.0049	28.029	0.0058	0.6078	0.0001	0.0003	0.6078	0.0001	0.0003	0.6067	0.0001	0.0003	812059
17	#	79.621	34.53	79.668	126	0	27.892	0.0085	27.885	0.0071	27.982	0.0065	0.6079	0.0001	0.0003	0.6080	0.0001	0.0003	0.6069	0.0001	0.0003	811829
18	#	79.212	34.52	79.637	127	0	27.864	0.0063	27.861	0.0058	27.980	0.0034	0.6080	0.0001	0.0003	0.6080	0.0001	0.0003	0.6067	0.0001	0.0003	811350

[Test Run Date Codes # - 07/03/85]

Table 48G. Orifice Discharge Coefficient Values - Meter Tube FE-4

Meter Tube FE-4ABC Diameter 3.0781 Inches -- Orifice Plate FE-3/4-2A Diameter 1.1250 Inches, Beta Ratio = 0.36549

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	117.89	33.73	3.1901	187	0	1.0003	0.0025	1.0009	0.0031	1.0002	0.0029	0.6035	0.0015	0.0017	0.6033	0.0015	0.0017	0.6035	0.0014	0.0017	31937
2	#	117.65	33.74	3.1914	191	0	0.9933	0.0021	0.9938	0.0022	0.9932	0.0023	0.6058	0.0014	0.0018	0.6057	0.0013	0.0017	0.6058	0.0013	0.0018	31956
3	#	118.41	33.75	3.1782	192	0	0.9922	0.0020	0.9919	0.0023	0.9915	0.0022	0.6037	0.0014	0.0017	0.6037	0.0013	0.0017	0.6039	0.0013	0.0017	31831
4	#	67.886	33.82	5.5389	110	0	3.0221	0.0041	3.0222	0.0049	3.0215	0.0053	0.6028	0.0006	0.0008	0.6028	0.0007	0.0008	0.6028	0.0007	0.0008	55552
7	#	67.643	33.87	5.5304	109	0	3.0132	0.0087	3.0122	0.0109	3.0096	0.0103	0.6028	0.0010	0.0008	0.6029	0.0012	0.0008	0.6031	0.0011	0.0008	55523
8	#	68.147	33.89	5.5651	111	0	3.0236	0.0068	3.0197	0.0105	3.0191	0.0097	0.6055	0.0008	0.0008	0.6059	0.0011	0.0008	0.6059	0.0011	0.0008	55895
9	#	167.01	33.86	2.0360	200	0	0.4057	0.0007	0.4048	0.0010	0.4052	0.0010	0.6047	0.0032	0.0039	0.6055	0.0029	0.0039	0.6051	0.0026	0.0039	20437
10	#	166.45	33.88	2.0351	200	0	0.4054	0.0007	0.4044	0.0007	0.4047	0.0007	0.6048	0.0032	0.0039	0.6054	0.0028	0.0039	0.6053	0.0026	0.0039	20436
11	#	171.24	33.89	2.0302	200	1	0.4028	0.0006	0.4020	0.0008	0.4024	0.0008	0.6052	0.0032	0.0039	0.6058	0.0029	0.0039	0.6055	0.0026	0.0039	20391
12	#	334.98	34.00	5.5580	166	0	3.0501	0.0063	3.0473	0.0080	3.0474	0.0079	0.6021	0.0008	0.0008	0.6024	0.0009	0.0008	0.6024	0.0009	0.0008	55948
13	#	335.46	34.03	5.5398	166	0	3.0274	0.0065	3.0258	0.0067	3.0258	0.0069	0.6024	0.0008	0.0008	0.6025	0.0008	0.0008	0.6025	0.0008	0.0008	55798
14	#	334.96	34.06	5.5293	166	0	3.0171	0.0062	3.0144	0.0070	3.0145	0.0076	0.6023	0.0008	0.0008	0.6025	0.0008	0.0008	0.6025	0.0008	0.0008	55726
15	#	108.19	34.14	16.794	176	0	27.986	0.0145	27.982	0.0170	27.969	0.0195	0.6006	0.0002	0.0003	0.6006	0.0002	0.0003	0.6008	0.0003	0.0003	169525
16	#	108.25	34.16	16.791	176	0	27.981	0.0132	27.977	0.0113	27.961	0.0133	0.6006	0.0002	0.0003	0.6006	0.0002	0.0003	0.6008	0.0002	0.0003	169571

[Test Run Date Codes # - 07/16/85]

Table 48H. Orifice Discharge Coefficient Values - Meter Tube FE-4

Meter Tube FE-4ABC Diameter 3.0781 Inches -- Orifice Plate FE-3/4-6A Diameter 2.2492 Inches, Beta Ratio = 0.73071

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	69.756	33.39	26.229	113	0	3.0139	0.0042	3.0139	0.0053	3.0051	0.0048	0.6101	0.0006	0.0007	0.6101	0.0007	0.0007	0.6110	0.0006	0.0007	260777
2	#	69.338	33.41	26.224	109	0	3.0112	0.0032	3.0112	0.0057	3.0021	0.0064	0.6102	0.0006	0.0007	0.6102	0.0007	0.0007	0.6111	0.0008	0.0007	260834
3	#	69.596	33.43	26.252	107	0	3.0166	0.0060	3.0162	0.0046	3.0098	0.0048	0.6103	0.0008	0.0007	0.6104	0.0006	0.0007	0.6110	0.0006	0.0007	261218
4	#	38.234	33.48	47.754	62	0	10.057	0.0091	10.055	0.0060	10.025	0.0080	0.6080	0.0005	0.0004	0.6081	0.0005	0.0004	0.6090	0.0005	0.0004	475654
5	#	37.612	33.49	47.782	61	0	10.068	0.0048	10.066	0.0075	10.036	0.0034	0.6081	0.0005	0.0004	0.6081	0.0005	0.0004	0.6090	0.0005	0.0004	476033
6	#	37.630	33.50	47.777	61	0	10.060	0.0042	10.065	0.0045	10.037	0.0025	0.6082	0.0005	0.0004	0.6081	0.0005	0.0004	0.6089	0.0004	0.0004	476074
7	#	169.07	33.50	9.692	200	0	0.4047	0.0007	0.4041	0.0008	0.4041	0.0008	0.6152	0.0032	0.0039	0.6156	0.0029	0.0039	0.6156	0.0027	0.0039	96573
8	#	190.62	33.54	9.634	200	0	0.3997	0.0009	0.3986	0.0007	0.3987	0.0009	0.6154	0.0033	0.0039	0.6162	0.0029	0.0040	0.6161	0.0027	0.0039	96079
9	#	190.62	33.56	9.662	198	0	0.4021	0.0008	0.4007	0.0009	0.4009	0.0008	0.6153	0.0033	0.0039	0.6163	0.0029	0.0039	0.6161	0.0027	0.0039	96391
10	#	120.24	33.61	15.536	188	0	1.0483	0.0018	1.0468	0.0020	1.0442	0.0020	0.6127	0.0013	0.0017	0.6132	0.0013	0.0017	0.6139	0.0012	0.0016	155158
11	#	120.19	33.64	15.499	194	0	1.0433	0.0017	1.0417	0.0017	1.0392	0.0019	0.6127	0.0013	0.0017	0.6132	0.0012	0.0017	0.6139	0.0012	0.0017	154879
12	#	120.59	33.65	15.537	195	0	1.0479	0.0012	1.0467	0.0014	1.0447	0.0012	0.6129	0.0013	0.0017	0.6132	0.0012	0.0017	0.6138	0.0011	0.0017	155290
13	#	124.51	33.72	47.861	200	0	10.092	0.0040	10.098	0.0041	10.061	0.0031	0.6084	0.0002	0.0004	0.6082	0.0002	0.0004	0.6093	0.0002	0.0004	479050
14	#	124.86	33.74	47.787	200	0	10.062	0.0029	10.062	0.0036	10.030	0.0044	0.6083	0.0002	0.0004	0.6083	0.0002	0.0004	0.6093	0.0002	0.0004	478507
15	#	124.85	33.75	47.832	197	0	10.091	0.0040	10.086	0.0038	10.048	0.0037	0.6080	0.0002	0.0004	0.6082	0.0002	0.0004	0.6093	0.0002	0.0004	479051
16	#	74.641	33.85	79.550	122	0	27.974	0.0088	27.975	0.0055	27.876	0.0064	0.6074	0.0002	0.0003	0.6073	0.0001	0.0003	0.6084	0.0001	0.0003	798338
17	#	74.848	33.84	79.538	122	0	27.966	0.0049	27.960	0.0080	27.856	0.0057	0.6073	0.0001	0.0003	0.6074	0.0002	0.0003	0.6085	0.0001	0.0003	798051
18	#	74.876	33.84	79.508	122	0	27.931	0.0079	27.931	0.0091	27.843	0.0061	0.6075	0.0002	0.0003	0.6075	0.0002	0.0003	0.6085	0.0001	0.0003	797750

[Test Run Date Codes # - 07/16/85]

Table 48I. Orifice Discharge Coefficient Values - Meter Tube FE-5

Meter Tube FE-5ABC Diameter 4.0478 Inches -- Orifice Plate FE-5/6-2B Diameter 1.5002 Inches, Beta Ratio = 0.37062

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	188.91	28.20	9.870	200	0	3.0206	0.0048	3.0200	0.0060	3.0186	0.0057	0.6035	0.0006	0.0007	0.6035	0.0007	0.0007	0.6037	0.0007	0.0007	66885
2	#	190.80	28.23	9.888	196	0	3.0305	0.0058	3.0301	0.0063	3.0287	0.0059	0.6036	0.0007	0.0007	0.6036	0.0007	0.0007	0.6038	0.0007	0.0007	67054
3	#	189.97	28.25	9.888	193	0	3.0299	0.0049	3.0299	0.0051	3.0296	0.0045	0.6037	0.0006	0.0007	0.6037	0.0006	0.0007	0.6037	0.0006	0.0007	67083
4	#	61.260	28.33	29.814	84	0	27.679	0.0153	27.677	0.0140	27.670	0.0176	0.6022	0.0003	0.0003	0.6022	0.0003	0.0003	0.6023	0.0003	0.0003	202615
5	#	62.022	28.35	29.820	87	0	27.686	0.0132	27.687	0.0120	27.678	0.0132	0.6022	0.0003	0.0003	0.6022	0.0003	0.0003	0.6023	0.0003	0.0003	202738
6	#	61.334	28.36	29.836	86	0	27.735	0.0170	27.732	0.0165	27.728	0.0124	0.6020	0.0003	0.0003	0.6020	0.0003	0.0003	0.6021	0.0003	0.0003	202892
7	#	105.78	28.40	18.115	149	0	10.203	0.0172	10.204	0.0172	10.201	0.0192	0.6027	0.0005	0.0004	0.6026	0.0005	0.0004	0.6027	0.0006	0.0004	123298
8	#	105.14	28.43	18.062	148	0	10.147	0.0109	10.148	0.0114	10.141	0.0117	0.6025	0.0004	0.0004	0.6025	0.0004	0.0004	0.6027	0.0004	0.0004	123015
9	#	105.53	28.45	18.042	148	0	10.121	0.0156	10.124	0.0155	10.119	0.0151	0.6026	0.0005	0.0004	0.6025	0.0005	0.0004	0.6027	0.0005	0.0004	122929
10	#	324.91	28.50	5.7069	161	0	1.0082	0.0018	1.0093	0.0021	1.0087	0.0022	0.6040	0.0012	0.0017	0.6036	0.0013	0.0017	0.6038	0.0013	0.0017	38927
11	#	326.70	28.52	5.7395	162	0	1.0202	0.0016	1.0207	0.0015	1.0196	0.0014	0.6038	0.0012	0.0016	0.6037	0.0012	0.0016	0.6040	0.0011	0.0016	39166
12	#	326.81	28.53	5.7523	162	0	1.0244	0.0014	1.0254	0.0018	1.0245	0.0018	0.6040	0.0011	0.0016	0.6037	0.0012	0.0016	0.6039	0.0012	0.0016	39262
13	#	65.389	28.55	5.7069	92	0	1.0060	0.0047	1.0066	0.0056	1.0057	0.0048	0.6047	0.0018	0.0017	0.6045	0.0020	0.0017	0.6047	0.0018	0.0017	38969
14	#	65.378	28.56	5.7126	92	4	1.0094	0.0016	1.0106	0.0015	1.0099	0.0020	0.6042	0.0012	0.0017	0.6039	0.0012	0.0017	0.6041	0.0013	0.0017	39017
15	#	65.566	28.57	5.7225	91	1	1.0127	0.0018	1.0134	0.0018	1.0129	0.0017	0.6043	0.0012	0.0017	0.6041	0.0013	0.0017	0.6042	0.0012	0.0017	39093
16	#	106.19	28.58	3.6193	150	0	0.4034	0.0010	0.4048	0.0011	0.4035	0.0012	0.6056	0.0028	0.0038	0.6045	0.0029	0.0038	0.6055	0.0028	0.0038	24730
17	#	106.35	28.60	3.6367	148	0	0.4075	0.0006	0.4089	0.0006	0.4071	0.0005	0.6054	0.0027	0.0038	0.6044	0.0028	0.0038	0.6057	0.0027	0.0038	24860
18	#	106.29	28.61	3.6319	150	0	0.4059	0.0007	0.4074	0.0008	0.4057	0.0008	0.6058	0.0027	0.0038	0.6047	0.0029	0.0038	0.6059	0.0027	0.0038	24833

[Test Run Date Codes # - 09/17/85]

Table 48J. Orifice Discharge Coefficient Values - Meter Tube FE-5

Meter Tube FE-5ABC Diameter 4.0478 Inches -- Orifice Plate FE-5/6-6B Diameter 3.0000 Inches, Beta Ratio = 0.74114

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	135.13	27.62	47.173	190	0	3.0126	0.0033	3.0114	0.0030	3.0193	0.0030	0.6092	0.0005	0.0007	0.6093	0.0005	0.0007	0.6085	0.0005	0.0007	315642
2	#	134.75	27.65	47.307	188	0	3.0324	0.0024	3.0307	0.0025	3.0364	0.0023	0.6090	0.0004	0.0007	0.6091	0.0005	0.0007	0.6086	0.0004	0.0007	316743
3	#	134.61	27.66	47.224	182	0	3.0208	0.0035	3.0192	0.0035	3.0249	0.0036	0.6091	0.0005	0.0007	0.6092	0.0005	0.0007	0.6086	0.0005	0.0007	316255
4	#	45.192	27.77	142.64	64	0	27.907	0.0163	27.910	0.0163	27.961	0.0176	0.6053	0.0002	0.0003	0.6052	0.0002	0.0003	0.6047	0.0003	0.0003	957574
5	#	44.672	27.78	142.60	63	0	27.901	0.0242	27.902	0.0262	27.945	0.0191	0.6052	0.0003	0.0003	0.6051	0.0003	0.0003	0.6047	0.0003	0.0003	957509
6	#	44.712	27.81	142.64	63	0	27.912	0.0207	27.911	0.0214	27.956	0.0194	0.6052	0.0003	0.0003	0.6052	0.0003	0.0003	0.6047	0.0003	0.0003	958397
7	#	74.495	27.86	85.619	105	0	10.007	0.0055	10.009	0.0055	10.032	0.0042	0.6067	0.0002	0.0004	0.6066	0.0002	0.0004	0.6060	0.0002	0.0004	575913
8	#	74.954	27.88	85.829	101	0	10.063	0.0146	10.064	0.0156	10.071	0.0098	0.6065	0.0005	0.0004	0.6065	0.0005	0.0004	0.6063	0.0003	0.0004	577578
9	#	74.725	27.89	85.624	105	0	10.016	0.0047	10.015	0.0048	10.027	0.0058	0.6065	0.0002	0.0004	0.6065	0.0002	0.0004	0.6061	0.0002	0.0004	576320
10	#	39.917	27.85	47.665	56	0	3.0794	0.0051	3.0798	0.0054	3.0865	0.0066	0.6089	0.0007	0.0007	0.6088	0.0008	0.0007	0.6082	0.0008	0.0007	320548
11	#	39.218	27.86	48.139	55	0	3.1405	0.0040	3.1416	0.0045	3.1459	0.0027	0.6089	0.0007	0.0007	0.6088	0.0007	0.0007	0.6084	0.0006	0.0007	323805
12	#	39.956	27.87	47.996	56	0	3.1214	0.0055	3.1215	0.0078	3.1270	0.0033	0.6090	0.0008	0.0007	0.6090	0.0009	0.0007	0.6084	0.0006	0.0007	322915
13	#	108.91	27.90	17.530	146	0	0.4245	0.0008	0.4103	0.0012	0.4105	0.0010	0.6031	0.0026	0.0036	0.6135	0.0030	0.0038	0.6133	0.0028	0.0035	118021
14	#	109.22	27.93	17.713	150	0	0.4183	0.0007	0.4195	0.0007	0.4191	0.0009	0.6139	0.0027	0.0037	0.6130	0.0028	0.0037	0.6134	0.0027	0.0037	119332
15	#	109.28	27.97	17.319	154	0	0.3997	0.0010	0.4000	0.0010	0.4011	0.0009	0.6141	0.0028	0.0039	0.6139	0.0030	0.0039	0.6130	0.0028	0.0039	116779
16	#	70.513	28.02	27.941	99	0	1.0484	0.0012	1.0481	0.0012	1.0518	0.0019	0.6117	0.0011	0.0016	0.6118	0.0012	0.0016	0.6107	0.0012	0.0016	188600
17	#	70.427	28.04	27.887	99	0	1.0447	0.0014	1.0443	0.0016	1.0475	0.0018	0.6116	0.0011	0.0016	0.6117	0.0012	0.0016	0.6108	0.0012	0.0016	188319
18	#	70.403	28.06	27.879	99	0	1.0451	0.0016	1.0448	0.0018	1.0466	0.0014	0.6113	0.0012	0.0016	0.6114	0.0012	0.0016	0.6109	0.0012	0.0016	188351
19	#	69.771	28.10	27.889	98	0	1.0442	0.0018	1.0440	0.0024	1.0479	0.0027	0.6118	0.0012	0.0016	0.6119	0.0013	0.0016	0.6107	0.0013	0.0016	188581
20	#	69.702	28.11	27.871	98	0	1.0436	0.0018	1.0434	0.0022	1.0466	0.0019	0.6116	0.0012	0.0016	0.6117	0.0013	0.0016	0.6107	0.0012	0.0016	188499
21	#	70.382	28.14	27.825	99	0	1.0400	0.0025	1.0396	0.0026	1.0414	0.0025	0.6116	0.0013	0.0016	0.6117	0.0014	0.0016	0.6112	0.0013	0.0016	188313

[Test Run Date Codes # - 09/17/85]

Table 48K. Orifice Discharge Coefficient Values - Meter Tube FE-6

Meter Tube FE-6ABC Diameter 4.0331 Inches -- Orifice Plate FE-5/6-6C Diameter 2.9998 Inches, Beta Ratio = 0.74380

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	44.778	33.67	143.73	72	0	28.215	0.0147	28.206	0.0108	28.305	0.0083	0.6052	0.0002	0.0003	0.6053	0.0002	0.0003	0.6042	0.0002	0.0003	1096868
2	#	45.013	33.70	143.64	71	0	28.169	0.0133	28.170	0.0116	28.263	0.0284	0.6053	0.0002	0.0003	0.6053	0.0002	0.0003	0.6043	0.0003	0.0003	1096828
3	#	45.291	33.73	143.50	72	0	28.113	0.0133	28.104	0.0162	28.209	0.0129	0.6053	0.0002	0.0003	0.6054	0.0002	0.0003	0.6043	0.0002	0.0003	1096447
4	#	127.09	33.81	47.139	200	0	3.0070	0.0019	3.0079	0.0019	3.0181	0.0026	0.6080	0.0004	0.0007	0.6079	0.0004	0.0007	0.6069	0.0004	0.0007	360757
5	#	129.74	33.82	47.126	198	0	3.0073	0.0026	3.0069	0.0024	3.0155	0.0027	0.6078	0.0005	0.0007	0.6078	0.0005	0.0007	0.6070	0.0005	0.0007	360731
6	#	127.82	33.84	46.860	200	0	2.9741	0.0023	2.9723	0.0023	2.9788	0.0026	0.6077	0.0005	0.0007	0.6079	0.0005	0.0007	0.6072	0.0005	0.0007	358843
7	#	74.821	33.87	85.906	114	0	10.043	0.0059	10.044	0.0046	10.081	0.0036	0.6063	0.0002	0.0004	0.6063	0.0002	0.0004	0.6051	0.0002	0.0004	658247
8	#	74.591	33.88	85.525	118	0	9.957	0.0054	9.959	0.0066	9.988	0.0036	0.6062	0.0002	0.0004	0.6061	0.0003	0.0004	0.6052	0.0002	0.0004	655460
9	#	74.632	33.88	85.753	118	1	10.023	0.0053	10.016	0.0038	10.037	0.0039	0.6058	0.0002	0.0004	0.6060	0.0002	0.0004	0.6054	0.0002	0.0004	657207
10	#	40.412	33.89	47.191	62	0	3.0123	0.0060	3.0115	0.0067	3.0206	0.0040	0.6081	0.0008	0.0007	0.6082	0.0009	0.0007	0.6073	0.0007	0.0007	361738
11	#	40.596	33.89	47.226	64	0	3.0186	0.0058	3.0159	0.0059	3.0236	0.0033	0.6079	0.0008	0.0007	0.6082	0.0008	0.0007	0.6074	0.0006	0.0007	362011
12	#	40.051	33.90	47.112	63	0	3.0038	0.0076	3.0041	0.0085	3.0102	0.0060	0.6080	0.0010	0.0007	0.6079	0.0010	0.0007	0.6073	0.0008	0.0007	361212
13	#	104.71	33.92	17.256	165	0	0.3973	0.0009	0.3969	0.0011	0.3975	0.0007	0.6123	0.0030	0.0039	0.6126	0.0030	0.0039	0.6122	0.0027	0.0039	132353
14	#	104.63	33.94	17.296	158	0	0.3989	0.0007	0.3985	0.0010	0.3991	0.0007	0.6125	0.0029	0.0039	0.6128	0.0029	0.0039	0.6123	0.0027	0.0039	132720
15	#	104.16	33.95	17.252	158	0	0.3967	0.0008	0.3965	0.0009	0.3970	0.0007	0.6126	0.0030	0.0039	0.6128	0.0029	0.0039	0.6124	0.0027	0.0039	132403
16	#	69.358	34.00	27.335	107	0	1.0029	0.0015	1.0012	0.0016	1.0052	0.0024	0.6105	0.0013	0.0017	0.6110	0.0013	0.0017	0.6098	0.0013	0.0017	210006
17	#	69.827	34.02	27.332	110	0	1.0033	0.0014	1.0006	0.0013	1.0055	0.0013	0.6103	0.0013	0.0017	0.6111	0.0012	0.0017	0.6096	0.0011	0.0017	210066
18	#	69.801	34.02	27.216	110	0	0.9956	0.0021	0.9942	0.0019	0.9969	0.0019	0.6101	0.0013	0.0017	0.6105	0.0013	0.0017	0.6097	0.0012	0.0017	209176
19	#	44.865	34.24	143.01	72	0	27.951	0.0138	27.945	0.0218	27.999	0.0117	0.6050	0.0002	0.0003	0.6051	0.0003	0.0003	0.6045	0.0002	0.0003	1104059
20	#	44.620	34.25	142.94	71	0	27.893	0.0129	27.900	0.0163	27.982	0.0146	0.6053	0.0002	0.0003	0.6053	0.0002	0.0003	0.6044	0.0002	0.0003	1103699
21	#	44.538	34.28	142.96	71	0	27.911	0.0185	27.899	0.0135	28.002	0.0142	0.6052	0.0003	0.0003	0.6054	0.0002	0.0003	0.6042	0.0002	0.0003	1104493

[Test Run Date Codes # - 06/18/85]

Table 48L. Orifice Discharge Coefficient Values - Meter Tube FE-7

Meter Tube FE-7ABC Diameter 6.1200 Inches -- Orifice Plate FE-7/8-2B Diameter 2.2499 Inches, Beta Ratio = 0.36763

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	36.469	30.18	50.513	65	0	15.798	0.0134	15.799	0.0108	15.800	0.0090	0.6007	0.0005	0.0003	0.6007	0.0005	0.0003	0.6007	0.0005	0.0003	236268
2	#	35.551	30.19	50.444	62	0	15.753	0.0099	15.759	0.0130	15.758	0.0105	0.6008	0.0005	0.0003	0.6006	0.0005	0.0003	0.6007	0.0005	0.0003	235994
4	#	35.859	30.26	50.507	64	0	15.792	0.0088	15.792	0.0100	15.804	0.0113	0.6008	0.0005	0.0003	0.6008	0.0005	0.0003	0.6005	0.0005	0.0003	236640
5	#	144.97	30.28	12.883	180	0	1.0222	0.0006	1.0221	0.0006	1.0223	0.0006	0.6023	0.0010	0.0016	0.6023	0.0011	0.0016	0.6023	0.0009	0.0016	60384
6	#	144.81	30.32	12.954	180	0	1.0328	0.0010	1.0326	0.0010	1.0331	0.0009	0.6025	0.0010	0.0016	0.6026	0.0012	0.0016	0.6024	0.0009	0.0016	60768
7	#	145.13	30.34	12.964	180	0	1.0347	0.0005	1.0343	0.0006	1.0346	0.0007	0.6024	0.0010	0.0016	0.6025	0.0011	0.0016	0.6025	0.0009	0.0016	60842
8	#	82.696	30.41	22.271	147	0	3.0612	0.0036	3.0597	0.0041	3.0610	0.0034	0.6017	0.0005	0.0006	0.6018	0.0006	0.0006	0.6017	0.0005	0.0006	104679
9	#	82.582	30.42	22.269	139	0	3.0615	0.0025	3.0599	0.0030	3.0634	0.0029	0.6016	0.0005	0.0006	0.6018	0.0005	0.0006	0.6014	0.0005	0.0006	104692
10	#	83.186	30.45	22.087	148	0	3.0091	0.0030	3.0074	0.0038	3.0116	0.0030	0.6019	0.0005	0.0007	0.6020	0.0006	0.0007	0.6016	0.0005	0.0007	103901
11	#	45.608	30.55	40.246	81	0	10.027	0.0165	10.028	0.0188	10.031	0.0210	0.6008	0.0006	0.0003	0.6008	0.0007	0.0003	0.6007	0.0007	0.0003	189725
12	#	45.573	30.55	40.314	81	0	10.057	0.0104	10.056	0.0120	10.057	0.0081	0.6009	0.0005	0.0003	0.6010	0.0005	0.0003	0.6009	0.0004	0.0003	190048
13	#	45.660	30.56	40.277	81	0	10.027	0.0067	10.030	0.0069	10.034	0.0081	0.6013	0.0004	0.0003	0.6012	0.0004	0.0003	0.6011	0.0004	0.0003	189912
14	#	215.22	30.58	8.1317	178	0	0.4063	0.0002	0.4056	0.0003	0.4059	0.0003	0.6031	0.0025	0.0037	0.6036	0.0028	0.0037	0.6034	0.0022	0.0037	38359
15	#	215.29	30.61	8.1241	178	0	0.4050	0.0002	0.4043	0.0002	0.4049	0.0003	0.6034	0.0025	0.0038	0.6039	0.0029	0.0038	0.6035	0.0023	0.0037	38347
16	#	215.31	30.64	8.1197	178	0	0.4048	0.0002	0.4036	0.0003	0.4043	0.0003	0.6033	0.0025	0.0038	0.6042	0.0029	0.0038	0.6037	0.0023	0.0037	38351
17	#	83.161	30.69	21.936	148	0	2.9694	0.0023	2.9670	0.0026	2.9697	0.0021	0.6018	0.0005	0.0007	0.6020	0.0005	0.0007	0.6017	0.0004	0.0007	103716
18	#	82.579	30.70	22.016	147	0	2.9905	0.0049	2.9875	0.0050	2.9905	0.0045	0.6018	0.0006	0.0007	0.6021	0.0007	0.0007	0.6018	0.0006	0.0007	104119
19	#	83.187	30.71	22.008	148	0	2.9889	0.0023	2.9865	0.0023	2.9904	0.0019	0.6018	0.0005	0.0007	0.6020	0.0005	0.0007	0.6016	0.0004	0.0007	104103

[Test Run Date Codes # - 08/23/85]

Table 48M. Orifice Discharge Coefficient Values - Meter Tube FE-7

Meter Tube FE-7ABC Diameter 6.1200 Inches -- Orifice Plate FE-7/8-6B Diameter 4.4997 Inches, Beta Ratio = 0.73525

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	59.559	29.68	105.86	106	0	3.0990	0.0020	3.0957	0.0022	3.0985	0.0030	0.6034	0.0004	0.0006	0.6037	0.0005	0.0006	0.6034	0.0004	0.0006	489903
2 #	60.053	29.67	106.15	107	1	3.1148	0.0015	3.1142	0.0033	3.1146	0.0036	0.6035	0.0004	0.0006	0.6035	0.0005	0.0006	0.6035	0.0005	0.0006	491131
3 #	59.910	29.66	106.17	104	0	3.1161	0.0028	3.1140	0.0026	3.1179	0.0037	0.6035	0.0005	0.0006	0.6037	0.0005	0.0006	0.6033	0.0005	0.0006	491115
4 #	99.54	29.67	60.866	175	0	1.0177	0.0012	1.0166	0.0012	1.0177	0.0011	0.6054	0.0011	0.0016	0.6057	0.0012	0.0016	0.6054	0.0010	0.0016	281611
5 #	99.82	29.69	60.950	178	0	1.0205	0.0011	1.0192	0.0010	1.0203	0.0009	0.6054	0.0011	0.0016	0.6058	0.0012	0.0016	0.6054	0.0009	0.0016	282122
6 #	99.498	29.71	60.741	168	0	1.0131	0.0016	1.0119	0.0019	1.0132	0.0013	0.6055	0.0011	0.0016	0.6059	0.0013	0.0016	0.6055	0.0010	0.0016	281274
7 #	160.16	29.74	38.704	199	0	0.4079	0.0004	0.4069	0.0005	0.4073	0.0005	0.6080	0.0026	0.0037	0.6088	0.0029	0.0037	0.6085	0.0023	0.0037	179344
8 #	160.21	29.78	38.826	199	0	0.4107	0.0005	0.4096	0.0006	0.4101	0.0007	0.6079	0.0026	0.0037	0.6087	0.0029	0.0037	0.6084	0.0023	0.0037	180063
9 #	160.36	29.80	38.974	199	0	0.4131	0.0003	0.4120	0.0004	0.4136	0.0004	0.6084	0.0025	0.0037	0.6093	0.0028	0.0037	0.6080	0.0022	0.0037	180826
10 #	390.19	29.84	104.65	161	0	3.0337	0.0019	3.0280	0.0017	3.0301	0.0020	0.6028	0.0004	0.0007	0.6034	0.0004	0.0007	0.6032	0.0004	0.0007	485932
11 #	390.02	29.85	104.91	161	0	3.0454	0.0028	3.0417	0.0023	3.0444	0.0017	0.6032	0.0005	0.0007	0.6036	0.0005	0.0007	0.6033	0.0004	0.0007	487274
12 #	390.00	29.87	104.93	161	0	3.0481	0.0025	3.0447	0.0023	3.0466	0.0020	0.6030	0.0004	0.0007	0.6034	0.0005	0.0007	0.6032	0.0004	0.0007	487567
13 #	194.49	29.87	189.28	161	0	9.971	0.0048	9.966	0.0050	9.982	0.0045	0.6015	0.0002	0.0004	0.6016	0.0002	0.0004	0.6011	0.0002	0.0004	879519
14 #	195.73	29.85	190.56	162	0	10.111	0.0039	10.109	0.0044	10.124	0.0047	0.6013	0.0002	0.0004	0.6014	0.0002	0.0004	0.6009	0.0002	0.0004	885076
15 #	194.64	29.85	188.39	161	0	9.880	0.0040	9.876	0.0042	9.895	0.0035	0.6014	0.0002	0.0004	0.6015	0.0002	0.0004	0.6009	0.0002	0.0004	874985
16 #	113.05	29.92	314.51	200	0	27.680	0.0111	27.677	0.0121	27.701	0.0113	0.5998	0.0002	0.0003	0.5998	0.0002	0.0003	0.5996	0.0002	0.0003	1462941
17 #	112.99	29.98	314.57	200	0	27.694	0.0108	27.691	0.0111	27.715	0.0132	0.5998	0.0002	0.0003	0.5998	0.0002	0.0003	0.5996	0.0002	0.0003	1465098
18 #	113.03	30.03	314.73	200	0	27.720	0.0113	27.715	0.0130	27.755	0.0124	0.5998	0.0002	0.0003	0.5999	0.0002	0.0003	0.5994	0.0002	0.0003	1467390

[Test Run Date Codes # - 08/23/85]

Table 48N. Orifice Discharge Coefficient Values - Meter Tube FE-8

Meter Tube FE-8ABC Diameter 6.0840 Inches -- Orifice Plate FE-7/8-2A Diameter 2.2500 Inches, Beta Ratio = 0.36982

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	82.592	34.75	22.295	134	0	3.0785	0.0023	3.0758	0.0022	3.0771	0.0020	0.6008	0.0005	0.0006	0.6011	0.0005	0.0006	0.6010	0.0004	0.0006	115273
2 #	82.558	34.77	22.260	134	0	3.0657	0.0038	3.0652	0.0043	3.0678	0.0047	0.6011	0.0006	0.0006	0.6012	0.0006	0.0006	0.6009	0.0006	0.0006	115135
3 #	82.419	34.80	22.251	134	1	3.0631	0.0033	3.0629	0.0037	3.0655	0.0040	0.6011	0.0005	0.0006	0.6012	0.0006	0.0006	0.6009	0.0005	0.0006	115161
4 #	220.47	34.81	8.1642	182	1	0.4116	0.0005	0.4107	0.0004	0.4107	0.0003	0.6017	0.0028	0.0037	0.6023	0.0028	0.0037	0.6024	0.0023	0.0037	42262
5 #	220.18	34.84	8.1860	182	1	0.4130	0.0005	0.4129	0.0002	0.4130	0.0002	0.6023	0.0028	0.0037	0.6024	0.0028	0.0037	0.6023	0.0023	0.0037	42400
6 #	220.33	34.86	8.1927	182	0	0.4139	0.0007	0.4131	0.0004	0.4135	0.0004	0.6021	0.0028	0.0037	0.6027	0.0028	0.0037	0.6024	0.0023	0.0037	42452
7 #	130.84	34.91	13.053	200	0	1.0526	0.0011	1.0510	0.0011	1.0516	0.0011	0.6016	0.0011	0.0015	0.6020	0.0012	0.0015	0.6018	0.0010	0.0015	67705
8 #	133.85	34.92	13.046	200	0	1.0510	0.0012	1.0496	0.0012	1.0508	0.0009	0.6017	0.0011	0.0015	0.6021	0.0012	0.0016	0.6017	0.0010	0.0015	67679
9 #	131.06	34.95	12.998	200	0	1.0441	0.0010	1.0424	0.0011	1.0427	0.0011	0.6015	0.0011	0.0016	0.6020	0.0012	0.0016	0.6019	0.0010	0.0016	67475
10 #	35.642	35.01	50.045	58	0	15.540	0.0171	15.545	0.0339	15.546	0.0176	0.6003	0.0006	0.0003	0.6002	0.0008	0.0003	0.6001	0.0006	0.0003	260099
11 #	35.602	35.01	49.727	58	0	15.331	0.0138	15.343	0.0114	15.351	0.0103	0.6005	0.0005	0.0003	0.6003	0.0005	0.0003	0.6001	0.0005	0.0003	258446
12 #	36.215	35.02	49.704	59	0	15.336	0.0122	15.336	0.0165	15.344	0.0157	0.6001	0.0005	0.0003	0.6001	0.0005	0.0003	0.6000	0.0005	0.0003	258376
13 #	48.070	35.04	40.215	76	0	10.030	0.0153	10.033	0.0160	10.034	0.0208	0.6004	0.0006	0.0003	0.6003	0.0006	0.0003	0.6003	0.0007	0.0003	209135
14 #	48.038	35.05	40.272	74	0	10.065	0.0120	10.061	0.0112	10.066	0.0119	0.6002	0.0005	0.0003	0.6003	0.0005	0.0003	0.6002	0.0005	0.0003	209472
15 #	47.529	35.06	40.286	77	0	10.060	0.0142	10.060	0.0151	10.068	0.0180	0.6006	0.0006	0.0003	0.6006	0.0006	0.0003	0.6003	0.0006	0.0003	209585

[Test Run Date Codes # - 07/18/85]

Table 480. Orifice Discharge Coefficient Values - Meter Tube FE-8

Meter Tube FE-8ABC Diameter 6.0840 Inches -- Orifice Plate FE-7/8-6A Diameter 4.4992 Inches, Beta Ratio = 0.73951

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	104.64	33.81	61.191	170	1	1.0211	0.0013	1.0194	0.0009	1.0237	0.0009	0.6051	0.0012	0.0016	0.6056	0.0012	0.0016	0.6043	0.0010	0.0016	310436
2	#	104.55	33.92	61.164	170	0	1.0196	0.0013	1.0175	0.0010	1.0217	0.0008	0.6053	0.0012	0.0016	0.6059	0.0012	0.0016	0.6046	0.0010	0.0016	310990
3	#	104.62	33.94	61.104	170	0	1.0188	0.0014	1.0179	0.0011	1.0186	0.0010	0.6049	0.0012	0.0016	0.6052	0.0012	0.0016	0.6050	0.0010	0.0016	310814
4	#	161.45	33.96	39.129	200	0	0.4147	0.0006	0.4122	0.0007	0.4159	0.0006	0.6072	0.0028	0.0037	0.6090	0.0029	0.0037	0.6063	0.0023	0.0037	199116
5	#	161.42	33.99	39.250	200	1	0.4166	0.0005	0.4149	0.0003	0.4186	0.0005	0.6077	0.0028	0.0037	0.6089	0.0028	0.0037	0.6062	0.0023	0.0037	199853
6	#	161.07	34.01	39.027	200	0	0.4128	0.0006	0.4099	0.0005	0.4135	0.0006	0.6070	0.0028	0.0037	0.6091	0.0029	0.0037	0.6065	0.0023	0.0037	198798
7	#	61.006	34.03	105.35	100	0	3.0451	0.0038	3.0410	0.0026	3.0489	0.0023	0.6033	0.0006	0.0006	0.6037	0.0005	0.0006	0.6029	0.0004	0.0006	536828
8	#	62.294	34.03	105.51	101	0	3.0446	0.0036	3.0463	0.0022	3.0592	0.0026	0.6042	0.0005	0.0006	0.6040	0.0005	0.0006	0.6028	0.0004	0.0006	537644
9	#	61.404	34.04	105.50	99	0	3.0566	0.0029	3.0525	0.0026	3.0591	0.0028	0.6030	0.0005	0.0006	0.6034	0.0005	0.0006	0.6028	0.0004	0.0006	537734
10	#	360.12	34.07	105.29	149	0	3.0467	0.0039	3.0434	0.0020	3.0487	0.0026	0.6028	0.0006	0.0007	0.6031	0.0005	0.0007	0.6026	0.0004	0.0007	536975
11	#	360.26	34.07	105.29	149	0	3.0441	0.0033	3.0431	0.0021	3.0491	0.0012	0.6031	0.0005	0.0007	0.6032	0.0005	0.0007	0.6026	0.0004	0.0007	537003
12	#	360.26	34.07	105.28	149	1	3.0466	0.0034	3.0423	0.0021	3.0502	0.0015	0.6027	0.0005	0.0007	0.6032	0.0005	0.0007	0.6024	0.0004	0.0007	536927
13	#	123.94	34.11	312.84	200	0	27.072	0.0143	27.069	0.0122	27.097	0.0105	0.6008	0.0002	0.0003	0.6009	0.0002	0.0003	0.6006	0.0002	0.0003	1596787
14	#	123.92	34.13	312.82	200	0	27.086	0.0135	27.073	0.0112	27.092	0.0119	0.6006	0.0002	0.0003	0.6008	0.0002	0.0003	0.6006	0.0002	0.0003	1597346
15	#	123.76	34.17	312.75	200	0	27.052	0.0114	27.045	0.0080	27.091	0.0103	0.6009	0.0002	0.0003	0.6010	0.0002	0.0003	0.6005	0.0002	0.0003	1598270
16	#	230.60	34.29	189.99	190	0	9.970	0.0067	9.972	0.0048	10.001	0.0055	0.6013	0.0003	0.0004	0.6012	0.0002	0.0004	0.6004	0.0002	0.0004	973273
17	#	229.98	34.37	189.91	190	0	9.959	0.0089	9.958	0.0040	9.984	0.0050	0.6014	0.0003	0.0004	0.6014	0.0002	0.0004	0.6006	0.0002	0.0004	974410
18	#	230.07	34.43	189.90	190	0	9.957	0.0084	9.956	0.0052	9.983	0.0039	0.6014	0.0003	0.0004	0.6014	0.0002	0.0004	0.6006	0.0002	0.0004	975542
19	#	205.45	34.52	190.78	170	0	10.043	0.0118	10.041	0.0054	10.081	0.0034	0.6016	0.0004	0.0004	0.6017	0.0002	0.0004	0.6005	0.0002	0.0004	981834
20	#	205.63	34.58	190.52	170	0	10.016	0.0094	10.013	0.0039	10.052	0.0060	0.6016	0.0003	0.0004	0.6017	0.0002	0.0004	0.6005	0.0002	0.0004	981693
21	#	205.56	34.64	190.46	170	1	9.995	0.0077	10.007	0.0051	10.048	0.0052	0.6020	0.0003	0.0004	0.6017	0.0002	0.0004	0.6004	0.0002	0.0004	982545

[Test Run Date Codes # - 07/18/85]

Table 48P. Orifice Discharge Coefficient Values - Meter Tube FE-9

Meter Tube FE-9ABC Diameter 10.0829 Inches -- Orifice Plate FE-9/0-2B Diameter 3.7480 Inches, Beta Ratio = 0.37172

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	34.747	32.83	167.46	57	0	22.620	0.0317	22.621	0.0367	22.617	0.0250	0.5997	0.0005	0.0002	0.5997	0.0005	0.0002	0.5997	0.0004	0.0002	502487
2	#	35.750	32.83	167.64	58	0	22.678	0.0210	22.680	0.0275	22.682	0.0290	0.5995	0.0003	0.0002	0.5995	0.0004	0.0002	0.5995	0.0004	0.0002	503002
3	#	35.919	32.83	167.71	58	0	22.682	0.0210	22.677	0.0232	22.681	0.0258	0.5998	0.0003	0.0002	0.5998	0.0004	0.0002	0.5998	0.0004	0.0002	503225
4	#	53.981	32.83	111.56	86	0	10.028	0.0071	10.028	0.0111	10.022	0.0102	0.6000	0.0003	0.0003	0.6000	0.0004	0.0003	0.6002	0.0004	0.0003	334744
5	#	53.930	32.85	111.62	84	0	10.041	0.0078	10.047	0.0094	10.040	0.0104	0.6000	0.0003	0.0003	0.5998	0.0003	0.0003	0.6000	0.0004	0.0003	335075
6	#	53.914	32.85	111.54	87	0	10.022	0.0083	10.022	0.0117	10.021	0.0085	0.6001	0.0003	0.0003	0.6001	0.0004	0.0003	0.6001	0.0003	0.0003	334817
7	#	99.421	32.87	61.171	160	0	3.0089	0.0017	3.0080	0.0021	3.0081	0.0020	0.6006	0.0004	0.0006	0.6007	0.0004	0.0006	0.6007	0.0004	0.0006	183698
8	#	99.98	32.88	61.180	161	1	3.0088	0.0016	3.0090	0.0022	3.0117	0.0014	0.6007	0.0004	0.0006	0.6007	0.0004	0.0006	0.6004	0.0004	0.0006	183765
9	#	99.80	32.90	61.201	159	3	3.0103	0.0025	3.0081	0.0025	3.0078	0.0036	0.6008	0.0004	0.0006	0.6010	0.0004	0.0006	0.6010	0.0005	0.0006	183901
10	#	161.50	32.92	35.358	200	0	1.0042	0.0005	1.0041	0.0007	1.0054	0.0005	0.6010	0.0009	0.0016	0.6010	0.0010	0.0016	0.6006	0.0009	0.0016	106289
11	#	161.52	32.95	35.295	200	0	1.0009	0.0004	1.0008	0.0004	1.0022	0.0004	0.6009	0.0009	0.0016	0.6009	0.0010	0.0016	0.6005	0.0009	0.0016	106166
12	#	161.51	32.97	35.254	200	0	0.9989	0.0006	0.9981	0.0006	0.9989	0.0006	0.6008	0.0010	0.0016	0.6010	0.0010	0.0016	0.6008	0.0009	0.0016	106087
13	#	100.19	32.99	60.754	161	0	2.9684	0.0016	2.9659	0.0014	2.9680	0.0015	0.6006	0.0004	0.0006	0.6009	0.0004	0.0006	0.6006	0.0004	0.0006	182896
14	#	99.364	33.00	60.828	159	0	2.9742	0.0013	2.9725	0.0019	2.9760	0.0016	0.6007	0.0004	0.0006	0.6009	0.0004	0.0006	0.6006	0.0004	0.0006	183157
15	#	99.59	33.02	60.916	160	1	2.9839	0.0013	2.9827	0.0017	2.9861	0.0016	0.6006	0.0004	0.0006	0.6008	0.0004	0.0006	0.6004	0.0004	0.0006	183496
16	#	52.281	33.05	35.620	84	0	1.0182	0.0006	1.0172	0.0009	1.0189	0.0006	0.6012	0.0010	0.0015	0.6015	0.0011	0.0015	0.6010	0.0010	0.0015	107362
17	#	53.549	33.06	35.600	86	1	1.0178	0.0004	1.0160	0.0004	1.0163	0.0007	0.6010	0.0010	0.0015	0.6016	0.0010	0.0016	0.6015	0.0010	0.0015	107326
18	#	52.906	33.06	35.597	85	1	1.0162	0.0008	1.0150	0.0007	1.0166	0.0017	0.6015	0.0010	0.0016	0.6018	0.0011	0.0016	0.6013	0.0011	0.0016	107315
19	#	83.779	33.08	22.346	135	0	0.4004	0.0003	0.3997	0.0003	0.4007	0.0004	0.6015	0.0023	0.0037	0.6020	0.0025	0.0037	0.6013	0.0023	0.0037	67397
20	#	84.374	33.10	22.341	136	0	0.4002	0.0003	0.3997	0.0003	0.4005	0.0003	0.6015	0.0023	0.0037	0.6019	0.0025	0.0037	0.6013	0.0023	0.0037	67409
21	#	83.686	33.11	22.323	135	0	0.3996	0.0004	0.3991	0.0005	0.3999	0.0003	0.6015	0.0023	0.0037	0.6019	0.0025	0.0038	0.6013	0.0023	0.0037	67368

[Test Run Date Codes # - 07/12/85]

Table 48Q. Orifice Discharge Coefficient Values - Meter Tube FE-9

Meter Tube FE-9ABC Diameter 10.0829 Inches -- Orifice Plate FE-9/0-6B Diameter 7.4997 Inches, Beta Ratio = 0.74380

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	57.279	32.70	108.32	89	0	0.4149	0.0006	0.4147	0.0007	0.4141	0.0007	0.6016	0.0023	0.0036	0.6018	0.0024	0.0036	0.6022	0.0022	0.0036	324148
2	#	58.184	32.71	108.25	94	0	0.4135	0.0007	0.4126	0.0006	0.4132	0.0007	0.6023	0.0023	0.0036	0.6030	0.0025	0.0036	0.6025	0.0022	0.0036	324010
3	#	57.548	32.72	108.33	92	0	0.4155	0.0005	0.4147	0.0007	0.4126	0.0006	0.6013	0.0023	0.0036	0.6019	0.0024	0.0036	0.6034	0.0022	0.0036	324329
4	#	34.434	32.74	166.77	55	0	0.9912	0.0031	0.9887	0.0035	0.9861	0.0028	0.5993	0.0014	0.0016	0.6001	0.0015	0.0016	0.6009	0.0013	0.0016	499494
5	#	34.884	32.73	167.88	54	0	1.0024	0.0012	1.0014	0.0011	0.9989	0.0009	0.5999	0.0010	0.0016	0.6002	0.0011	0.0016	0.6009	0.0010	0.0016	502692
7	#	34.380	32.74	167.94	56	0	1.0015	0.0021	0.9994	0.0025	1.0004	0.0016	0.6004	0.0011	0.0016	0.6010	0.0013	0.0016	0.6007	0.0010	0.0016	502976
9	#	178.18	32.79	172.09	200	0	1.0513	0.0007	1.0497	0.0010	1.0518	0.0011	0.6005	0.0009	0.0015	0.6009	0.0010	0.0016	0.6003	0.0009	0.0015	515935
10	#	174.23	32.79	172.08	200	0	1.0520	0.0009	1.0508	0.0008	1.0524	0.0011	0.6003	0.0009	0.0015	0.6006	0.0010	0.0015	0.6001	0.0009	0.0015	515912
11	#	180.31	33.31	168.49	200	1	1.0107	0.0013	1.0099	0.0009	1.0105	0.0011	0.5997	0.0010	0.0016	0.5999	0.0010	0.0016	0.5997	0.0010	0.0016	510574
12	#	186.41	33.38	168.20	200	0	1.0067	0.0009	1.0073	0.0011	1.0071	0.0011	0.5998	0.0010	0.0016	0.5996	0.0011	0.0016	0.5997	0.0010	0.0016	510404
13	#	189.53	33.47	168.17	195	0	1.0064	0.0009	1.0058	0.0008	1.0075	0.0009	0.5998	0.0010	0.0016	0.6000	0.0010	0.0016	0.5995	0.0009	0.0016	511264
14	#	155.42	33.57	290.23	193	0	3.0111	0.0031	3.0095	0.0036	3.0162	0.0049	0.5985	0.0005	0.0007	0.5986	0.0005	0.0007	0.5980	0.0006	0.0007	884122
15	#	155.56	33.60	290.19	193	0	3.0128	0.0026	3.0096	0.0029	3.0175	0.0028	0.5982	0.0004	0.0007	0.5985	0.0005	0.0007	0.5977	0.0004	0.0007	884536
16	#	154.93	33.64	290.47	192	0	3.0215	0.0035	3.0181	0.0033	3.0236	0.0033	0.5979	0.0005	0.0007	0.5983	0.0005	0.0007	0.5977	0.0005	0.0007	886120
17	#	84.587	33.86	525.89	136	0	9.942	0.0068	9.941	0.0100	9.956	0.0087	0.5968	0.0003	0.0003	0.5968	0.0003	0.0003	0.5964	0.0003	0.0003	1611480
18	#	84.617	33.89	524.35	136	0	9.887	0.0099	9.885	0.0094	9.897	0.0078	0.5967	0.0003	0.0003	0.5968	0.0003	0.0003	0.5964	0.0003	0.0003	1607738
19	#	84.587	33.91	523.01	131	0	9.840	0.0101	9.837	0.0105	9.860	0.0093	0.5966	0.0003	0.0003	0.5967	0.0004	0.0003	0.5960	0.0003	0.0003	1604274
21	#	44.577	34.19	877.79	72	0	27.822	0.0208	27.815	0.0188	27.902	0.0191	0.5955	0.0003	0.0002	0.5956	0.0003	0.0002	0.5947	0.0003	0.0002	2707808
22	#	45.158	34.28	876.23	72	0	27.730	0.0201	27.711	0.0198	27.836	0.0297	0.5955	0.0003	0.0002	0.5957	0.0003	0.0002	0.5943	0.0004	0.0002	2707924
23	#	45.352	34.41	879.42	73	0	27.948	0.0537	27.914	0.0796	28.026	0.0885	0.5953	0.0006	0.0002	0.5957	0.0009	0.0002	0.5945	0.0010	0.0002	2724884

[Test Run Date Codes # - 07/12/85]

Table 48R. Orifice Discharge Coefficient Values - Meter Tube FE-0

Meter Tube FE-0ABC Diameter 10.0258 Inches -- Orifice Plate FE-9/0-2A Diameter 3.7480 Inches, Beta Ratio = 0.37384

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	79.472	28.47	22.710	105	0	0.4112	0.0003	0.4103	0.0004	0.4111	0.0003	0.6027	0.0029	0.0036	0.6034	0.0028	0.0037	0.6028	0.0025	0.0036	62500
2	#	79.440	28.50	22.874	105	0	0.4171	0.0003	0.4162	0.0004	0.4167	0.0006	0.6028	0.0029	0.0036	0.6034	0.0027	0.0036	0.6031	0.0025	0.0036	62993
3	#	79.444	28.51	22.863	105	1	0.4177	0.0003	0.4165	0.0006	0.4166	0.0004	0.6020	0.0029	0.0036	0.6029	0.0027	0.0036	0.6029	0.0025	0.0036	62977
4	#	52.000	28.57	35.799	68	0	1.0233	0.0007	1.0214	0.0006	1.0232	0.0010	0.6023	0.0012	0.0015	0.6028	0.0012	0.0015	0.6023	0.0011	0.0015	98738
5	#	42.468	28.59	35.543	56	0	1.0087	0.0004	1.0066	0.0003	1.0094	0.0008	0.6023	0.0013	0.0016	0.6029	0.0012	0.0016	0.6021	0.0011	0.0016	98073
6	#	52.324	28.60	35.539	69	0	1.0089	0.0008	1.0066	0.0010	1.0091	0.0007	0.6022	0.0013	0.0016	0.6028	0.0012	0.0016	0.6021	0.0011	0.0016	98084
7	#	161.85	28.66	36.192	200	1	1.0460	0.0004	1.0441	0.0004	1.0453	0.0005	0.6023	0.0012	0.0015	0.6028	0.0011	0.0015	0.6025	0.0010	0.0015	100017
8	#	162.55	28.69	36.117	200	1	1.0421	0.0005	1.0398	0.0006	1.0400	0.0007	0.6021	0.0012	0.0015	0.6028	0.0011	0.0015	0.6027	0.0010	0.0015	99874
9	#	161.57	28.71	36.158	200	1	1.0450	0.0005	1.0432	0.0006	1.0440	0.0008	0.6020	0.0012	0.0015	0.6025	0.0011	0.0015	0.6023	0.0010	0.0015	100032
10	#	104.45	28.74	61.373	138	0	3.0149	0.0016	3.0128	0.0020	3.0133	0.0014	0.6016	0.0004	0.0006	0.6018	0.0004	0.0006	0.6017	0.0004	0.0006	169900
11	#	104.53	28.74	61.421	138	0	3.0208	0.0017	3.0192	0.0016	3.0188	0.0011	0.6015	0.0005	0.0006	0.6016	0.0004	0.0006	0.6017	0.0004	0.0006	170032
12	#	104.59	28.76	61.448	138	4	3.0219	0.0021	3.0195	0.0019	3.0195	0.0020	0.6016	0.0005	0.0006	0.6019	0.0004	0.0006	0.6018	0.0004	0.0006	170180
13	#	58.213	28.91	111.71	77	0	10.015	0.0093	10.011	0.0089	10.015	0.0057	0.6008	0.0003	0.0003	0.6009	0.0003	0.0003	0.6008	0.0002	0.0003	310374
14	#	57.429	28.94	111.75	75	0	10.028	0.0029	10.023	0.0055	10.016	0.0043	0.6006	0.0002	0.0003	0.6008	0.0002	0.0003	0.6010	0.0002	0.0003	310693
15	#	57.179	28.96	111.74	75	0	10.015	0.0112	10.014	0.0117	10.016	0.0107	0.6009	0.0004	0.0003	0.6010	0.0004	0.0003	0.6009	0.0004	0.0003	310795
16	#	34.573	29.03	168.11	46	1	22.716	0.0040	22.712	0.0148	22.722	0.0205	0.6003	0.0002	0.0002	0.6004	0.0003	0.0002	0.6003	0.0003	0.0002	468310
17	#	34.691	29.04	168.42	46	0	22.795	0.0177	22.788	0.0156	22.784	0.0138	0.6004	0.0003	0.0002	0.6005	0.0003	0.0002	0.6006	0.0003	0.0002	469284
18	#	34.702	29.05	168.19	46	2	22.726	0.0210	22.724	0.0084	22.714	0.0113	0.6005	0.0003	0.0002	0.6005	0.0002	0.0002	0.6006	0.0003	0.0002	468718

[Test Run Date Codes # - 09/30/85]

Table 48S. Orifice Discharge Coefficient Values - Meter Tube FE-0

Meter Tube FE-0ABC Diameter 10.0258 Inches -- Orifice Plate FE-9/0-6A Diameter 7.4996 Inches, Beta Ratio = 0.74803

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	59.077	27.03	109.77	78	0	0.4208	0.0014	0.4206	0.0013	0.4193	0.0013	0.6020	0.0030	0.0036	0.6021	0.0028	0.0036	0.6031	0.0026	0.0035	292692
2	#	59.662	27.05	108.96	79	0	0.4137	0.0007	0.4132	0.0010	0.4137	0.0005	0.6026	0.0030	0.0036	0.6030	0.0028	0.0036	0.6026	0.0025	0.0036	290664
3	#	59.669	27.08	108.97	79	0	0.4139	0.0005	0.4138	0.0010	0.4124	0.0006	0.6026	0.0029	0.0036	0.6026	0.0028	0.0036	0.6036	0.0025	0.0036	290892
4	#	34.228	27.17	173.74	44	0	1.0642	0.0024	1.0629	0.0026	1.0568	0.0020	0.5991	0.0013	0.0015	0.5995	0.0013	0.0015	0.6012	0.0011	0.0015	464718
5	#	34.236	27.20	177.42	44	0	1.1070	0.0033	1.1068	0.0038	1.1002	0.0030	0.5999	0.0014	0.0014	0.5999	0.0015	0.0014	0.6017	0.0013	0.0014	474876
6	#	34.668	27.23	179.37	44	0	1.1290	0.0025	1.1307	0.0010	1.1255	0.0012	0.6005	0.0013	0.0014	0.6001	0.0010	0.0014	0.6015	0.0010	0.0014	480407
7	#	194.86	27.33	170.03	161	0	1.0120	0.0013	1.0132	0.0009	1.0137	0.0011	0.6013	0.0013	0.0016	0.6009	0.0011	0.0016	0.6008	0.0011	0.0016	456399
8	#	194.38	27.37	169.91	162	0	1.0165	0.0020	1.0156	0.0016	1.0125	0.0011	0.5995	0.0013	0.0016	0.5998	0.0012	0.0016	0.6007	0.0011	0.0016	456477
9	#	195.42	27.43	171.86	162	0	1.0366	0.0008	1.0386	0.0007	1.0342	0.0008	0.6005	0.0012	0.0016	0.5999	0.0011	0.0016	0.6012	0.0010	0.0016	462321
11	#	154.28	27.55	295.63	191	0	3.0952	0.0020	3.0914	0.0024	3.0808	0.0022	0.5978	0.0005	0.0006	0.5982	0.0004	0.0006	0.5992	0.0004	0.0006	797403
12	#	154.84	27.59	296.38	192	0	3.1101	0.0028	3.1093	0.0039	3.0960	0.0032	0.5979	0.0005	0.0006	0.5980	0.0005	0.0006	0.5992	0.0005	0.0006	800133
13	#	155.33	27.63	296.48	192	0	3.1150	0.0026	3.1115	0.0035	3.0960	0.0033	0.5976	0.0005	0.0006	0.5980	0.0005	0.0006	0.5994	0.0005	0.0006	801109
14	#	84.866	27.73	530.39	112	0	10.013	0.0110	10.012	0.0100	9.972	0.0056	0.5963	0.0004	0.0003	0.5963	0.0003	0.0003	0.5975	0.0002	0.0003	1436295
15	#	84.858	27.80	530.87	112	0	10.031	0.0114	10.034	0.0124	9.993	0.0099	0.5963	0.0004	0.0003	0.5962	0.0004	0.0003	0.5974	0.0003	0.0003	1439793
16	#	84.913	27.87	531.11	112	0	10.043	0.0106	10.047	0.0089	9.994	0.0110	0.5962	0.0004	0.0003	0.5961	0.0003	0.0003	0.5977	0.0004	0.0003	1442664
17	#	44.648	28.11	882.79	59	0	27.901	0.0200	27.875	0.0186	27.736	0.0170	0.5946	0.0003	0.0002	0.5949	0.0003	0.0002	0.5964	0.0002	0.0002	2410564
18	#	44.584	28.20	882.38	59	0	27.822	0.0242	27.818	0.0338	27.691	0.0254	0.5952	0.0003	0.0002	0.5952	0.0004	0.0002	0.5966	0.0003	0.0002	2414177
19	#	44.686	28.29	882.29	59	0	27.807	0.0218	27.818	0.0205	27.731	0.0247	0.5953	0.0003	0.0002	0.5952	0.0003	0.0002	0.5961	0.0003	0.0002	2418677

[Test Run Date Codes # - 09/30/85]

Table 49A. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-1C Diameter 0.8747 Inches, Beta Ratio = 0.21701

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	200.52	33.32	1.9061	166	0	1.0072	0.0021	1.0072	0.0024	1.0070	0.0024	0.5991	0.0012	0.0018	0.5991	0.0014	0.0018	0.5991	0.0012	0.0018	14452
2 #	200.90	33.35	1.9255	166	0	1.0271	0.0029	1.0274	0.0030	1.0272	0.0026	0.5993	0.0013	0.0017	0.5992	0.0014	0.0017	0.5993	0.0012	0.0017	14608
4 #	199.71	33.39	1.9278	165	0	1.0300	0.0026	1.0295	0.0026	1.0293	0.0027	0.5992	0.0013	0.0017	0.5993	0.0014	0.0017	0.5994	0.0012	0.0017	14637
5 #	310.57	33.38	1.1992	154	1	0.3968	0.0007	0.3983	0.0007	0.3973	0.0008	0.6005	0.0027	0.0040	0.5994	0.0029	0.0040	0.6001	0.0025	0.0040	9103
6 #	310.56	33.40	1.2016	154	0	0.4002	0.0020	0.3999	0.0020	0.3991	0.0019	0.5992	0.0030	0.0039	0.5994	0.0032	0.0039	0.6000	0.0028	0.0039	9125
7 #	310.24	33.42	1.2207	154	0	0.4134	0.0013	0.4128	0.0014	0.4118	0.0015	0.5989	0.0027	0.0038	0.5993	0.0030	0.0038	0.6000	0.0026	0.0038	9274
8 #	60.338	33.57	5.9484	96	0	9.879	0.0317	9.871	0.0394	9.871	0.0405	0.5970	0.0010	0.0005	0.5972	0.0012	0.0005	0.5972	0.0013	0.0005	45330
9 #	60.411	33.58	5.9774	96	0	9.958	0.0158	9.958	0.0219	9.961	0.0265	0.5975	0.0006	0.0005	0.5975	0.0007	0.0005	0.5974	0.0008	0.0005	45561
10 #	59.321	33.59	5.9936	94	0	10.018	0.0290	10.013	0.0322	10.012	0.0298	0.5973	0.0009	0.0005	0.5975	0.0010	0.0005	0.5975	0.0009	0.0005	45693
12 #	115.62	33.61	3.2546	176	0	2.9458	0.0044	2.9436	0.0049	2.9422	0.0053	0.5981	0.0006	0.0008	0.5984	0.0007	0.0008	0.5985	0.0007	0.0008	24822
13 #	115.56	33.63	3.2690	179	0	2.9716	0.0080	2.9706	0.0089	2.9705	0.0088	0.5982	0.0009	0.0008	0.5983	0.0010	0.0008	0.5983	0.0010	0.0008	24942
14 #	178.21	33.73	10.002	200	0	27.964	0.0166	27.973	0.0174	27.977	0.0170	0.5966	0.0002	0.0004	0.5965	0.0002	0.0004	0.5965	0.0002	0.0004	76473
15 #	180.31	33.75	9.993	180	0	27.916	0.0182	27.909	0.0175	27.911	0.0192	0.5966	0.0002	0.0004	0.5967	0.0002	0.0004	0.5966	0.0002	0.0004	76431
16 #	179.36	33.76	10.012	185	1	28.039	0.0134	28.030	0.0123	28.031	0.0139	0.5964	0.0002	0.0004	0.5965	0.0002	0.0004	0.5965	0.0002	0.0004	76593
17 #	300.39	33.77	6.0033	149	0	10.053	0.0114	10.055	0.0138	10.053	0.0147	0.5972	0.0004	0.0005	0.5972	0.0004	0.0005	0.5972	0.0005	0.0005	45935
18 #	300.15	33.79	5.9810	149	0	9.982	0.0156	9.982	0.0141	9.982	0.0166	0.5971	0.0005	0.0005	0.5971	0.0004	0.0005	0.5971	0.0005	0.0005	45783
19 #	300.08	33.82	5.9827	149	0	9.986	0.0159	9.984	0.0180	9.983	0.0186	0.5972	0.0005	0.0005	0.5973	0.0006	0.0005	0.5973	0.0006	0.0005	45824
23 $	163.70	33.45	10.016	200	0	28.059	0.0139	28.058	0.0153	28.058	0.0157	0.5964	0.0002	0.0004	0.5964	0.0002	0.0004	0.5964	0.0002	0.0004	76142
24 $	178.44	33.48	10.014	200	0	28.042	0.0156	28.043	0.0175	28.043	0.0165	0.5965	0.0002	0.0004	0.5965	0.0002	0.0004	0.5965	0.0002	0.0004	76174
25 $	180.10	33.50	10.011	180	0	28.018	0.0094	28.010	0.0131	28.011	0.0147	0.5965	0.0001	0.0004	0.5966	0.0002	0.0004	0.5966	0.0002	0.0004	76179
26 $	300.41	33.55	6.0379	149	0	10.171	0.0134	10.168	0.0125	10.168	0.0125	0.5972	0.0004	0.0005	0.5972	0.0004	0.0005	0.5973	0.0004	0.0005	45994
27 $	300.02	33.57	6.0265	149	0	10.143	0.0205	10.135	0.0210	10.134	0.0218	0.5969	0.0006	0.0005	0.5971	0.0006	0.0005	0.5971	0.0007	0.0005	45925
28 $	300.08	33.59	6.0395	149	0	10.169	0.0147	10.174	0.0154	10.173	0.0157	0.5974	0.0004	0.0005	0.5973	0.0005	0.0005	0.5973	0.0005	0.0005	46043
32 $	200.50	33.61	1.9467	166	0	1.0509	0.0027	1.0502	0.0031	1.0505	0.0031	0.5990	0.0012	0.0017	0.5992	0.0013	0.0017	0.5991	0.0013	0.0017	14847
33 $	200.53	33.63	1.9452	166	0	1.0483	0.0018	1.0476	0.0022	1.0481	0.0025	0.5993	0.0011	0.0017	0.5995	0.0012	0.0017	0.5994	0.0011	0.0017	14842
34 $	199.72	33.65	1.9422	165	0	1.0447	0.0026	1.0436	0.0035	1.0439	0.0033	0.5994	0.0012	0.0017	0.5997	0.0014	0.0017	0.5996	0.0013	0.0017	14825
35 $	59.720	33.77	6.0276	95	0	10.141	0.0273	10.137	0.0311	10.136	0.0278	0.5971	0.0009	0.0005	0.5972	0.0010	0.0005	0.5972	0.0009	0.0005	46121
36 $	60.310	33.78	6.0311	94	0	10.147	0.0322	10.147	0.0392	10.149	0.0348	0.5972	0.0010	0.0005	0.5972	0.0012	0.0005	0.5972	0.0011	0.0005	46157
37 $	59.633	33.79	6.0329	95	0	10.157	0.0215	10.152	0.0291	10.149	0.0255	0.5971	0.0007	0.0005	0.5973	0.0009	0.0005	0.5973	0.0008	0.0005	46180

[Test Run Date Codes # - 07/08/85 $ - 07/09/85]

Table 49A. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-1C Diameter 0.8747 Inches, Beta Ratio = 0.21701

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
39 #	114.67	33.81	3.2700	180	0	2.9723	0.0066	2.9719	0.0083	2.9732	0.0079	0.5983	0.0008	0.0008	0.5983	0.0009	0.0008	0.5982	0.0009	0.0008	25041
40 #	114.69	33.83	3.2743	180	0	2.9855	0.0062	2.9802	0.0078	2.9810	0.0076	0.5978	0.0007	0.0008	0.5983	0.0009	0.0008	0.5982	0.0008	0.0008	25084
41 #	115.62	33.86	3.2781	181	0	2.9910	0.0086	2.9864	0.0096	2.9882	0.0090	0.5979	0.0009	0.0008	0.5984	0.0010	0.0008	0.5982	0.0010	0.0008	25129
42 #	310.53	33.79	1.2337	154	0	0.4221	0.0009	0.4200	0.0011	0.4199	0.0011	0.5990	0.0024	0.0037	0.6005	0.0025	0.0038	0.6006	0.0023	0.0037	9444
43 #	310.37	33.81	1.2326	154	0	0.4210	0.0012	0.4192	0.0014	0.4191	0.0013	0.5993	0.0025	0.0038	0.6006	0.0026	0.0038	0.6006	0.0024	0.0037	9439
44 #	310.28	33.83	1.2374	154	0	0.4246	0.0009	0.4229	0.0009	0.4226	0.0008	0.5990	0.0024	0.0037	0.6002	0.0025	0.0037	0.6004	0.0022	0.0037	9480
45 $	114.74	41.37	3.3371	175	0	3.1095	0.0057	3.1068	0.0075	3.1065	0.0073	0.5976	0.0007	0.0008	0.5979	0.0008	0.0008	0.5979	0.0008	0.0008	29572
46 $	115.30	41.38	3.3227	176	1	3.0724	0.0052	3.0796	0.0074	3.0800	0.0066	0.5986	0.0007	0.0008	0.5979	0.0008	0.0008	0.5979	0.0008	0.0008	29450
47 $	115.26	41.39	3.3220	176	0	3.0783	0.0082	3.0779	0.0067	3.0785	0.0069	0.5979	0.0009	0.0008	0.5980	0.0008	0.0008	0.5979	0.0008	0.0008	29449
48 $	59.493	41.47	5.9857	91	0	10.025	0.0146	10.029	0.0219	10.031	0.0253	0.5970	0.0005	0.0005	0.5969	0.0007	0.0005	0.5968	0.0008	0.0005	53141
49 $	59.365	41.48	5.9319	91	0	9.842	0.0358	9.846	0.0389	9.850	0.0347	0.5971	0.0011	0.0005	0.5970	0.0012	0.0005	0.5969	0.0011	0.0005	52673
50 $	60.171	41.49	5.9422	92	0	9.869	0.0255	9.879	0.0354	9.878	0.0357	0.5974	0.0008	0.0005	0.5971	0.0011	0.0005	0.5971	0.0011	0.0005	52774
51 $	199.33	41.36	1.9037	165	0	1.0069	0.0023	1.0086	0.0029	1.0083	0.0029	0.5991	0.0014	0.0018	0.5986	0.0015	0.0018	0.5987	0.0014	0.0018	16867
52 $	199.62	41.36	1.9010	165	0	1.0083	0.0024	1.0067	0.0023	1.0056	0.0025	0.5979	0.0014	0.0018	0.5983	0.0014	0.0018	0.5987	0.0014	0.0018	16843
53 $	200.60	41.37	1.9012	166	0	1.0056	0.0030	1.0062	0.0023	1.0058	0.0025	0.5987	0.0015	0.0018	0.5985	0.0014	0.0018	0.5987	0.0014	0.0018	16848
54 $	310.21	41.28	1.2035	154	0	0.4021	0.0013	0.4031	0.0008	0.4030	0.0009	0.5995	0.0031	0.0039	0.5986	0.0031	0.0039	0.5987	0.0030	0.0039	10647
55 $	310.32	41.28	1.2014	154	0	0.4007	0.0016	0.4012	0.0011	0.4017	0.0010	0.5995	0.0032	0.0039	0.5990	0.0032	0.0039	0.5986	0.0030	0.0039	10629
56 $	310.25	41.28	1.2044	154	0	0.4065	0.0016	0.4034	0.0012	0.4039	0.0010	0.5967	0.0031	0.0039	0.5988	0.0032	0.0039	0.5985	0.0030	0.0038	10655
57 $	161.72	41.64	9.987	200	0	27.988	0.0172	27.987	0.0218	27.991	0.0215	0.5962	0.0002	0.0004	0.5962	0.0003	0.0004	0.5961	0.0003	0.0004	88941
58 $	161.66	41.66	9.990	200	0	28.008	0.0112	28.009	0.0156	28.016	0.0160	0.5961	0.0002	0.0004	0.5961	0.0002	0.0004	0.5961	0.0002	0.0004	89002
59 $	162.11	41.69	9.988	200	0	27.990	0.0147	27.985	0.0189	27.986	0.0201	0.5962	0.0002	0.0004	0.5963	0.0002	0.0004	0.5963	0.0002	0.0004	89034
60 @	59.874	38.41	5.9689	92	0	9.953	0.0270	9.957	0.0330	9.959	0.0329	0.5972	0.0009	0.0005	0.5971	0.0010	0.0005	0.5970	0.0010	0.0005	50047
61 @	60.466	38.42	5.9557	93	0	9.913	0.0192	9.918	0.0259	9.918	0.0248	0.5971	0.0006	0.0005	0.5969	0.0008	0.0005	0.5969	0.0008	0.0005	49946
62 @	59.853	38.43	5.9864	91	0	10.010	0.0119	10.014	0.0128	10.014	0.0140	0.5972	0.0005	0.0005	0.5971	0.0005	0.0005	0.5971	0.0005	0.0005	50213
63 @	310.21	38.24	1.2058	154	0	0.4033	0.0010	0.4042	0.0009	0.4025	0.0008	0.5993	0.0033	0.0039	0.5987	0.0029	0.0039	0.5999	0.0027	0.0039	10077
64 @	310.36	38.24	1.2024	154	0	0.4013	0.0006	0.4017	0.0007	0.4001	0.0007	0.5991	0.0033	0.0039	0.5988	0.0029	0.0039	0.6000	0.0027	0.0039	10049
65 @	310.22	38.26	1.2215	154	0	0.4133	0.0010	0.4140	0.0009	0.4127	0.0009	0.5997	0.0032	0.0038	0.5992	0.0028	0.0038	0.6002	0.0026	0.0038	10212
66 @	114.42	38.45	3.2776	171	0	2.9933	0.0057	2.9913	0.0072	2.9916	0.0066	0.5980	0.0007	0.0008	0.5982	0.0008	0.0008	0.5981	0.0008	0.0008	27503
67 @	115.00	38.46	3.2599	177	0	2.9630	0.0055	2.9624	0.0071	2.9626	0.0071	0.5978	0.0007	0.0008	0.5978	0.0008	0.0008	0.5978	0.0008	0.0008	27359
68 @	115.53	38.48	3.2647	178	0	2.9695	0.0061	2.9693	0.0074	2.9700	0.0071	0.5980	0.0008	0.0008	0.5980	0.0009	0.0008	0.5980	0.0008	0.0008	27410

[Test Run Date Codes # - 07/09/85 $ - 08/01/85 @ - 08/14/85]

Table 49A. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-1C Diameter 0.8747 Inches, Beta Ratio = 0.21701

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
69 #	200.54	38.43	1.9044	166	0	1.0064	0.0017	1.0072	0.0018	1.0059	0.0018	0.5992	0.0014	0.0018	0.5989	0.0013	0.0018	0.5993	0.0012	0.0018	15974
70 #	200.74	38.44	1.8990	166	0	1.0006	0.0014	1.0012	0.0014	0.9997	0.0016	0.5993	0.0014	0.0018	0.5991	0.0012	0.0018	0.5995	0.0012	0.0018	15932
71 #	200.86	38.46	1.8982	166	0	1.0002	0.0019	1.0011	0.0023	0.9998	0.0022	0.5991	0.0014	0.0018	0.5989	0.0013	0.0018	0.5992	0.0013	0.0018	15931
72 #	161.78	38.66	9.985	200	0	27.964	0.0163	27.959	0.0178	27.956	0.0187	0.5960	0.0002	0.0004	0.5961	0.0002	0.0004	0.5961	0.0002	0.0004	84122
73 #	161.64	38.68	9.973	200	0	27.879	0.0125	27.873	0.0145	27.874	0.0142	0.5962	0.0002	0.0004	0.5963	0.0002	0.0004	0.5963	0.0002	0.0004	84055
74 #	161.74	38.69	9.981	200	0	27.928	0.0140	27.922	0.0143	27.924	0.0153	0.5962	0.0002	0.0004	0.5962	0.0002	0.0004	0.5962	0.0002	0.0004	84136
76 $	310.60	29.93	1.2103	154	0	0.4035	0.0003	0.4038	0.0003	0.4035	0.0003	0.6007	0.0137	0.0039	0.6005	0.0024	0.0039	0.6007	0.0023	0.0039	8550
77 $	310.51	29.94	1.2128	154	1	0.4137	0.0017	0.4055	0.0001	0.4052	0.0002	0.5946	0.0132	0.0038	0.6005	0.0024	0.0039	0.6007	0.0023	0.0037	8569
78 $	310.47	29.94	1.2105	154	2	0.4030	0.0002	0.4032	0.0002	0.4029	0.0002	0.6012	0.0137	0.0039	0.6011	0.0024	0.0039	0.6013	0.0023	0.0039	8553
79 $	200.53	29.94	1.9227	166	2	1.0214	0.0003	1.0210	0.0003	1.0210	0.0003	0.5998	0.0054	0.0017	0.5999	0.0010	0.0018	0.5999	0.0009	0.0017	13585
80 $	200.64	29.94	1.9187	166	2	1.0170	0.0002	1.0165	0.0002	1.0163	0.0003	0.5999	0.0054	0.0018	0.6000	0.0010	0.0018	0.6001	0.0009	0.0018	13557
81 $	200.54	29.95	1.9172	166	3	1.0151	0.0004	1.0146	0.0004	1.0146	0.0004	0.5999	0.0054	0.0018	0.6001	0.0010	0.0018	0.6001	0.0009	0.0018	13549
82 $	115.35	29.99	3.3035	162	0	3.0283	0.0007	3.0266	0.0007	3.0266	0.0006	0.5985	0.0018	0.0008	0.5987	0.0004	0.0008	0.5987	0.0004	0.0008	23367
83 $	115.24	29.98	3.3012	162	0	3.0245	0.0007	3.0229	0.0007	3.0225	0.0008	0.5985	0.0018	0.0008	0.5986	0.0004	0.0008	0.5987	0.0004	0.0008	23346
84 $	115.03	29.96	3.2999	160	5	3.0201	0.0010	3.0183	0.0012	3.0176	0.0015	0.5987	0.0018	0.0008	0.5988	0.0004	0.0008	0.5989	0.0004	0.0008	23326
85 $	59.149	30.01	6.0088	81	0	10.051	0.0020	10.048	0.0024	10.048	0.0024	0.5976	0.0006	0.0005	0.5976	0.0003	0.0005	0.5976	0.0003	0.0005	42520
86 $	60.487	29.99	6.0056	85	3	10.044	0.0021	10.042	0.0022	10.047	0.0012	0.5975	0.0006	0.0005	0.5975	0.0003	0.0005	0.5974	0.0003	0.0005	42480
87 $	60.117	30.00	6.0147	82	1	10.063	0.0058	10.060	0.0063	10.061	0.0068	0.5978	0.0006	0.0005	0.5979	0.0003	0.0005	0.5978	0.0003	0.0005	42553
88 $	300.04	29.99	6.0015	149	0	10.055	0.0040	10.033	0.0023	10.035	0.0028	0.5967	0.0006	0.0005	0.5974	0.0001	0.0005	0.5973	0.0002	0.0005	42451
89 $	300.27	30.01	5.9843	149	0	9.996	0.0122	9.972	0.0172	9.972	0.0157	0.5968	0.0007	0.0005	0.5975	0.0005	0.0005	0.5975	0.0005	0.0005	42347
90 $	300.32	30.01	6.0149	149	2	10.103	0.0014	10.080	0.0015	10.081	0.0015	0.5966	0.0006	0.0005	0.5973	0.0001	0.0005	0.5973	0.0001	0.0005	42564
91 $	220.48	30.15	8.6054	182	0	20.705	0.0052	20.676	0.0057	20.676	0.0053	0.5963	0.0003	0.0004	0.5967	0.0001	0.0004	0.5967	0.0001	0.0004	61077
92 $	220.63	30.14	8.6151	182	8	20.752	0.0047	20.722	0.0024	20.722	0.0023	0.5963	0.0003	0.0004	0.5967	0.0001	0.0004	0.5967	0.0001	0.0004	61132
93 $	220.47	30.14	8.6097	182	5	20.728	0.0046	20.694	0.0031	20.694	0.0035	0.5962	0.0003	0.0004	0.5967	0.0001	0.0004	0.5967	0.0001	0.0004	61094
94 @	310.59	22.58	1.2169	154	3	0.4054	0.0014	0.4045	0.0013	0.4063	0.0013	0.6022	0.0029	0.0039	0.6028	0.0026	0.0039	0.6015	0.0026	0.0039	7290
95 @	310.41	22.66	1.2123	154	0	0.4015	0.0022	0.3998	0.0023	0.4015	0.0021	0.6028	0.0032	0.0039	0.6041	0.0030	0.0040	0.6028	0.0029	0.0039	7276
96 @	310.29	22.62	1.2000	154	2	0.3946	0.0018	0.3925	0.0016	0.3940	0.0013	0.6019	0.0030	0.0040	0.6035	0.0028	0.0040	0.6023	0.0027	0.0040	7196
97 @	161.69	22.58	1.2304	200	0	0.4129	0.0023	0.4113	0.0026	0.4133	0.0024	0.6033	0.0031	0.0038	0.6045	0.0031	0.0039	0.6030	0.0030	0.0039	7371
98 @	161.49	22.58	1.2371	200	0	0.4177	0.0011	0.4160	0.0014	0.4178	0.0013	0.6031	0.0027	0.0038	0.6043	0.0026	0.0038	0.6030	0.0025	0.0038	7411
99 @	161.86	22.58	1.2370	200	0	0.4176	0.0018	0.4161	0.0022	0.4178	0.0020	0.6032	0.0029	0.0038	0.6042	0.0029	0.0038	0.6030	0.0028	0.0038	7410

[Test Run Date Codes # - 08/14/85 $ - 09/25/85 @ - 09/26/85]

Table 49A. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-1C Diameter 0.8747 Inches, Beta Ratio = 0.21701

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
100	#	200.14	28.63	1.8974	165	1	0.9949	0.0004	0.9940	0.0005	0.9934	0.0005	0.5997	0.0011	0.0018	0.5999	0.0010	0.0018	0.6001	0.0010	0.0018	13034
101	#	200.75	28.62	1.9024	166	0	0.9993	0.0014	0.9986	0.0016	0.9978	0.0017	0.5999	0.0012	0.0018	0.6001	0.0011	0.0018	0.6004	0.0011	0.0018	13066
102	#	200.84	28.62	1.9093	166	3	1.0073	0.0003	1.0057	0.0004	1.0049	0.0005	0.5997	0.0011	0.0018	0.6002	0.0010	0.0018	0.6004	0.0010	0.0018	13113
103	#	59.856	28.70	6.0054	75	0	10.034	0.0016	10.036	0.0023	10.036	0.0035	0.5976	0.0003	0.0005	0.5976	0.0003	0.0005	0.5976	0.0003	0.0005	41317
104	#	60.136	28.68	6.0023	77	1	10.031	0.0021	10.026	0.0034	10.025	0.0038	0.5974	0.0003	0.0005	0.5976	0.0003	0.0005	0.5976	0.0003	0.0005	41278
105	#	60.180	28.67	6.0023	77	2	10.027	0.0036	10.027	0.0030	10.026	0.0030	0.5975	0.0003	0.0005	0.5975	0.0003	0.0005	0.5976	0.0003	0.0005	41269
106	#	114.76	28.62	3.3217	147	0	3.0588	0.0008	3.0573	0.0011	3.0563	0.0012	0.5987	0.0004	0.0008	0.5989	0.0004	0.0008	0.5990	0.0004	0.0008	22814
107	#	115.20	28.64	3.3186	146	0	3.0531	0.0012	3.0511	0.0013	3.0516	0.0014	0.5987	0.0004	0.0008	0.5989	0.0004	0.0008	0.5989	0.0004	0.0008	22802
108	#	115.45	28.64	3.3199	148	0	3.0573	0.0007	3.0549	0.0008	3.0552	0.0009	0.5985	0.0004	0.0008	0.5988	0.0004	0.0008	0.5987	0.0004	0.0008	22811
110	#	200.17	28.83	8.5900	165	3	20.592	0.0036	20.591	0.0031	20.592	0.0033	0.5967	0.0001	0.0004	0.5968	0.0001	0.0004	0.5967	0.0001	0.0004	59266
111	#	199.88	28.84	8.5921	165	1	20.596	0.0046	20.596	0.0034	20.595	0.0037	0.5968	0.0001	0.0004	0.5968	0.0001	0.0004	0.5968	0.0001	0.0004	59293
112	#	200.70	28.84	8.5959	166	3	20.619	0.0035	20.617	0.0033	20.619	0.0026	0.5968	0.0001	0.0004	0.5968	0.0001	0.0004	0.5967	0.0001	0.0004	59319
116	$	200.96	26.60	1.8951	166	0	0.9933	0.0004	0.9926	0.0003	0.9913	0.0004	0.5993	0.0013	0.0018	0.5995	0.0012	0.0018	0.5999	0.0010	0.0018	12450
117	$	199.76	26.60	1.8934	165	1	0.9903	0.0004	0.9896	0.0004	0.9882	0.0004	0.5997	0.0013	0.0018	0.5999	0.0012	0.0018	0.6003	0.0010	0.0018	12439
118	$	200.81	26.60	1.8932	166	5	0.9907	0.0006	0.9899	0.0005	0.9882	0.0006	0.5995	0.0013	0.0018	0.5997	0.0012	0.0018	0.6002	0.0011	0.0018	12437
122	$	59.671	26.68	6.0031	82	2	10.029	0.0022	10.027	0.0031	10.026	0.0018	0.5974	0.0003	0.0005	0.5975	0.0003	0.0005	0.5975	0.0003	0.0005	39508
123	$	60.317	26.67	5.9892	83	1	9.979	0.0052	9.978	0.0053	9.978	0.0051	0.5975	0.0003	0.0005	0.5975	0.0003	0.0005	0.5976	0.0003	0.0005	39408
124	$	60.243	26.66	5.9821	81	2	9.952	0.0033	9.952	0.0033	9.952	0.0017	0.5976	0.0003	0.0005	0.5976	0.0003	0.0005	0.5976	0.0003	0.0005	39352
125	$	114.86	26.61	3.3198	158	0	3.0535	0.0010	3.0538	0.0012	3.0529	0.0007	0.5988	0.0005	0.0008	0.5987	0.0004	0.0008	0.5988	0.0004	0.0008	21814
126	$	114.93	26.61	3.3182	156	5	3.0502	0.0009	3.0493	0.0012	3.0486	0.0012	0.5988	0.0005	0.0008	0.5989	0.0004	0.0008	0.5989	0.0004	0.0008	21804
127	$	115.19	26.63	3.3103	155	0	3.0370	0.0008	3.0361	0.0006	3.0345	0.0009	0.5987	0.0005	0.0008	0.5987	0.0004	0.0008	0.5989	0.0004	0.0008	21762
128	$	220.53	26.83	8.5480	182	1	20.364	0.0069	20.366	0.0092	20.365	0.0097	0.5970	0.0002	0.0004	0.5970	0.0002	0.0004	0.5970	0.0002	0.0004	56445
129	$	220.32	26.82	8.5648	182	4	20.468	0.0033	20.461	0.0025	20.459	0.0021	0.5967	0.0001	0.0004	0.5968	0.0001	0.0004	0.5968	0.0001	0.0004	56543
130	$	220.57	26.82	8.5675	182	4	20.472	0.0049	20.470	0.0038	20.472	0.0029	0.5968	0.0001	0.0004	0.5968	0.0001	0.0004	0.5968	0.0001	0.0004	56561
131	@	162.56	26.63	10.016	200	0	28.059	0.0112	27.975	0.0148	27.980	0.0167	0.5959	0.0002	0.0004	0.5968	0.0002	0.0004	0.5968	0.0002	0.0004	65843
132	@	161.86	26.67	10.005	200	0	28.015	0.0121	27.930	0.0161	27.930	0.0151	0.5958	0.0002	0.0004	0.5967	0.0002	0.0004	0.5967	0.0002	0.0004	65834
133	@	162.23	26.72	9.998	200	1	27.989	0.0132	27.897	0.0141	27.897	0.0136	0.5956	0.0002	0.0004	0.5966	0.0002	0.0004	0.5966	0.0002	0.0004	65857
134	@	300.15	26.79	5.9995	149	0	10.054	0.0095	10.021	0.0066	10.021	0.0069	0.5963	0.0005	0.0005	0.5973	0.0002	0.0005	0.5973	0.0002	0.0005	39581
135	@	300.56	26.83	5.9818	149	0	9.993	0.0135	9.961	0.0177	9.962	0.0188	0.5964	0.0006	0.0005	0.5973	0.0005	0.0005	0.5973	0.0006	0.0005	39499
136	@	300.26	26.87	5.9812	149	0	9.991	0.0186	9.959	0.0190	9.959	0.0184	0.5964	0.0007	0.0005	0.5974	0.0006	0.0005	0.5973	0.0006	0.0005	39531

[Test Run Date Codes # - 09/26/85 $ - 10/22/85 @ - 11/06/85]

Table 49A. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-1C Diameter 0.8747 Inches, Beta Ratio = 0.21701

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
137	#	310.62	17.05	1.2178	154	4	0.4057	0.0009	0.4042	0.0009	0.4040	0.0008	0.6021	0.0113	0.0039	0.6032	0.0025	0.0039	0.6034	0.0025	0.0039	6367
138	#	310.35	16.06	1.2279	154	0	0.4117	0.0007	0.4099	0.0007	0.4099	0.0006	0.6026	0.0111	0.0039	0.6040	0.0024	0.0039	0.6040	0.0024	0.0038	6258
139	#	310.55	15.60	1.2222	154	5	0.4081	0.0004	0.4059	0.0005	0.4065	0.0006	0.6025	0.0112	0.0039	0.6041	0.0024	0.0039	0.6037	0.0024	0.0039	6154
140	$	300.10	29.90	6.0237	149	0	10.109	0.0133	10.111	0.0094	10.113	0.0100	0.5973	0.0004	0.0005	0.5973	0.0003	0.0005	0.5972	0.0003	0.0005	42526
141	$	300.06	29.94	6.0117	149	1	10.068	0.0169	10.066	0.0173	10.067	0.0171	0.5973	0.0005	0.0005	0.5974	0.0005	0.0005	0.5974	0.0005	0.0005	42478
142	$	300.38	29.98	6.0132	149	0	10.078	0.0112	10.078	0.0089	10.080	0.0102	0.5972	0.0004	0.0005	0.5972	0.0003	0.0005	0.5971	0.0003	0.0005	42524
143	$	162.19	30.04	10.013	200	1	27.997	0.0124	27.996	0.0155	28.003	0.0143	0.5966	0.0002	0.0004	0.5966	0.0002	0.0004	0.5966	0.0002	0.0004	70900
144	$	162.06	30.09	10.019	200	0	28.040	0.0143	28.027	0.0168	28.033	0.0174	0.5965	0.0002	0.0004	0.5967	0.0002	0.0004	0.5966	0.0002	0.0004	71016
145	$	162.21	30.14	10.013	200	0	28.014	0.0116	28.003	0.0124	28.009	0.0122	0.5965	0.0002	0.0004	0.5966	0.0002	0.0004	0.5965	0.0002	0.0004	71054
146	$	60.311	30.20	5.9841	84	0	9.965	0.0281	9.971	0.0245	9.973	0.0251	0.5977	0.0009	0.0005	0.5975	0.0008	0.0005	0.5974	0.0008	0.0005	42517
147	$	59.636	30.21	5.9760	83	0	9.935	0.0178	9.942	0.0196	9.942	0.0188	0.5978	0.0006	0.0005	0.5976	0.0007	0.0005	0.5976	0.0006	0.0005	42469
148	$	59.654	30.22	5.9867	83	0	9.966	0.0183	9.975	0.0213	9.977	0.0199	0.5979	0.0006	0.0005	0.5976	0.0007	0.0005	0.5976	0.0007	0.0005	42554
149	$	114.49	30.20	3.2882	159	0	2.9984	0.0057	2.9997	0.0092	3.0003	0.0087	0.5987	0.0007	0.0008	0.5986	0.0010	0.0008	0.5985	0.0009	0.0008	23363
150	$	115.26	30.22	3.2455	160	0	2.9246	0.0075	2.9236	0.0081	2.9250	0.0086	0.5984	0.0009	0.0008	0.5985	0.0009	0.0008	0.5983	0.0010	0.0008	23069
151	$	114.99	30.24	3.1950	153	0	2.8311	0.0050	2.8321	0.0070	2.8327	0.0063	0.5987	0.0007	0.0008	0.5986	0.0008	0.0008	0.5985	0.0008	0.0008	22720
152	$	200.52	30.25	1.9322	166	0	1.0317	0.0025	1.0325	0.0028	1.0319	0.0030	0.5998	0.0013	0.0017	0.5996	0.0013	0.0017	0.5997	0.0013	0.0017	13743
153	$	200.67	30.26	1.9336	166	0	1.0348	0.0026	1.0339	0.0021	1.0328	0.0022	0.5993	0.0013	0.0017	0.5996	0.0012	0.0017	0.5999	0.0011	0.0017	13756
154	$	200.79	30.28	1.9291	166	0	1.0286	0.0027	1.0293	0.0030	1.0283	0.0030	0.5997	0.0013	0.0017	0.5995	0.0013	0.0017	0.5998	0.0013	0.0017	13730
155	$	310.62	11.65	1.2649	154	0	0.4349	0.0014	0.4342	0.0018	0.4340	0.0020	0.6040	0.0026	0.0037	0.6044	0.0027	0.0037	0.6046	0.0027	0.0037	5722
156	$	310.61	10.12	1.2669	154	0	0.4366	0.0041	0.4363	0.0044	0.4358	0.0040	0.6039	0.0037	0.0037	0.6041	0.0039	0.0037	0.6045	0.0035	0.0037	5488
157	$	310.46	9.66	1.2363	154	1	0.4148	0.0007	0.4142	0.0007	0.4133	0.0007	0.6044	0.0026	0.0038	0.6048	0.0026	0.0038	0.6055	0.0024	0.0038	5285

[Test Run Date Codes # - 11/06/85 $ - 12/10/85]

Table 49B. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37245

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34	#	104.92	30.30	3.6031	148	0	0.4013	0.0007	0.4025	0.0010	0.4007	0.0009	0.6037	0.0027	0.0038	0.6028	0.0027	0.0038	0.6041	0.0025	0.0038	25655
35	#	104.87	30.33	3.5992	147	0	0.4006	0.0009	0.4015	0.0009	0.3998	0.0008	0.6035	0.0028	0.0038	0.6028	0.0027	0.0038	0.6041	0.0025	0.0038	25643
36	#	105.60	30.35	3.5935	149	0	0.3993	0.0010	0.4004	0.0012	0.3986	0.0014	0.6035	0.0028	0.0039	0.6027	0.0027	0.0038	0.6040	0.0027	0.0039	25613
37	#	64.622	30.41	5.6928	91	0	1.0047	0.0027	1.0052	0.0034	1.0041	0.0033	0.6028	0.0014	0.0017	0.6026	0.0015	0.0017	0.6029	0.0014	0.0017	40628
38	#	65.282	30.43	5.6846	92	0	1.0031	0.0026	1.0022	0.0034	1.0013	0.0037	0.6024	0.0013	0.0017	0.6026	0.0015	0.0017	0.6029	0.0015	0.0017	40587
39	#	65.286	30.44	5.6865	92	0	1.0037	0.0031	1.0031	0.0034	1.0016	0.0034	0.6024	0.0014	0.0017	0.6026	0.0015	0.0017	0.6030	0.0014	0.0017	40609
40	#	167.08	30.50	9.798	200	0	2.9877	0.0041	2.9883	0.0059	2.9895	0.0057	0.6016	0.0006	0.0007	0.6015	0.0007	0.0007	0.6014	0.0007	0.0007	70061
41	#	180.93	30.54	9.788	200	0	2.9825	0.0040	2.9818	0.0047	2.9834	0.0041	0.6015	0.0006	0.0007	0.6016	0.0006	0.0007	0.6014	0.0005	0.0007	70050
42	#	178.31	30.56	9.794	200	0	2.9867	0.0041	2.9858	0.0046	2.9859	0.0052	0.6015	0.0006	0.0007	0.6015	0.0006	0.0007	0.6015	0.0006	0.0007	70120
43	#	60.449	30.61	29.836	85	0	27.888	0.0311	27.894	0.0279	27.888	0.0263	0.5996	0.0004	0.0003	0.5995	0.0004	0.0003	0.5996	0.0004	0.0003	213837
44	#	59.841	30.62	29.830	84	0	27.860	0.0213	27.870	0.0209	27.866	0.0246	0.5998	0.0004	0.0003	0.5997	0.0004	0.0003	0.5997	0.0004	0.0003	213837
45	#	60.495	30.64	29.815	85	0	27.846	0.0166	27.842	0.0201	27.858	0.0194	0.5996	0.0003	0.0003	0.5997	0.0003	0.0003	0.5995	0.0003	0.0003	213822
46	#	104.57	30.66	17.846	147	0	9.954	0.0167	9.958	0.0186	9.960	0.0191	0.6003	0.0005	0.0004	0.6002	0.0006	0.0004	0.6001	0.0006	0.0004	128038
47	#	105.20	30.67	17.793	148	2	9.900	0.0120	9.900	0.0129	9.899	0.0112	0.6001	0.0004	0.0004	0.6001	0.0004	0.0004	0.6002	0.0004	0.0004	127681
48	#	105.23	30.69	17.781	148	0	9.880	0.0146	9.883	0.0184	9.882	0.0191	0.6004	0.0005	0.0004	0.6002	0.0006	0.0004	0.6003	0.0006	0.0004	127649
1	$	64.706	32.74	5.7119	103	0	1.0123	0.0028	1.0121	0.0042	1.0131	0.0037	0.6027	0.0014	0.0017	0.6027	0.0017	0.0017	0.6024	0.0015	0.0017	42795
2	$	65.335	32.75	5.7248	104	0	1.0154	0.0019	1.0150	0.0021	1.0162	0.0020	0.6031	0.0012	0.0017	0.6032	0.0013	0.0017	0.6029	0.0012	0.0017	42901
3	$	65.338	32.76	5.6981	104	0	1.0068	0.0037	1.0062	0.0048	1.0073	0.0037	0.6029	0.0016	0.0017	0.6031	0.0019	0.0017	0.6027	0.0015	0.0017	42710
4	$	104.92	32.77	3.6455	167	0	0.4111	0.0013	0.4103	0.0012	0.4109	0.0011	0.6036	0.0028	0.0038	0.6042	0.0030	0.0038	0.6038	0.0025	0.0038	27330
5	$	104.17	32.79	3.6353	166	0	0.4091	0.0011	0.4079	0.0015	0.4084	0.0012	0.6034	0.0027	0.0038	0.6043	0.0031	0.0038	0.6039	0.0025	0.0038	27265
6	$	105.21	32.81	3.6384	160	0	0.4093	0.0009	0.4087	0.0012	0.4093	0.0010	0.6038	0.0027	0.0038	0.6042	0.0030	0.0038	0.6037	0.0025	0.0038	27299
7	$	326.01	32.89	5.7235	161	0	1.0165	0.0030	1.0157	0.0030	1.0170	0.0030	0.6027	0.0014	0.0017	0.6029	0.0015	0.0017	0.6025	0.0013	0.0017	43015
8	$	326.48	32.93	5.7159	161	0	1.0159	0.0023	1.0133	0.0018	1.0148	0.0019	0.6021	0.0013	0.0017	0.6028	0.0013	0.0017	0.6024	0.0011	0.0016	42993
9	$	325.96	32.95	5.7470	161	0	1.0247	0.0019	1.0229	0.0016	1.0242	0.0016	0.6027	0.0012	0.0016	0.6032	0.0012	0.0016	0.6029	0.0011	0.0016	43244
10	$	105.11	33.04	18.029	157	0	10.165	0.0202	10.164	0.0273	10.164	0.0260	0.6003	0.0006	0.0004	0.6004	0.0008	0.0004	0.6003	0.0008	0.0004	135913
11	$	104.66	33.06	17.831	165	0	9.942	0.0167	9.939	0.0165	9.941	0.0155	0.6004	0.0005	0.0004	0.6004	0.0005	0.0004	0.6004	0.0005	0.0004	134476
12	$	105.17	33.08	17.929	161	0	10.053	0.0130	10.050	0.0145	10.049	0.0131	0.6003	0.0004	0.0004	0.6004	0.0005	0.0004	0.6004	0.0004	0.0004	135267
13	$	190.36	33.29	9.785	181	0	2.9856	0.0070	2.9800	0.0066	2.9812	0.0055	0.6012	0.0008	0.0007	0.6018	0.0008	0.0007	0.6016	0.0007	0.0007	74142
17	$	60.130	33.38	29.912	96	0	28.041	0.0104	28.053	0.0132	28.060	0.0156	0.5997	0.0003	0.0003	0.5996	0.0003	0.0003	0.5995	0.0003	0.0003	227070
18	$	59.530	33.38	29.908	95	0	28.048	0.0136	28.043	0.0180	28.041	0.0223	0.5995	0.0003	0.0003	0.5996	0.0003	0.0003	0.5996	0.0004	0.0003	227035

[Test Run Date Codes # - 09/24/84 $ - 07/08/85]

Table 49B. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37245

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
19 #	104.98	34.72	17.845	165	0	9.962	0.0173	9.964	0.0209	9.964	0.0207	0.6003	0.0006	0.0004	0.6003	0.0007	0.0004	0.6003	0.0007	0.0004	139182
20 #	104.61	34.73	17.878	159	0	9.998	0.0189	9.998	0.0205	10.002	0.0188	0.6004	0.0006	0.0004	0.6004	0.0006	0.0004	0.6003	0.0006	0.0004	139473
21 #	104.64	34.75	17.850	166	0	9.972	0.0156	9.969	0.0180	9.968	0.0172	0.6002	0.0005	0.0004	0.6003	0.0006	0.0004	0.6003	0.0006	0.0004	139306
22 #	325.61	34.74	5.7038	161	0	1.0114	0.0014	1.0109	0.0013	1.0108	0.0015	0.6023	0.0011	0.0017	0.6024	0.0011	0.0017	0.6024	0.0010	0.0017	44505
23 #	325.27	34.77	5.7033	161	0	1.0123	0.0020	1.0106	0.0019	1.0106	0.0018	0.6019	0.0011	0.0017	0.6024	0.0012	0.0017	0.6024	0.0011	0.0017	44528
24 #	324.77	34.78	5.6962	161	0	1.0082	0.0016	1.0076	0.0017	1.0078	0.0020	0.6024	0.0011	0.0017	0.6026	0.0011	0.0017	0.6025	0.0011	0.0017	44482
25 #	60.020	34.88	29.779	96	0	27.811	0.0237	27.806	0.0280	27.813	0.0263	0.5996	0.0004	0.0003	0.5997	0.0004	0.0003	0.5996	0.0004	0.0003	233007
26 #	60.313	34.88	29.822	94	0	27.898	0.0114	27.886	0.0095	27.896	0.0082	0.5995	0.0003	0.0003	0.5997	0.0003	0.0003	0.5996	0.0003	0.0003	233346
27 #	60.626	34.89	29.822	97	0	27.894	0.0157	27.894	0.0130	27.884	0.0165	0.5996	0.0003	0.0003	0.5996	0.0003	0.0003	0.5997	0.0003	0.0003	233391
28 #	190.02	34.88	9.766	181	0	2.9750	0.0047	2.9771	0.0051	2.9768	0.0049	0.6012	0.0006	0.0007	0.6010	0.0006	0.0007	0.6011	0.0006	0.0007	76416
29 #	190.63	34.90	9.768	182	0	2.9758	0.0045	2.9749	0.0043	2.9748	0.0049	0.6013	0.0006	0.0007	0.6014	0.0006	0.0007	0.6014	0.0006	0.0007	76459
30 #	189.36	34.92	9.791	182	0	2.9893	0.0054	2.9884	0.0063	2.9881	0.0058	0.6014	0.0006	0.0007	0.6014	0.0007	0.0007	0.6015	0.0007	0.0007	76673
31 #	64.841	34.93	5.7387	103	0	1.0241	0.0027	1.0249	0.0031	1.0245	0.0028	0.6022	0.0013	0.0016	0.6019	0.0014	0.0016	0.6021	0.0013	0.0016	44948
32 #	65.487	34.93	5.7113	104	2	1.0121	0.0027	1.0147	0.0038	1.0140	0.0036	0.6028	0.0013	0.0017	0.6021	0.0015	0.0017	0.6023	0.0014	0.0017	44734
33 #	65.114	34.94	5.7220	102	0	1.0192	0.0029	1.0182	0.0032	1.0182	0.0034	0.6019	0.0013	0.0016	0.6022	0.0014	0.0016	0.6022	0.0014	0.0016	44826
34 #	104.75	34.93	3.6294	167	0	0.4089	0.0010	0.4091	0.0010	0.4083	0.0008	0.6027	0.0025	0.0038	0.6025	0.0026	0.0038	0.6032	0.0024	0.0038	28427
35 #	105.39	34.95	3.6278	168	0	0.4086	0.0013	0.4091	0.0015	0.4082	0.0013	0.6027	0.0026	0.0038	0.6023	0.0027	0.0038	0.6029	0.0025	0.0038	28426
36 #	105.32	34.97	3.6252	168	0	0.4082	0.0012	0.4083	0.0015	0.4074	0.0013	0.6025	0.0026	0.0038	0.6025	0.0027	0.0038	0.6032	0.0025	0.0038	28417
1 $	65.174	40.48	5.7020	97	0	1.0119	0.0044	1.0095	0.0036	1.0119	0.0042	0.6025	0.0018	0.0017	0.6031	0.0017	0.0017	0.6024	0.0017	0.0017	49702
2 $	64.711	40.50	5.6995	99	0	1.0085	0.0032	1.0086	0.0031	1.0107	0.0035	0.6032	0.0015	0.0017	0.6032	0.0016	0.0017	0.6025	0.0016	0.0017	49699
3 $	64.840	40.51	5.6739	99	0	1.0012	0.0034	0.9991	0.0038	1.0023	0.0035	0.6027	0.0016	0.0017	0.6033	0.0017	0.0017	0.6023	0.0016	0.0017	49485
4 $	326.86	40.55	5.6982	162	0	1.0101	0.0024	1.0097	0.0021	1.0115	0.0023	0.6026	0.0014	0.0017	0.6027	0.0014	0.0017	0.6021	0.0013	0.0017	49734
5 $	326.75	40.57	5.6800	162	0	1.0057	0.0025	1.0025	0.0027	1.0049	0.0026	0.6020	0.0014	0.0017	0.6029	0.0015	0.0017	0.6022	0.0014	0.0017	49594
6 $	326.84	40.58	5.6439	162	1	0.9899	0.0022	0.9896	0.0022	0.9921	0.0021	0.6029	0.0014	0.0017	0.6030	0.0014	0.0017	0.6022	0.0013	0.0017	49288
7 $	190.00	40.67	9.934	189	0	3.0835	0.0069	3.0821	0.0070	3.0849	0.0071	0.6012	0.0008	0.0007	0.6014	0.0008	0.0007	0.6011	0.0008	0.0007	86894
8 $	190.16	40.69	9.924	189	0	3.0785	0.0058	3.0757	0.0066	3.0788	0.0065	0.6011	0.0007	0.0007	0.6014	0.0008	0.0007	0.6011	0.0008	0.0007	86842
9 $	180.64	40.72	9.964	200	0	3.1030	0.0047	3.1033	0.0049	3.1051	0.0051	0.6012	0.0006	0.0007	0.6012	0.0006	0.0007	0.6010	0.0006	0.0007	87246
10 $	60.264	40.78	29.881	92	0	28.094	0.0103	28.092	0.0100	28.094	0.0134	0.5992	0.0003	0.0003	0.5992	0.0003	0.0003	0.5991	0.0003	0.0003	261915
11 $	60.181	40.78	29.874	92	0	28.065	0.0111	28.052	0.0147	28.059	0.0163	0.5993	0.0003	0.0003	0.5995	0.0003	0.0003	0.5994	0.0003	0.0003	261862
12 $	59.548	40.78	29.870	91	0	28.062	0.0089	28.061	0.0097	28.063	0.0151	0.5993	0.0003	0.0003	0.5993	0.0003	0.0003	0.5993	0.0003	0.0003	261821

[Test Run Date Codes # - 07/09/85 $ - 07/31/85]

Table 49B. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37245

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
13	#	104.69	40.79	17.842	160	0	9.990	0.0102	9.990	0.0103	9.992	0.0113	0.6000	0.0004	0.0004	0.6000	0.0004	0.0004	0.5999	0.0004	0.0004	156425
14	#	105.08	40.80	17.929	160	0	10.090	0.0122	10.089	0.0152	10.090	0.0150	0.5999	0.0004	0.0004	0.5999	0.0005	0.0004	0.5999	0.0005	0.0004	157210
15	#	105.20	40.82	17.912	161	1	10.078	0.0366	10.069	0.0475	10.065	0.0516	0.5997	0.0011	0.0004	0.6000	0.0014	0.0004	0.6001	0.0016	0.0004	157121
16	#	104.58	40.76	3.7664	160	0	0.4386	0.0013	0.4405	0.0013	0.4420	0.0012	0.6045	0.0028	0.0035	0.6032	0.0030	0.0035	0.6021	0.0028	0.0036	33002
17	#	104.75	40.77	3.7487	156	0	0.4364	0.0010	0.4355	0.0012	0.4371	0.0010	0.6032	0.0028	0.0036	0.6037	0.0030	0.0036	0.6027	0.0028	0.0036	32853
18	#	105.53	40.77	3.7535	158	0	0.4361	0.0011	0.4364	0.0014	0.4378	0.0014	0.6041	0.0028	0.0036	0.6039	0.0030	0.0036	0.6029	0.0028	0.0036	32895
19	$	64.807	37.70	5.6841	97	0	1.0043	0.0028	1.0047	0.0031	1.0054	0.0024	0.6025	0.0014	0.0017	0.6024	0.0015	0.0017	0.6022	0.0013	0.0017	47012
20	$	64.635	37.71	5.6988	99	0	1.0097	0.0012	1.0097	0.0014	1.0102	0.0018	0.6025	0.0012	0.0017	0.6025	0.0013	0.0017	0.6023	0.0013	0.0017	47143
21	$	55.592	37.72	5.6868	85	0	1.0043	0.0028	1.0048	0.0032	1.0061	0.0026	0.6028	0.0014	0.0017	0.6027	0.0016	0.0017	0.6023	0.0014	0.0017	47053
22	$	105.06	37.70	3.6015	159	0	0.4020	0.0012	0.4026	0.0012	0.4030	0.0010	0.6034	0.0030	0.0038	0.6030	0.0031	0.0038	0.6027	0.0029	0.0038	29788
23	$	105.31	37.72	3.6052	157	0	0.4029	0.0011	0.4034	0.0013	0.4039	0.0012	0.6034	0.0029	0.0038	0.6030	0.0031	0.0038	0.6027	0.0029	0.0038	29830
24	$	105.56	37.73	3.6134	161	0	0.4045	0.0012	0.4054	0.0014	0.4057	0.0012	0.6036	0.0030	0.0038	0.6029	0.0031	0.0038	0.6027	0.0029	0.0038	29903
25	$	59.845	37.85	29.838	91	0	27.981	0.0129	27.976	0.0121	27.980	0.0169	0.5992	0.0003	0.0003	0.5993	0.0003	0.0003	0.5992	0.0003	0.0003	247499
26	$	60.178	37.86	29.851	92	0	27.986	0.0116	27.987	0.0137	27.983	0.0110	0.5994	0.0003	0.0003	0.5994	0.0003	0.0003	0.5995	0.0003	0.0003	247657
27	$	60.181	37.88	29.839	92	0	27.970	0.0152	27.974	0.0182	27.968	0.0143	0.5994	0.0003	0.0003	0.5993	0.0003	0.0003	0.5994	0.0003	0.0003	247656
28	$	104.64	37.88	17.888	160	0	10.023	0.0123	10.029	0.0123	10.030	0.0128	0.6002	0.0004	0.0004	0.6000	0.0004	0.0004	0.6000	0.0004	0.0004	148462
29	$	105.71	37.89	17.894	160	0	10.033	0.0172	10.039	0.0168	10.040	0.0172	0.6001	0.0006	0.0004	0.5999	0.0005	0.0004	0.5999	0.0006	0.0004	148540
30	$	105.56	37.91	17.870	157	0	10.006	0.0156	10.009	0.0146	10.008	0.0182	0.6002	0.0005	0.0004	0.6001	0.0005	0.0004	0.6001	0.0006	0.0004	148401
31	$	188.39	37.90	9.840	200	0	3.0194	0.0075	3.0210	0.0084	3.0218	0.0081	0.6016	0.0008	0.0007	0.6014	0.0009	0.0007	0.6013	0.0009	0.0007	81699
32	$	190.71	37.92	9.862	191	0	3.0356	0.0057	3.0392	0.0066	3.0395	0.0065	0.6014	0.0007	0.0007	0.6010	0.0008	0.0007	0.6010	0.0007	0.0007	81918
33	$	190.27	37.92	9.878	189	0	3.0467	0.0035	3.0478	0.0052	3.0483	0.0052	0.6012	0.0005	0.0007	0.6011	0.0007	0.0007	0.6010	0.0006	0.0007	82047
50	@	105.56	28.07	3.6353	145	0	0.4072	0.0009	0.4078	0.0011	0.4063	0.0009	0.6044	0.0026	0.0038	0.6040	0.0030	0.0038	0.6051	0.0026	0.0038	24670
51	@	105.70	28.09	3.6260	146	0	0.4050	0.0009	0.4056	0.0010	0.4039	0.0009	0.6045	0.0026	0.0038	0.6041	0.0031	0.0038	0.6054	0.0026	0.0038	24618
52	@	65.113	28.14	5.6964	88	1	1.0037	0.0014	1.0043	0.0018	1.0033	0.0019	0.6033	0.0011	0.0017	0.6031	0.0013	0.0017	0.6034	0.0012	0.0017	38716
53	@	65.243	28.16	5.6768	90	0	0.9973	0.0032	0.9977	0.0046	0.9966	0.0042	0.6031	0.0014	0.0017	0.6030	0.0018	0.0017	0.6033	0.0016	0.0017	38600
54	@	64.528	28.17	5.6864	89	0	1.0006	0.0029	1.0009	0.0027	1.0001	0.0028	0.6031	0.0014	0.0017	0.6031	0.0015	0.0017	0.6033	0.0014	0.0017	38674
55	@	190.19	28.22	9.878	185	0	3.0325	0.0038	3.0329	0.0040	3.0323	0.0043	0.6019	0.0005	0.0007	0.6018	0.0006	0.0007	0.6019	0.0006	0.0007	67257
56	@	190.35	28.25	9.868	186	0	3.0278	0.0032	3.0272	0.0038	3.0259	0.0039	0.6017	0.0005	0.0007	0.6018	0.0006	0.0007	0.6019	0.0005	0.0007	67234
57	@	190.74	28.28	9.864	194	0	3.0267	0.0033	3.0245	0.0037	3.0229	0.0039	0.6016	0.0005	0.0007	0.6018	0.0006	0.0007	0.6019	0.0005	0.0007	67248

[Test Run Date Codes # - 07/31/85 $ - 08/13/85 @ - 10/24/85]

Table 49B. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-2C Diameter 1.5012 Inches, Beta Ratio = 0.37245

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
58	#	60.370	28.33	29.727	83	0	27.656	0.0205	27.663	0.0209	27.664	0.0200	0.5998	0.0003	0.0003	0.5997	0.0004	0.0003	0.5997	0.0003	0.0003	202886
59	#	59.612	28.34	29.800	82	0	27.805	0.0341	27.795	0.0366	27.795	0.0405	0.5996	0.0005	0.0003	0.5997	0.0005	0.0003	0.5997	0.0005	0.0003	203428
60	#	59.658	28.36	29.895	82	0	27.991	0.0727	27.992	0.1045	27.994	0.0984	0.5995	0.0008	0.0003	0.5995	0.0012	0.0003	0.5995	0.0011	0.0003	204162
61	#	104.85	28.37	17.911	144	0	10.016	0.0138	10.020	0.0143	10.019	0.0145	0.6005	0.0005	0.0004	0.6004	0.0005	0.0004	0.6004	0.0005	0.0004	122349
62	#	104.83	28.38	17.916	144	0	10.019	0.0160	10.022	0.0214	10.021	0.0196	0.6005	0.0005	0.0004	0.6005	0.0007	0.0004	0.6005	0.0006	0.0004	122408
63	#	105.52	28.40	17.951	145	0	10.065	0.0167	10.067	0.0196	10.064	0.0188	0.6004	0.0005	0.0004	0.6003	0.0006	0.0004	0.6004	0.0006	0.0004	122703
64	$	105.23	28.61	3.6288	142	0	0.4052	0.0011	0.4053	0.0012	0.4052	0.0010	0.6049	0.0027	0.0038	0.6048	0.0026	0.0038	0.6048	0.0028	0.0038	24917
65	$	105.71	28.63	3.6282	149	0	0.4056	0.0012	0.4054	0.0011	0.4050	0.0011	0.6045	0.0027	0.0038	0.6046	0.0026	0.0038	0.6050	0.0028	0.0038	24924
66	$	105.50	28.65	3.6228	147	0	0.4043	0.0009	0.4038	0.0010	0.4035	0.0011	0.6046	0.0026	0.0038	0.6049	0.0026	0.0038	0.6051	0.0028	0.0038	24898
67	$	64.807	28.72	5.7845	90	0	1.0369	0.0027	1.0347	0.0030	1.0351	0.0028	0.6028	0.0013	0.0016	0.6034	0.0013	0.0016	0.6033	0.0014	0.0016	39814
68	$	65.221	28.73	5.7813	90	0	1.0324	0.0032	1.0320	0.0039	1.0322	0.0037	0.6037	0.0014	0.0016	0.6039	0.0015	0.0016	0.6038	0.0015	0.0016	39801
69	$	65.518	28.74	5.7907	91	0	1.0381	0.0027	1.0367	0.0037	1.0367	0.0029	0.6031	0.0013	0.0016	0.6035	0.0015	0.0016	0.6035	0.0014	0.0016	39874
70	$	324.82	28.81	5.8097	161	0	1.0461	0.0021	1.0448	0.0021	1.0445	0.0020	0.6027	0.0012	0.0016	0.6031	0.0011	0.0016	0.6032	0.0012	0.0016	40066
71	$	324.98	28.85	5.7960	161	0	1.0412	0.0023	1.0395	0.0020	1.0401	0.0020	0.6027	0.0012	0.0016	0.6032	0.0011	0.0016	0.6030	0.0012	0.0016	40006
72	$	324.79	28.88	5.8050	161	0	1.0452	0.0022	1.0432	0.0024	1.0430	0.0022	0.6025	0.0012	0.0016	0.6031	0.0012	0.0016	0.6031	0.0012	0.0016	40094
73	$	59.717	28.98	29.824	83	0	27.813	0.0153	27.821	0.0202	27.818	0.0141	0.6001	0.0003	0.0003	0.6000	0.0003	0.0003	0.6000	0.0003	0.0003	206433
74	$	60.501	29.00	29.757	83	0	27.712	0.0127	27.709	0.0150	27.707	0.0149	0.5998	0.0003	0.0003	0.5998	0.0003	0.0003	0.5998	0.0003	0.0003	206059
75	$	60.382	29.02	29.727	84	0	27.637	0.0195	27.636	0.0196	27.640	0.0167	0.6000	0.0003	0.0003	0.6000	0.0003	0.0003	0.6000	0.0003	0.0003	205945
76	$	171.52	29.06	9.896	200	0	3.0478	0.0054	3.0456	0.0061	3.0453	0.0060	0.6015	0.0006	0.0007	0.6017	0.0007	0.0007	0.6017	0.0007	0.0007	68616
77	$	190.03	29.10	9.882	188	0	3.0367	0.0054	3.0359	0.0064	3.0358	0.0071	0.6017	0.0006	0.0007	0.6018	0.0007	0.0007	0.6018	0.0008	0.0007	68576
78	$	190.28	29.15	9.874	189	0	3.0301	0.0055	3.0314	0.0067	3.0306	0.0064	0.6019	0.0006	0.0007	0.6018	0.0008	0.0007	0.6019	0.0007	0.0007	68597
79	$	105.08	29.24	17.842	146	0	9.944	0.0128	9.936	0.0139	9.933	0.0130	0.6004	0.0004	0.0004	0.6006	0.0005	0.0004	0.6007	0.0004	0.0004	124190
80	$	105.82	29.27	17.822	147	0	9.915	0.0187	9.913	0.0235	9.911	0.0222	0.6006	0.0006	0.0004	0.6007	0.0007	0.0004	0.6007	0.0007	0.0004	124134
81	$	105.65	29.30	18.508	147	0	10.689	0.0118	10.691	0.0165	10.692	0.0144	0.6007	0.0004	0.0004	0.6006	0.0005	0.0004	0.6006	0.0004	0.0004	128995

[Test Run Date Codes # - 10/24/85 $ - 12/09/85]

Table 49C. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-3C Diameter 2.0005 Inches, Beta Ratio = 0.49633

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	99.96	32.18	18.086	159	0	3.0558	0.0043	3.0568	0.0042	3.0578	0.0034	0.6052	0.0006	0.0007	0.6051	0.0006	0.0007	0.6050	0.0005	0.0007	133949
2 #	99.308	32.20	18.077	158	0	3.0549	0.0050	3.0539	0.0056	3.0515	0.0060	0.6050	0.0007	0.0007	0.6051	0.0007	0.0007	0.6054	0.0007	0.0007	133940
3 #	100.61	32.22	18.019	160	0	3.0397	0.0055	3.0354	0.0054	3.0353	0.0047	0.6046	0.0007	0.0007	0.6050	0.0007	0.0007	0.6050	0.0006	0.0007	133563
4 #	181.04	32.26	10.386	141	0	1.0046	0.0017	1.0023	0.0015	1.0040	0.0017	0.6062	0.0013	0.0016	0.6069	0.0013	0.0017	0.6063	0.0012	0.0016	77048
5 #	179.83	32.28	10.390	135	0	1.0040	0.0012	1.0028	0.0014	1.0047	0.0016	0.6066	0.0012	0.0016	0.6069	0.0013	0.0017	0.6064	0.0011	0.0016	77110
6 #	180.97	32.30	10.377	128	0	1.0021	0.0029	1.0002	0.0025	1.0023	0.0024	0.6064	0.0015	0.0016	0.6070	0.0015	0.0017	0.6064	0.0013	0.0017	77045
7 #	290.88	32.33	6.5981	103	0	0.4035	0.0009	0.4021	0.0009	0.4033	0.0009	0.6077	0.0030	0.0038	0.6087	0.0032	0.0038	0.6078	0.0026	0.0038	49019
8 #	290.74	32.36	6.5884	103	0	0.4016	0.0013	0.4003	0.0011	0.4020	0.0011	0.6082	0.0031	0.0038	0.6091	0.0032	0.0039	0.6079	0.0027	0.0038	48978
9 #	290.79	32.38	6.5885	103	0	0.4032	0.0011	0.4007	0.0009	0.4022	0.0009	0.6070	0.0030	0.0038	0.6089	0.0032	0.0038	0.6077	0.0027	0.0038	48998
10 #	60.325	32.45	32.668	96	0	10.032	0.0085	10.028	0.0096	10.026	0.0085	0.6034	0.0004	0.0003	0.6035	0.0004	0.0003	0.6036	0.0004	0.0003	243303
11 #	59.725	32.50	32.550	95	0	9.950	0.0195	9.952	0.0172	9.947	0.0171	0.6037	0.0007	0.0003	0.6036	0.0006	0.0003	0.6038	0.0006	0.0003	242675
12 #	59.615	32.51	32.581	95	0	9.964	0.0106	9.960	0.0165	9.962	0.0171	0.6038	0.0004	0.0003	0.6039	0.0006	0.0003	0.6039	0.0006	0.0003	242959
13 #	195.14	32.53	32.697	121	0	10.056	0.0109	10.045	0.0105	10.044	0.0097	0.6032	0.0004	0.0003	0.6035	0.0003	0.0003	0.6036	0.0003	0.0003	243923
14 #	195.04	32.55	32.632	121	0	10.003	0.0114	10.005	0.0115	10.001	0.0103	0.6036	0.0004	0.0003	0.6035	0.0004	0.0003	0.6036	0.0003	0.0003	243533
15 #	195.03	32.56	32.488	121	0	9.920	0.0092	9.916	0.0088	9.918	0.0072	0.6034	0.0003	0.0003	0.6036	0.0003	0.0003	0.6035	0.0003	0.0003	242509
16 #	119.99	32.59	54.341	187	0	27.826	0.0094	27.816	0.0074	27.817	0.0080	0.6027	0.0001	0.0002	0.6028	0.0001	0.0002	0.6027	0.0001	0.0002	405887
17 #	119.55	32.59	54.441	186	0	27.909	0.0075	27.908	0.0081	27.914	0.0082	0.6029	0.0001	0.0002	0.6029	0.0001	0.0002	0.6028	0.0001	0.0002	406636
18 #	119.44	32.60	54.425	185	0	27.910	0.0078	27.900	0.0062	27.889	0.0042	0.6027	0.0001	0.0002	0.6028	0.0001	0.0002	0.6029	0.0001	0.0002	406596
19 $	59.737	33.52	32.690	91	0	10.036	0.0104	10.039	0.0127	10.034	0.0140	0.6037	0.0004	0.0003	0.6037	0.0005	0.0003	0.6038	0.0005	0.0003	248860
20 $	59.737	33.55	32.731	95	0	10.061	0.0206	10.060	0.0216	10.059	0.0138	0.6038	0.0007	0.0003	0.6038	0.0007	0.0003	0.6038	0.0005	0.0003	249330
21 $	59.145	33.56	32.722	94	0	10.051	0.0105	10.053	0.0146	10.057	0.0144	0.6039	0.0004	0.0003	0.6038	0.0005	0.0003	0.6037	0.0005	0.0003	249308
22 $	100.36	33.59	18.004	160	0	3.0312	0.0048	3.0326	0.0062	3.0319	0.0061	0.6050	0.0006	0.0007	0.6049	0.0007	0.0007	0.6050	0.0007	0.0007	137257
23 $	100.36	33.61	17.965	154	0	3.0191	0.0059	3.0190	0.0078	3.0174	0.0068	0.6049	0.0007	0.0007	0.6049	0.0009	0.0007	0.6051	0.0008	0.0007	137014
24 $	99.75	33.63	17.955	159	0	3.0186	0.0054	3.0178	0.0060	3.0161	0.0052	0.6047	0.0007	0.0007	0.6047	0.0007	0.0007	0.6049	0.0006	0.0007	136996
25 $	289.86	33.65	6.6259	162	0	0.4079	0.0010	0.4084	0.0011	0.4078	0.0010	0.6070	0.0025	0.0038	0.6066	0.0028	0.0038	0.6071	0.0024	0.0038	50575
26 $	289.37	33.68	6.6130	161	0	0.4053	0.0007	0.4064	0.0008	0.4059	0.0008	0.6078	0.0025	0.0038	0.6070	0.0028	0.0038	0.6074	0.0024	0.0038	50508
27 $	289.71	33.70	6.6163	162	0	0.4062	0.0008	0.4066	0.0009	0.4065	0.0008	0.6074	0.0025	0.0038	0.6071	0.0028	0.0038	0.6072	0.0024	0.0038	50553
28 $	180.22	33.74	10.376	192	0	1.0027	0.0021	1.0023	0.0021	1.0019	0.0023	0.6063	0.0012	0.0016	0.6064	0.0013	0.0016	0.6065	0.0012	0.0016	79341
29 $	180.50	33.75	10.399	187	0	1.0074	0.0020	1.0072	0.0025	1.0071	0.0023	0.6062	0.0012	0.0016	0.6063	0.0013	0.0016	0.6063	0.0012	0.0016	79537
30 $	180.48	33.78	10.383	186	0	1.0040	0.0024	1.0036	0.0028	1.0041	0.0025	0.6064	0.0012	0.0016	0.6064	0.0014	0.0016	0.6063	0.0012	0.0016	79467

[Test Run Date Codes # - 06/24/85 $ - 07/05/85]

Table 49C. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-3C Diameter 2.0005 Inches, Beta Ratio = 0.49633

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	289.86	33.80	6.5787	160	0	0.4015	0.0008	0.4015	0.0009	0.4015	0.0008	0.6075	0.0025	0.0038	0.6075	0.0028	0.0038	0.6075	0.0024	0.0038	50368
32 #	290.49	33.82	6.5639	160	0	0.3999	0.0009	0.3994	0.0008	0.3993	0.0009	0.6073	0.0025	0.0038	0.6077	0.0028	0.0039	0.6078	0.0025	0.0038	50275
33 #	290.09	33.84	6.5582	159	0	0.3992	0.0010	0.3987	0.0011	0.3988	0.0008	0.6073	0.0026	0.0038	0.6078	0.0029	0.0039	0.6076	0.0025	0.0038	50252
34 #	119.57	33.93	54.283	187	0	27.763	0.0048	27.764	0.0060	27.762	0.0073	0.6028	0.0001	0.0002	0.6028	0.0001	0.0002	0.6028	0.0001	0.0002	416705
35 #	119.59	33.94	54.259	181	0	27.744	0.0059	27.742	0.0063	27.736	0.0061	0.6027	0.0001	0.0002	0.6028	0.0001	0.0002	0.6028	0.0001	0.0002	416604
36 #	119.60	33.95	54.353	185	0	27.851	0.0052	27.850	0.0062	27.845	0.0091	0.6026	0.0001	0.0002	0.6026	0.0001	0.0002	0.6027	0.0001	0.0002	417411
37 $	290.69	41.66	6.5507	179	0	0.3995	0.0011	0.3988	0.0008	0.3993	0.0008	0.6072	0.0031	0.0038	0.6077	0.0032	0.0039	0.6073	0.0030	0.0038	58361
38 $	289.95	41.67	6.5589	177	0	0.4018	0.0013	0.3999	0.0009	0.4000	0.0008	0.6062	0.0031	0.0038	0.6076	0.0032	0.0038	0.6075	0.0030	0.0038	58444
39 $	280.35	41.68	6.5329	172	1	0.3967	0.0012	0.3965	0.0010	0.3971	0.0010	0.6077	0.0031	0.0039	0.6078	0.0033	0.0039	0.6073	0.0031	0.0039	58223
40 $	60.094	41.76	32.610	92	0	10.027	0.0141	10.029	0.0134	10.023	0.0167	0.6033	0.0005	0.0003	0.6032	0.0005	0.0003	0.6034	0.0006	0.0003	291060
41 $	60.132	41.77	32.603	92	0	10.028	0.0109	10.028	0.0133	10.016	0.0154	0.6031	0.0004	0.0003	0.6031	0.0005	0.0003	0.6035	0.0006	0.0003	291045
42 $	60.131	41.78	32.662	92	0	10.058	0.0161	10.069	0.0194	10.058	0.0099	0.6033	0.0006	0.0003	0.6030	0.0007	0.0003	0.6033	0.0004	0.0003	291627
43 $	162.13	41.76	10.458	200	0	1.0216	0.0019	1.0221	0.0018	1.0222	0.0018	0.6062	0.0013	0.0016	0.6060	0.0013	0.0016	0.6060	0.0013	0.0016	93346
44 $	161.78	41.77	10.449	200	0	1.0197	0.0017	1.0200	0.0023	1.0195	0.0023	0.6061	0.0013	0.0016	0.6061	0.0014	0.0016	0.6062	0.0013	0.0016	93275
45 $	161.74	41.78	10.442	200	0	1.0197	0.0021	1.0182	0.0021	1.0185	0.0020	0.6058	0.0013	0.0016	0.6062	0.0014	0.0016	0.6061	0.0013	0.0016	93233
46 $	99.448	41.81	17.915	152	0	3.0154	0.0045	3.0136	0.0063	3.0124	0.0054	0.6044	0.0006	0.0007	0.6046	0.0008	0.0007	0.6047	0.0007	0.0007	160047
47 $	100.03	41.81	17.948	153	0	3.0221	0.0057	3.0233	0.0067	3.0223	0.0061	0.6048	0.0007	0.0007	0.6047	0.0008	0.0007	0.6048	0.0007	0.0007	160341
48 $	100.43	41.82	17.945	153	0	3.0251	0.0046	3.0235	0.0050	3.0219	0.0053	0.6044	0.0006	0.0007	0.6046	0.0007	0.0007	0.6047	0.0007	0.0007	160340
49 $	120.03	41.88	54.393	184	0	27.991	0.0049	27.986	0.0063	27.981	0.0054	0.6023	0.0001	0.0002	0.6023	0.0001	0.0002	0.6024	0.0001	0.0002	486554
50 $	119.30	41.89	54.376	179	0	27.987	0.0080	27.982	0.0070	27.973	0.0080	0.6021	0.0001	0.0002	0.6022	0.0001	0.0002	0.6023	0.0001	0.0002	486489
51 $	119.98	41.90	54.378	183	0	27.983	0.0070	27.988	0.0102	27.966	0.0103	0.6022	0.0001	0.0002	0.6021	0.0001	0.0002	0.6024	0.0001	0.0002	486592
53 @	149.70	38.05	32.809	186	0	10.139	0.0094	10.140	0.0104	10.137	0.0088	0.6032	0.0003	0.0003	0.6032	0.0003	0.0003	0.6033	0.0003	0.0003	273193
54 @	149.63	38.07	32.991	186	0	10.254	0.0081	10.256	0.0101	10.256	0.0110	0.6032	0.0003	0.0003	0.6031	0.0003	0.0003	0.6031	0.0004	0.0003	274821
55 @	194.19	38.11	32.473	161	0	9.932	0.0093	9.936	0.0101	9.939	0.0106	0.6033	0.0003	0.0003	0.6032	0.0003	0.0003	0.6031	0.0004	0.0003	270714
56 @	119.42	38.13	54.461	182	0	28.015	0.0054	28.011	0.0055	28.018	0.0105	0.6024	0.0001	0.0002	0.6024	0.0001	0.0002	0.6024	0.0001	0.0002	454189
57 @	119.87	38.14	54.391	184	0	27.943	0.0075	27.942	0.0082	27.943	0.0088	0.6024	0.0001	0.0002	0.6024	0.0001	0.0002	0.6024	0.0001	0.0002	453694
58 @	119.37	38.14	54.385	183	0	27.940	0.0074	27.938	0.0080	27.945	0.0044	0.6024	0.0001	0.0002	0.6024	0.0001	0.0002	0.6023	0.0001	0.0002	453640
59 @	60.043	38.17	32.611	92	0	10.012	0.0141	10.013	0.0172	10.010	0.0137	0.6034	0.0005	0.0003	0.6034	0.0006	0.0003	0.6035	0.0005	0.0003	272180
60 @	60.057	38.18	32.492	92	0	9.939	0.0143	9.942	0.0158	9.951	0.0166	0.6034	0.0005	0.0003	0.6033	0.0006	0.0003	0.6030	0.0006	0.0003	271233
61 @	60.352	38.19	32.419	92	0	9.895	0.0168	9.896	0.0162	9.893	0.0158	0.6034	0.0006	0.0003	0.6034	0.0006	0.0003	0.6035	0.0006	0.0003	270679

[Test Run Date Codes # - 07/05/85 $ - 08/01/85 @ - 08/13/85]

Table 49C. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-3C Diameter 2.0005 Inches, Beta Ratio = 0.49633

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
62 #	162.10	38.20	10.533	200	0	1.0359	0.0023	1.0379	0.0027	1.0369	0.0026	0.6059	0.0013	0.0016	0.6053	0.0014	0.0016	0.6056	0.0013	0.0016	87960
63 #	161.94	38.23	10.564	200	0	1.0421	0.0025	1.0440	0.0023	1.0426	0.0024	0.6059	0.0013	0.0016	0.6054	0.0013	0.0016	0.6058	0.0013	0.0016	88272
64 #	161.78	38.25	10.579	200	0	1.0445	0.0011	1.0462	0.0013	1.0454	0.0015	0.6061	0.0012	0.0016	0.6056	0.0012	0.0016	0.6058	0.0012	0.0016	88434
69 #	99.67	38.40	17.976	153	0	3.0430	0.0041	3.0286	0.0053	3.0309	0.0059	0.6034	0.0006	0.0007	0.6048	0.0007	0.0007	0.6046	0.0007	0.0007	150697
70 #	99.395	38.41	17.968	152	0	3.0429	0.0053	3.0284	0.0064	3.0289	0.0062	0.6031	0.0007	0.0007	0.6045	0.0008	0.0007	0.6045	0.0007	0.0007	150653
71 #	99.98	38.43	17.915	153	0	3.0236	0.0066	3.0101	0.0080	3.0107	0.0075	0.6032	0.0008	0.0007	0.6046	0.0009	0.0007	0.6045	0.0009	0.0007	150266
72 #	289.89	38.43	6.5908	177	0	0.4177	0.0010	0.4045	0.0011	0.4043	0.0010	0.5971	0.0028	0.0036	0.6068	0.0031	0.0038	0.6069	0.0028	0.0035	55283
73 #	290.77	38.46	6.5351	175	0	0.4122	0.0008	0.3976	0.0011	0.3974	0.0008	0.5960	0.0028	0.0037	0.6068	0.0031	0.0039	0.6070	0.0029	0.0036	54847
74 #	289.93	38.47	6.5398	176	0	0.4141	0.0008	0.3981	0.0009	0.3979	0.0007	0.5951	0.0028	0.0036	0.6069	0.0031	0.0039	0.6070	0.0029	0.0035	54897
75 $	162.17	27.98	10.607	200	1	1.0453	0.0015	1.0461	0.0018	1.0452	0.0016	0.6066	0.0011	0.0016	0.6063	0.0011	0.0016	0.6066	0.0011	0.0016	71838
76 $	162.43	28.03	10.622	200	0	1.0481	0.0017	1.0486	0.0020	1.0470	0.0019	0.6066	0.0011	0.0016	0.6065	0.0012	0.0016	0.6070	0.0011	0.0016	72020
77 $	161.84	28.07	10.625	200	0	1.0483	0.0019	1.0488	0.0021	1.0475	0.0021	0.6067	0.0012	0.0016	0.6066	0.0012	0.0016	0.6070	0.0011	0.0016	72102
78 $	290.75	28.14	6.6095	179	0	0.4038	0.0009	0.4046	0.0009	0.4039	0.0008	0.6082	0.0027	0.0038	0.6076	0.0026	0.0038	0.6081	0.0025	0.0038	44922
79 $	290.55	28.18	6.6165	177	0	0.4047	0.0005	0.4053	0.0005	0.4045	0.0004	0.6081	0.0027	0.0038	0.6077	0.0026	0.0038	0.6083	0.0024	0.0038	45009
80 $	290.04	28.20	6.5961	177	0	0.4019	0.0007	0.4025	0.0008	0.4020	0.0009	0.6083	0.0027	0.0038	0.6079	0.0027	0.0038	0.6083	0.0025	0.0038	44890
81 $	99.57	28.26	18.044	140	0	3.0419	0.0050	3.0395	0.0054	3.0381	0.0041	0.6049	0.0006	0.0007	0.6052	0.0007	0.0007	0.6053	0.0005	0.0007	122964
82 $	99.80	28.28	18.071	140	0	3.0492	0.0057	3.0470	0.0056	3.0465	0.0050	0.6051	0.0007	0.0007	0.6053	0.0007	0.0007	0.6054	0.0006	0.0007	123201
83 $	100.32	28.31	18.073	141	0	3.0492	0.0045	3.0471	0.0045	3.0458	0.0040	0.6052	0.0006	0.0007	0.6054	0.0006	0.0007	0.6055	0.0005	0.0007	123290
84 $	59.950	28.38	32.649	83	0	10.013	0.0109	10.000	0.0124	9.994	0.0112	0.6033	0.0004	0.0003	0.6037	0.0005	0.0003	0.6039	0.0004	0.0003	223067
85 $	60.431	28.39	32.992	85	0	10.217	0.0137	10.204	0.0232	10.198	0.0164	0.6035	0.0005	0.0003	0.6039	0.0007	0.0003	0.6041	0.0006	0.0003	225462
86 $	59.598	28.42	33.154	84	0	10.325	0.0126	10.310	0.0122	10.306	0.0111	0.6033	0.0005	0.0003	0.6037	0.0005	0.0003	0.6039	0.0004	0.0003	226717
87 $	119.39	28.49	54.081	168	0	27.500	0.0171	27.497	0.0215	27.485	0.0162	0.6030	0.0002	0.0002	0.6031	0.0003	0.0002	0.6032	0.0002	0.0002	370387
88 $	119.41	28.50	54.584	168	10	28.043	0.0106	28.038	0.0111	28.016	0.0084	0.6027	0.0002	0.0002	0.6028	0.0002	0.0002	0.6030	0.0001	0.0002	373908
89 $	119.39	28.50	54.611	168	0	28.049	0.0070	28.044	0.0068	28.039	0.0088	0.6029	0.0001	0.0002	0.6030	0.0001	0.0002	0.6030	0.0001	0.0002	374095
90 $	194.17	28.51	32.627	161	0	9.982	0.0092	9.983	0.0088	9.978	0.0098	0.6038	0.0003	0.0003	0.6038	0.0003	0.0003	0.6040	0.0003	0.0003	223546
91 $	195.73	28.55	32.552	162	0	9.939	0.0097	9.939	0.0101	9.935	0.0092	0.6037	0.0003	0.0003	0.6038	0.0003	0.0003	0.6039	0.0003	0.0003	223227
92 $	195.13	28.59	32.787	162	0	10.079	0.0155	10.081	0.0170	10.077	0.0185	0.6039	0.0005	0.0003	0.6038	0.0005	0.0003	0.6039	0.0006	0.0003	225033
93 @	289.95	27.04	6.5508	178	0	0.3967	0.0009	0.3960	0.0009	0.3963	0.0009	0.6081	0.0024	0.0039	0.6086	0.0027	0.0039	0.6083	0.0025	0.0039	43459
94 @	291.32	27.08	6.5528	177	0	0.3969	0.0010	0.3964	0.0009	0.3967	0.0008	0.6081	0.0025	0.0039	0.6085	0.0027	0.0039	0.6083	0.0024	0.0039	43511
95 @	290.36	27.11	6.5562	177	0	0.3975	0.0008	0.3967	0.0009	0.3967	0.0009	0.6080	0.0024	0.0039	0.6086	0.0027	0.0039	0.6086	0.0025	0.0039	43562

[Test Run Date Codes # - 08/13/85 $ - 09/24/85 @ - 10/23/85]

Table 49C. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-3C Diameter 2.0005 Inches, Beta Ratio = 0.49633

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
96	#	100.34	27.16	18.153	138	0	3.0737	0.0054	3.0736	0.0065	3.0735	0.0056	0.6054	0.0006	0.0007	0.6054	0.0007	0.0007	0.6054	0.0007	0.0007	120752
97	#	100.31	27.17	18.166	138	0	3.0777	0.0043	3.0782	0.0046	3.0780	0.0052	0.6054	0.0006	0.0007	0.6054	0.0006	0.0007	0.6054	0.0006	0.0007	120866
98	#	100.19	27.20	18.150	135	0	3.0715	0.0052	3.0717	0.0052	3.0713	0.0056	0.6055	0.0006	0.0007	0.6054	0.0006	0.0007	0.6055	0.0007	0.0007	120834
99	#	161.78	27.24	10.279	200	0	0.9803	0.0024	0.9791	0.0027	0.9799	0.0029	0.6070	0.0012	0.0017	0.6073	0.0014	0.0017	0.6071	0.0013	0.0017	68493
100	#	162.41	27.26	10.220	200	0	0.9696	0.0019	0.9675	0.0025	0.9685	0.0021	0.6068	0.0011	0.0017	0.6075	0.0013	0.0017	0.6072	0.0012	0.0017	68135
101	#	162.41	27.30	10.242	200	0	0.9726	0.0018	0.9714	0.0020	0.9733	0.0017	0.6072	0.0011	0.0017	0.6076	0.0012	0.0017	0.6070	0.0011	0.0017	68340
102	#	60.066	27.35	32.609	81	0	9.971	0.0101	9.969	0.0079	9.965	0.0086	0.6038	0.0004	0.0003	0.6038	0.0004	0.0003	0.6039	0.0004	0.0003	217822
103	#	60.311	27.36	32.533	83	0	9.922	0.0156	9.924	0.0168	9.911	0.0195	0.6038	0.0006	0.0003	0.6038	0.0006	0.0003	0.6042	0.0007	0.0003	217363
104	#	59.628	27.37	32.559	82	0	9.929	0.0094	9.933	0.0103	9.931	0.0083	0.6041	0.0004	0.0003	0.6040	0.0004	0.0003	0.6040	0.0004	0.0003	217581
105	#	119.74	27.42	54.360	161	0	27.761	0.0115	27.764	0.0099	27.759	0.0077	0.6032	0.0002	0.0002	0.6032	0.0001	0.0002	0.6032	0.0001	0.0002	363676
106	#	119.82	27.45	54.306	165	0	27.734	0.0080	27.727	0.0061	27.708	0.0068	0.6029	0.0001	0.0002	0.6030	0.0001	0.0002	0.6032	0.0001	0.0002	363553
107	#	119.78	27.46	54.311	165	0	27.726	0.0074	27.721	0.0093	27.702	0.0068	0.6030	0.0001	0.0002	0.6031	0.0001	0.0002	0.6033	0.0001	0.0002	363667
108	$	59.611	28.33	32.606	83	0	9.963	0.0102	9.962	0.0116	9.962	0.0103	0.6040	0.0004	0.0003	0.6040	0.0005	0.0003	0.6040	0.0004	0.0003	222529
109	$	59.612	28.36	32.600	83	0	9.957	0.0107	9.962	0.0105	9.969	0.0089	0.6041	0.0004	0.0003	0.6039	0.0004	0.0003	0.6037	0.0004	0.0003	222639
110	$	59.607	28.38	32.562	83	0	9.936	0.0121	9.938	0.0109	9.939	0.0156	0.6040	0.0005	0.0003	0.6039	0.0004	0.0003	0.6039	0.0006	0.0003	222471
111	$	100.37	28.41	18.051	140	0	3.0395	0.0040	3.0410	0.0039	3.0406	0.0057	0.6054	0.0006	0.0007	0.6053	0.0006	0.0007	0.6053	0.0007	0.0007	123411
112	$	99.73	28.43	18.012	139	0	3.0282	0.0056	3.0282	0.0072	3.0273	0.0077	0.6052	0.0007	0.0007	0.6052	0.0008	0.0007	0.6053	0.0009	0.0007	123194
113	$	99.65	28.45	18.056	134	0	3.0462	0.0028	3.0426	0.0035	3.0439	0.0027	0.6049	0.0005	0.0007	0.6053	0.0005	0.0007	0.6051	0.0005	0.0007	123552
114	$	290.78	28.47	6.5697	179	0	0.3996	0.0009	0.3982	0.0011	0.3993	0.0009	0.6077	0.0028	0.0038	0.6087	0.0028	0.0039	0.6079	0.0026	0.0038	44974
115	$	290.66	28.51	6.5656	177	0	0.3995	0.0008	0.3977	0.0007	0.3984	0.0006	0.6074	0.0028	0.0038	0.6088	0.0027	0.0039	0.6082	0.0025	0.0038	44985
116	$	290.09	28.53	6.5613	178	0	0.3981	0.0007	0.3968	0.0007	0.3977	0.0006	0.6081	0.0028	0.0039	0.6090	0.0027	0.0039	0.6084	0.0025	0.0039	44975
117	$	161.77	28.58	10.447	200	0	1.0139	0.0020	1.0120	0.0022	1.0122	0.0022	0.6066	0.0012	0.0016	0.6072	0.0013	0.0016	0.6072	0.0012	0.0016	71685
118	$	161.61	28.61	10.461	200	0	1.0169	0.0014	1.0147	0.0020	1.0154	0.0021	0.6066	0.0012	0.0016	0.6072	0.0012	0.0016	0.6070	0.0012	0.0016	71830
119	$	161.81	28.62	10.422	200	0	1.0098	0.0020	1.0071	0.0022	1.0070	0.0017	0.6064	0.0012	0.0016	0.6072	0.0013	0.0016	0.6073	0.0011	0.0016	71575
120	$	119.77	28.71	54.504	167	0	27.891	0.0059	27.893	0.0094	27.884	0.0072	0.6035	0.0001	0.0002	0.6035	0.0001	0.0002	0.6035	0.0001	0.0002	375067
121	$	119.66	28.74	54.469	167	0	27.876	0.0066	27.874	0.0065	27.872	0.0064	0.6032	0.0001	0.0002	0.6033	0.0001	0.0002	0.6033	0.0001	0.0002	375073
122	$	119.76	28.74	54.517	167	0	27.914	0.0060	27.912	0.0067	27.916	0.0088	0.6034	0.0001	0.0002	0.6034	0.0001	0.0002	0.6033	0.0001	0.0002	375402

[Test Run Date Codes # - 10/23/85 $ - 12/10/85]

Table 49D. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55830

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
4	#	191.64	31.65	8.4832	119	0	0.3984	0.0011	0.3972	0.0011	0.3982	0.0011	0.6091	0.0031	0.0039	0.6101	0.0032	0.0039	0.6093	0.0027	0.0039	62141
5	#	190.41	31.67	8.4771	118	0	0.3976	0.0015	0.3964	0.0012	0.3975	0.0013	0.6094	0.0032	0.0039	0.6102	0.0033	0.0039	0.6094	0.0028	0.0039	62122
6	#	190.25	31.68	8.5385	118	0	0.4030	0.0009	0.4023	0.0011	0.4030	0.0011	0.6096	0.0030	0.0038	0.6102	0.0032	0.0038	0.6096	0.0027	0.0038	62585
7	#	135.74	31.71	13.405	168	0	0.9973	0.0012	0.9965	0.0014	0.9966	0.0019	0.6084	0.0013	0.0017	0.6086	0.0013	0.0017	0.6086	0.0012	0.0017	98313
8	#	134.64	31.73	13.379	167	0	0.9949	0.0022	0.9931	0.0026	0.9936	0.0025	0.6079	0.0014	0.0017	0.6085	0.0015	0.0017	0.6083	0.0013	0.0017	98164
9	#	134.79	31.75	13.375	167	0	0.9938	0.0018	0.9937	0.0019	0.9929	0.0019	0.6081	0.0013	0.0017	0.6081	0.0014	0.0017	0.6084	0.0012	0.0017	98181
10	#	42.821	31.79	23.242	68	0	3.0149	0.0093	3.0103	0.0100	3.0101	0.0093	0.6067	0.0011	0.0007	0.6071	0.0012	0.0007	0.6072	0.0011	0.0007	170749
11	#	43.428	31.80	23.364	69	0	3.0494	0.0089	3.0471	0.0067	3.0472	0.0099	0.6064	0.0010	0.0007	0.6066	0.0009	0.0007	0.6066	0.0011	0.0007	171678
12	#	42.795	31.81	23.404	68	0	3.0562	0.0106	3.0553	0.0118	3.0546	0.0091	0.6068	0.0012	0.0007	0.6068	0.0013	0.0007	0.6069	0.0010	0.0007	172007
13	#	42.639	31.86	42.433	68	0	10.092	0.0136	10.091	0.0123	10.094	0.0075	0.6054	0.0006	0.0003	0.6054	0.0005	0.0003	0.6053	0.0005	0.0003	312188
14	#	42.696	31.86	42.203	68	0	9.989	0.0149	10.000	0.0235	9.990	0.0128	0.6052	0.0006	0.0003	0.6049	0.0008	0.0003	0.6052	0.0006	0.0003	310503
15	#	42.755	31.87	42.019	68	0	9.907	0.0116	9.912	0.0157	9.899	0.0156	0.6050	0.0005	0.0003	0.6049	0.0006	0.0003	0.6053	0.0006	0.0003	309208
16	#	600.59	31.95	8.6904	88	0	0.4189	0.0031	0.4193	0.0029	0.4182	0.0027	0.6086	0.0036	0.0037	0.6084	0.0036	0.0037	0.6091	0.0032	0.0037	64057
17	#	603.15	31.99	8.6907	88	0	0.4180	0.0009	0.4186	0.0007	0.4178	0.0006	0.6093	0.0029	0.0037	0.6088	0.0030	0.0037	0.6094	0.0025	0.0037	64113
18	#	603.22	32.03	8.7303	88	0	0.4223	0.0013	0.4225	0.0010	0.4209	0.0008	0.6089	0.0030	0.0037	0.6088	0.0030	0.0037	0.6099	0.0025	0.0036	64458
19	#	89.665	32.21	70.260	144	0	27.803	0.0076	27.800	0.0077	27.795	0.0089	0.6040	0.0001	0.0002	0.6040	0.0001	0.0002	0.6040	0.0001	0.0002	520691
20	#	89.430	32.22	70.389	140	0	27.899	0.0115	27.907	0.0089	27.881	0.0050	0.6040	0.0002	0.0002	0.6039	0.0001	0.0002	0.6042	0.0001	0.0002	521751
21	#	89.938	32.21	70.421	138	0	27.928	0.0115	27.927	0.0059	27.922	0.0073	0.6040	0.0002	0.0002	0.6040	0.0001	0.0002	0.6040	0.0001	0.0002	521878
22	$	79.836	33.98	23.075	127	0	2.9756	0.0057	2.9777	0.0065	2.9723	0.0050	0.6065	0.0007	0.0007	0.6062	0.0008	0.0007	0.6068	0.0006	0.0007	177314
23	$	79.776	33.99	23.077	123	0	2.9737	0.0036	2.9776	0.0049	2.9723	0.0048	0.6067	0.0005	0.0007	0.6063	0.0007	0.0007	0.6068	0.0006	0.0007	177366
24	$	79.780	34.00	23.064	127	0	2.9733	0.0049	2.9739	0.0058	2.9711	0.0070	0.6064	0.0006	0.0007	0.6063	0.0007	0.0007	0.6066	0.0008	0.0007	177299
25	$	42.796	34.03	42.084	68	0	9.942	0.0167	9.942	0.0216	9.928	0.0237	0.6051	0.0006	0.0003	0.6051	0.0008	0.0003	0.6055	0.0008	0.0003	323707
26	$	43.422	34.05	42.203	69	0	9.985	0.0053	9.995	0.0074	9.980	0.0075	0.6055	0.0004	0.0003	0.6052	0.0004	0.0003	0.6057	0.0004	0.0003	324760
27	$	43.217	34.05	42.134	68	0	9.956	0.0132	9.961	0.0179	9.952	0.0152	0.6054	0.0006	0.0003	0.6052	0.0007	0.0003	0.6055	0.0006	0.0003	324229
28	$	133.01	34.06	13.485	200	0	1.0105	0.0020	1.0133	0.0025	1.0095	0.0024	0.6082	0.0012	0.0016	0.6073	0.0013	0.0016	0.6085	0.0012	0.0016	103790
29	$	135.26	34.08	13.597	194	0	1.0289	0.0018	1.0311	0.0025	1.0275	0.0023	0.6077	0.0011	0.0016	0.6071	0.0013	0.0016	0.6081	0.0012	0.0016	104694
30	$	134.83	34.09	13.568	198	0	1.0241	0.0018	1.0263	0.0021	1.0227	0.0019	0.6079	0.0011	0.0016	0.6072	0.0012	0.0016	0.6083	0.0011	0.0016	104493
31	$	189.55	34.11	8.5280	176	0	0.4032	0.0008	0.4052	0.0009	0.4019	0.0010	0.6089	0.0025	0.0038	0.6074	0.0028	0.0038	0.6099	0.0025	0.0038	65704
32	$	191.00	34.13	8.5231	178	0	0.4028	0.0006	0.4049	0.0009	0.4012	0.0010	0.6089	0.0025	0.0038	0.6072	0.0028	0.0038	0.6100	0.0025	0.0038	65692
33	$	190.01	34.14	8.5613	177	0	0.4063	0.0009	0.4081	0.0009	0.4048	0.0009	0.6089	0.0025	0.0038	0.6076	0.0028	0.0038	0.6101	0.0024	0.0038	66000

[Test Run Date Codes # - 06/24/85 $ - 07/05/85]

Table 49D. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55830

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
34	#	89.873	34.22	70.448	144	0	27.963	0.0075	27.968	0.0077	27.947	0.0055	0.6040	0.0001	0.0002	0.6039	0.0001	0.0002	0.6042	0.0001	0.0002	543973
35	#	90.538	34.24	70.600	140	0	28.094	0.0086	28.093	0.0088	28.063	0.0074	0.6039	0.0001	0.0002	0.6039	0.0001	0.0002	0.6042	0.0001	0.0002	545362
36	#	89.486	34.25	70.462	143	0	27.976	0.0078	27.980	0.0089	27.954	0.0086	0.6040	0.0001	0.0002	0.6039	0.0001	0.0002	0.6042	0.0001	0.0002	544408
37	#	189.99	34.23	8.6226	175	0	0.4122	0.0010	0.4163	0.0010	0.4114	0.0010	0.6089	0.0025	0.0037	0.6059	0.0027	0.0037	0.6095	0.0024	0.0037	66594
38	#	189.79	34.25	8.6647	175	0	0.4160	0.0006	0.4200	0.0009	0.4155	0.0011	0.6091	0.0024	0.0037	0.6061	0.0027	0.0037	0.6094	0.0024	0.0037	66946
39	#	190.03	34.28	8.6602	176	0	0.4155	0.0007	0.4192	0.0011	0.4144	0.0010	0.6091	0.0024	0.0037	0.6064	0.0027	0.0037	0.6099	0.0024	0.0037	66951
40	$	189.56	32.56	8.6665	182	0	0.4131	0.0010	0.4134	0.0010	0.4150	0.0012	0.6112	0.0027	0.0037	0.6110	0.0029	0.0037	0.6098	0.0025	0.0038	64692
41	$	189.90	32.60	8.6473	179	0	0.4118	0.0010	0.4112	0.0012	0.4125	0.0009	0.6109	0.0027	0.0038	0.6113	0.0030	0.0038	0.6103	0.0025	0.0038	64602
42	$	189.25	32.63	8.6492	180	0	0.4111	0.0007	0.4110	0.0007	0.4129	0.0008	0.6115	0.0027	0.0038	0.6116	0.0029	0.0038	0.6101	0.0024	0.0038	64656
43	$	134.85	32.60	13.586	200	0	1.0234	0.0014	1.0220	0.0015	1.0227	0.0017	0.6088	0.0011	0.0016	0.6092	0.0012	0.0016	0.6090	0.0011	0.0016	101501
44	$	134.90	32.62	13.589	198	0	1.0238	0.0015	1.0229	0.0020	1.0238	0.0020	0.6088	0.0012	0.0016	0.6091	0.0013	0.0016	0.6088	0.0011	0.0016	101566
45	$	132.37	32.75	13.568	200	0	1.0197	0.0017	1.0186	0.0020	1.0201	0.0022	0.6091	0.0012	0.0016	0.6094	0.0013	0.0016	0.6089	0.0012	0.0016	101679
1	@	79.900	41.02	23.391	119	0	3.0638	0.0043	3.0688	0.0057	3.0679	0.0056	0.6065	0.0006	0.0007	0.6060	0.0007	0.0007	0.6061	0.0007	0.0007	205947
2	@	80.095	41.03	23.332	121	0	3.0582	0.0042	3.0554	0.0049	3.0511	0.0059	0.6055	0.0006	0.0007	0.6058	0.0007	0.0007	0.6062	0.0007	0.0007	205469
3	@	80.630	41.04	23.278	121	0	3.0410	0.0061	3.0405	0.0080	3.0372	0.0084	0.6058	0.0008	0.0007	0.6059	0.0009	0.0007	0.6062	0.0009	0.0007	205025
4	@	168.25	41.02	8.6434	200	0	0.4133	0.0007	0.4147	0.0006	0.4146	0.0007	0.6102	0.0029	0.0037	0.6091	0.0031	0.0037	0.6092	0.0029	0.0037	76101
5	@	189.20	41.03	8.6622	200	0	0.4152	0.0009	0.4164	0.0009	0.4167	0.0007	0.6101	0.0029	0.0037	0.6092	0.0031	0.0037	0.6090	0.0029	0.0037	76281
6	@	188.40	41.03	8.6603	200	0	0.4172	0.0012	0.4162	0.0009	0.4162	0.0008	0.6085	0.0030	0.0037	0.6092	0.0031	0.0037	0.6093	0.0029	0.0037	76264
7	@	131.44	41.05	13.475	200	0	1.0134	0.0020	1.0127	0.0017	1.0110	0.0019	0.6075	0.0013	0.0016	0.6077	0.0013	0.0016	0.6082	0.0013	0.0016	118702
8	@	131.23	41.07	13.470	200	1	1.0104	0.0018	1.0116	0.0021	1.0120	0.0019	0.6082	0.0013	0.0016	0.6078	0.0014	0.0016	0.6077	0.0013	0.0016	118710
9	@	131.96	41.08	13.501	200	0	1.0158	0.0018	1.0156	0.0019	1.0152	0.0019	0.6079	0.0013	0.0016	0.6080	0.0014	0.0016	0.6081	0.0013	0.0016	118997
10	@	43.149	41.14	42.232	66	0	10.047	0.0147	10.054	0.0141	10.041	0.0094	0.6047	0.0006	0.0003	0.6045	0.0006	0.0003	0.6049	0.0005	0.0003	372655
11	@	42.331	41.15	42.189	64	0	10.029	0.0090	10.032	0.0081	10.031	0.0079	0.6046	0.0005	0.0003	0.6045	0.0005	0.0003	0.6046	0.0005	0.0003	372347
12	@	42.799	41.15	41.886	64	0	9.885	0.0083	9.882	0.0098	9.870	0.0128	0.6046	0.0005	0.0003	0.6047	0.0005	0.0003	0.6051	0.0006	0.0003	369677
13	@	149.60	41.16	42.390	186	0	10.128	0.0083	10.134	0.0069	10.119	0.0085	0.6045	0.0003	0.0003	0.6043	0.0003	0.0003	0.6048	0.0003	0.0003	374194
14	@	149.64	41.16	42.115	186	0	10.000	0.0084	10.002	0.0083	9.994	0.0081	0.6044	0.0003	0.0003	0.6044	0.0003	0.0003	0.6046	0.0003	0.0003	371767
15	@	150.49	41.17	42.344	187	0	10.111	0.0090	10.109	0.0096	10.104	0.0123	0.6044	0.0003	0.0003	0.6044	0.0003	0.0003	0.6046	0.0004	0.0003	373850
16	@	89.666	41.20	70.208	134	0	27.880	0.0126	27.876	0.0119	27.860	0.0048	0.6035	0.0002	0.0002	0.6035	0.0002	0.0002	0.6037	0.0001	0.0002	620209
17	@	90.026	41.21	70.198	138	0	27.871	0.0076	27.874	0.0050	27.851	0.0074	0.6035	0.0001	0.0002	0.6034	0.0001	0.0002	0.6037	0.0001	0.0002	620235
18	@	89.392	41.21	70.278	137	0	27.925	0.0077	27.930	0.0066	27.907	0.0075	0.6036	0.0001	0.0002	0.6035	0.0001	0.0002	0.6038	0.0001	0.0002	620944

[Test Run Date Codes # - 07/05/85 $ - 07/08/85 @ - 07/31/85]

Table 49D. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55830

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
19	#	164.66	38.13	8.5044	200	0	0.4003	0.0006	0.4006	0.0005	0.4006	0.0006	0.6098	0.0033	0.0038	0.6095	0.0029	0.0038	0.6095	0.0027	0.0039	70924
20	#	174.03	38.15	8.5135	200	0	0.4011	0.0007	0.4012	0.0008	0.4015	0.0007	0.6098	0.0033	0.0038	0.6097	0.0030	0.0038	0.6095	0.0027	0.0038	71028
21	#	172.65	38.17	8.4936	200	0	0.3984	0.0008	0.3989	0.0010	0.3998	0.0009	0.6104	0.0034	0.0039	0.6101	0.0030	0.0039	0.6094	0.0028	0.0039	70889
22	#	79.648	38.23	23.317	121	0	3.0468	0.0042	3.0487	0.0050	3.0414	0.0065	0.6060	0.0006	0.0007	0.6058	0.0007	0.0007	0.6065	0.0008	0.0007	194831
23	#	79.569	38.24	23.281	121	0	3.0354	0.0049	3.0358	0.0054	3.0318	0.0057	0.6062	0.0007	0.0007	0.6061	0.0007	0.0007	0.6065	0.0007	0.0007	194568
24	#	80.109	38.25	23.287	123	0	3.0347	0.0046	3.0364	0.0058	3.0336	0.0068	0.6064	0.0007	0.0007	0.6062	0.0007	0.0007	0.6065	0.0008	0.0007	194652
25	#	42.534	38.29	42.218	65	0	10.025	0.0079	10.031	0.0052	10.030	0.0085	0.6049	0.0005	0.0003	0.6047	0.0004	0.0003	0.6047	0.0005	0.0003	353172
26	#	43.216	38.30	42.240	66	0	10.038	0.0108	10.040	0.0150	10.034	0.0129	0.6048	0.0005	0.0003	0.6047	0.0006	0.0003	0.6049	0.0005	0.0003	353424
27	#	43.050	38.31	42.221	66	0	10.020	0.0117	10.025	0.0111	10.021	0.0148	0.6051	0.0005	0.0003	0.6049	0.0005	0.0003	0.6050	0.0006	0.0003	353334
28	#	130.87	38.31	13.506	200	0	1.0159	0.0016	1.0163	0.0017	1.0150	0.0018	0.6079	0.0014	0.0016	0.6078	0.0013	0.0016	0.6082	0.0012	0.0016	113030
29	#	131.03	38.32	13.507	200	0	1.0150	0.0020	1.0157	0.0020	1.0153	0.0017	0.6082	0.0014	0.0016	0.6080	0.0013	0.0016	0.6081	0.0012	0.0016	113053
30	#	131.88	38.33	13.469	200	0	1.0099	0.0019	1.0097	0.0020	1.0099	0.0020	0.6080	0.0014	0.0016	0.6081	0.0013	0.0016	0.6080	0.0012	0.0016	112759
31	#	88.981	38.39	70.119	138	0	27.760	0.0073	27.764	0.0069	27.752	0.0101	0.6037	0.0001	0.0002	0.6037	0.0001	0.0002	0.6038	0.0002	0.0002	587698
32	#	89.584	38.39	70.112	138	0	27.753	0.0059	27.753	0.0053	27.729	0.0069	0.6037	0.0001	0.0002	0.6037	0.0001	0.0002	0.6040	0.0001	0.0002	587639
33	#	89.596	38.40	70.136	134	0	27.768	0.0074	27.765	0.0083	27.759	0.0084	0.6038	0.0001	0.0002	0.6038	0.0001	0.0002	0.6039	0.0001	0.0002	587959
34	$	165.86	29.54	8.6599	200	0	0.4141	0.0007	0.4144	0.0011	0.4128	0.0011	0.6098	0.0027	0.0037	0.6096	0.0026	0.0037	0.6108	0.0025	0.0037	60668
35	$	177.56	29.56	8.5803	200	0	0.4065	0.0007	0.4068	0.0008	0.4052	0.0007	0.6098	0.0027	0.0038	0.6096	0.0026	0.0038	0.6108	0.0025	0.0038	60136
36	$	189.94	29.58	8.5729	200	0	0.4053	0.0009	0.4062	0.0009	0.4047	0.0011	0.6101	0.0028	0.0038	0.6095	0.0027	0.0038	0.6106	0.0025	0.0038	60110
37	$	134.91	29.62	13.396	189	0	0.9933	0.0014	0.9953	0.0023	0.9944	0.0021	0.6091	0.0012	0.0017	0.6084	0.0013	0.0017	0.6087	0.0012	0.0017	94012
38	$	135.69	29.64	13.358	189	0	0.9882	0.0013	0.9900	0.0017	0.9877	0.0015	0.6089	0.0012	0.0017	0.6083	0.0012	0.0017	0.6090	0.0011	0.0017	93782
39	$	134.34	29.67	13.325	188	0	0.9829	0.0019	0.9844	0.0023	0.9829	0.0023	0.6090	0.0013	0.0017	0.6086	0.0013	0.0017	0.6090	0.0012	0.0017	93613
40	$	79.742	29.71	23.229	112	0	3.0085	0.0043	3.0102	0.0050	3.0067	0.0049	0.6068	0.0006	0.0007	0.6067	0.0007	0.0007	0.6070	0.0006	0.0007	163329
41	$	80.372	29.73	23.214	113	0	3.0041	0.0044	3.0051	0.0051	3.0036	0.0044	0.6069	0.0006	0.0007	0.6068	0.0007	0.0007	0.6069	0.0006	0.0007	163289
42	$	80.467	29.75	23.210	113	0	3.0032	0.0053	3.0040	0.0048	3.0020	0.0061	0.6069	0.0007	0.0007	0.6068	0.0006	0.0007	0.6070	0.0007	0.0007	163337
43	$	42.700	29.78	42.207	60	0	9.982	0.0105	9.991	0.0180	9.978	0.0171	0.6053	0.0005	0.0003	0.6050	0.0007	0.0003	0.6054	0.0006	0.0003	297210
44	$	43.352	29.79	42.085	61	0	9.930	0.0222	9.927	0.0174	9.921	0.0186	0.6052	0.0008	0.0003	0.6052	0.0007	0.0003	0.6054	0.0007	0.0003	296413
45	$	43.507	29.80	42.096	61	0	9.937	0.0098	9.937	0.0102	9.925	0.0134	0.6051	0.0005	0.0003	0.6051	0.0005	0.0003	0.6055	0.0006	0.0003	296552
46	$	89.831	29.87	70.432	127	0	27.899	0.0070	27.888	0.0065	27.872	0.0074	0.6042	0.0001	0.0002	0.6043	0.0001	0.0002	0.6045	0.0001	0.0002	496918
47	$	89.405	29.88	70.505	126	0	27.938	0.0085	27.934	0.0105	27.921	0.0064	0.6044	0.0001	0.0002	0.6045	0.0002	0.0002	0.6046	0.0001	0.0002	497536
48	$	89.663	29.89	70.501	123	0	27.952	0.0081	27.953	0.0080	27.936	0.0061	0.6042	0.0001	0.0002	0.6042	0.0001	0.0002	0.6044	0.0001	0.0002	497616

[Test Run Date Codes # - 08/14/85 $ - 09/24/85]

Table 49D. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55830

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
49 #	42.974	27.54	42.319	59	0	10.027	0.0174	10.022	0.0124	10.026	0.0156	0.6054	0.0007	0.0003	0.6056	0.0005	0.0003	0.6054	0.0006	0.0003	283867
50 #	42.719	27.55	42.321	57	0	10.021	0.0101	10.030	0.0196	10.021	0.0139	0.6056	0.0005	0.0003	0.6053	0.0007	0.0003	0.6056	0.0006	0.0003	283943
51 #	43.365	27.57	42.333	59	0	10.041	0.0091	10.043	0.0105	10.029	0.0092	0.6052	0.0005	0.0003	0.6051	0.0005	0.0003	0.6055	0.0005	0.0003	284147
52 #	79.966	27.60	23.222	110	0	3.0061	0.0057	3.0039	0.0051	3.0015	0.0063	0.6067	0.0007	0.0007	0.6070	0.0007	0.0007	0.6072	0.0008	0.0007	155975
53 #	80.519	27.62	23.195	110	0	2.9964	0.0049	2.9951	0.0057	2.9924	0.0053	0.6070	0.0006	0.0007	0.6072	0.0007	0.0007	0.6074	0.0007	0.0007	155865
54 #	80.714	27.64	23.212	111	0	3.0045	0.0044	3.0019	0.0068	2.9985	0.0073	0.6066	0.0006	0.0007	0.6069	0.0008	0.0007	0.6072	0.0008	0.0007	156041
55 #	165.79	27.65	8.6019	200	0	0.4087	0.0008	0.4084	0.0009	0.4070	0.0008	0.6095	0.0026	0.0038	0.6097	0.0030	0.0038	0.6108	0.0026	0.0038	57840
56 #	173.66	27.68	8.6101	200	0	0.4101	0.0008	0.4092	0.0009	0.4079	0.0009	0.6091	0.0026	0.0038	0.6098	0.0030	0.0038	0.6108	0.0026	0.0037	57933
57 #	189.83	27.71	8.6156	200	0	0.4100	0.0008	0.4093	0.0009	0.4082	0.0008	0.6095	0.0026	0.0038	0.6101	0.0030	0.0038	0.6109	0.0026	0.0037	58008
58 #	135.42	27.77	13.484	186	0	1.0090	0.0014	1.0067	0.0018	1.0056	0.0018	0.6081	0.0011	0.0016	0.6088	0.0013	0.0016	0.6091	0.0012	0.0016	90905
59 #	135.40	27.78	13.451	186	0	1.0044	0.0020	1.0020	0.0025	1.0012	0.0024	0.6080	0.0012	0.0016	0.6088	0.0014	0.0016	0.6090	0.0013	0.0016	90707
60 #	135.56	27.80	13.434	183	0	1.0007	0.0017	0.9988	0.0024	0.9980	0.0021	0.6084	0.0012	0.0017	0.6090	0.0014	0.0017	0.6092	0.0012	0.0016	90631
61 #	89.765	27.88	70.412	124	0	27.862	0.0062	27.853	0.0073	27.831	0.0105	0.6043	0.0001	0.0002	0.6044	0.0001	0.0002	0.6046	0.0002	0.0002	475851
62 #	89.995	27.89	70.403	124	0	27.862	0.0105	27.850	0.0057	27.827	0.0072	0.6042	0.0002	0.0002	0.6044	0.0001	0.0002	0.6046	0.0001	0.0002	475894
63 #	89.937	27.91	70.494	124	0	27.932	0.0093	27.922	0.0082	27.884	0.0061	0.6043	0.0001	0.0002	0.6044	0.0001	0.0002	0.6048	0.0001	0.0002	476722
64 $	90.192	29.44	70.578	120	0	27.977	0.0106	27.978	0.0077	27.973	0.0084	0.6046	0.0002	0.0002	0.6046	0.0001	0.0002	0.6046	0.0001	0.0002	493387
65 $	89.572	29.45	70.620	125	0	28.001	0.0085	28.002	0.0087	27.991	0.0082	0.6047	0.0001	0.0002	0.6047	0.0001	0.0002	0.6048	0.0001	0.0002	493783
66 $	89.633	29.46	70.600	125	0	27.983	0.0075	27.982	0.0066	27.978	0.0075	0.6047	0.0001	0.0002	0.6047	0.0001	0.0002	0.6048	0.0001	0.0002	493753
67 $	149.22	29.45	42.128	185	0	9.930	0.0063	9.932	0.0086	9.933	0.0086	0.6057	0.0002	0.0003	0.6057	0.0003	0.0003	0.6056	0.0003	0.0003	294564
68 $	150.03	29.49	42.460	186	0	10.090	0.0184	10.093	0.0228	10.095	0.0229	0.6057	0.0006	0.0003	0.6056	0.0007	0.0003	0.6055	0.0007	0.0003	297143
69 $	149.72	29.52	42.114	186	0	9.927	0.0048	9.928	0.0042	9.931	0.0045	0.6056	0.0002	0.0003	0.6056	0.0002	0.0003	0.6055	0.0002	0.0003	294912
70 $	134.36	29.54	13.495	186	0	1.0123	0.0020	1.0132	0.0022	1.0113	0.0019	0.6077	0.0012	0.0016	0.6075	0.0012	0.0016	0.6080	0.0011	0.0016	94541
71 $	135.61	29.56	13.515	188	0	1.0146	0.0016	1.0160	0.0017	1.0140	0.0017	0.6080	0.0012	0.0016	0.6075	0.0012	0.0016	0.6081	0.0011	0.0016	94723
72 $	135.65	29.59	13.514	180	1	1.0129	0.0016	1.0145	0.0018	1.0141	0.0016	0.6084	0.0012	0.0016	0.6080	0.0012	0.0016	0.6081	0.0011	0.0016	94778
73 $	173.94	29.63	8.5981	200	0	0.4084	0.0009	0.4092	0.0011	0.4088	0.0009	0.6096	0.0027	0.0038	0.6090	0.0027	0.0038	0.6094	0.0025	0.0038	60352
74 $	185.08	29.67	8.6112	200	0	0.4096	0.0006	0.4103	0.0004	0.4102	0.0005	0.6097	0.0027	0.0038	0.6091	0.0026	0.0038	0.6092	0.0024	0.0038	60495
75 $	187.44	29.70	8.5940	200	0	0.4080	0.0008	0.4088	0.0008	0.4087	0.0009	0.6097	0.0027	0.0038	0.6090	0.0027	0.0038	0.6091	0.0025	0.0038	60413
76 $	79.904	29.75	23.383	111	0	3.0473	0.0072	3.0488	0.0087	3.0478	0.0076	0.6070	0.0008	0.0007	0.6068	0.0010	0.0007	0.6069	0.0009	0.0007	164552
77 $	80.219	29.77	23.771	107	0	3.1513	0.0045	3.1521	0.0063	3.1493	0.0070	0.6068	0.0006	0.0007	0.6067	0.0007	0.0007	0.6069	0.0008	0.0007	167352
78 $	80.078	29.78	23.781	111	0	3.1563	0.0056	3.1557	0.0059	3.1509	0.0055	0.6065	0.0007	0.0007	0.6066	0.0007	0.0007	0.6071	0.0007	0.0007	167462

[Test Run Date Codes # - 10/24/85 $ - 12/10/85]

Table 49D. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55830

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
79 #	75.571	20.88	23.135	67	0	0.0000	0.0000	2.9747	0.0065	2.9719	0.0072	0.0000	0.0000	0.0000	0.6073	0.0008	0.0007	0.6076	0.0009	0.0007	133074
80 #	74.465	20.90	23.155	66	0	0.0000	0.0000	2.9756	0.0064	2.9752	0.0061	0.0000	0.0000	0.0000	0.6077	0.0008	0.0007	0.6078	0.0008	0.0007	133253
81 #	75.643	20.92	23.122	67	0	0.0000	0.0000	2.9894	0.0120	2.9884	0.0109	0.0000	0.0000	0.0000	0.6054	0.0013	0.0007	0.6055	0.0012	0.0007	133128
82 #	130.85	21.07	13.342	116	0	0.0000	0.0000	0.9829	0.0034	0.9830	0.0032	0.0000	0.0000	0.0000	0.6093	0.0016	0.0017	0.6092	0.0016	0.0017	77097
83 #	129.64	21.09	13.401	115	0	0.0000	0.0000	0.9914	0.0007	0.9915	0.0008	0.0000	0.0000	0.0000	0.6093	0.0012	0.0017	0.6093	0.0013	0.0017	77474
84 #	129.71	21.10	13.354	115	0	0.0000	0.0000	0.9844	0.0027	0.9842	0.0028	0.0000	0.0000	0.0000	0.6093	0.0014	0.0017	0.6094	0.0015	0.0017	77220
85 #	211.15	21.16	8.6424	174	0	0.0000	0.0000	0.4109	0.0010	0.4098	0.0009	0.0000	0.0000	0.0000	0.6104	0.0028	0.0038	0.6112	0.0031	0.0038	50049
86 #	209.98	21.19	8.6306	173	0	0.0000	0.0000	0.4096	0.0010	0.4084	0.0009	0.0000	0.0000	0.0000	0.6105	0.0028	0.0038	0.6115	0.0031	0.0038	50016
87 #	209.86	21.22	8.6469	173	1	0.0000	0.0000	0.4115	0.0009	0.4104	0.0010	0.0000	0.0000	0.0000	0.6103	0.0028	0.0038	0.6111	0.0031	0.0038	50147
91 #	150.01	21.37	42.307	134	0	0.0000	0.0000	9.992	0.0119	9.987	0.0112	0.0000	0.0000	0.0000	0.6060	0.0004	0.0003	0.6061	0.0004	0.0003	246246
92 #	150.09	21.39	42.275	134	0	0.0000	0.0000	9.976	0.0044	9.971	0.0063	0.0000	0.0000	0.0000	0.6060	0.0002	0.0003	0.6061	0.0002	0.0003	246174
93 #	150.06	21.41	42.232	134	0	0.0000	0.0000	9.960	0.0093	9.949	0.0100	0.0000	0.0000	0.0000	0.6058	0.0003	0.0003	0.6062	0.0003	0.0003	246041
94 #	88.111	21.47	70.150	79	0	0.0000	0.0000	27.584	0.0713	27.574	0.0787	0.0000	0.0000	0.0000	0.6047	0.0008	0.0002	0.6048	0.0009	0.0002	409281
95 #	87.619	21.47	70.023	78	0	0.0000	0.0000	27.465	0.0141	27.457	0.0150	0.0000	0.0000	0.0000	0.6049	0.0002	0.0002	0.6050	0.0002	0.0002	408544
96 #	88.326	21.48	69.920	79	0	0.0000	0.0000	27.385	0.0074	27.360	0.0068	0.0000	0.0000	0.0000	0.6049	0.0001	0.0002	0.6052	0.0001	0.0002	408039
97 #	42.556	21.51	42.357	38	0	0.0000	0.0000	10.031	0.0062	10.025	0.0056	0.0000	0.0000	0.0000	0.6055	0.0004	0.0003	0.6057	0.0004	0.0003	247364
98 #	42.563	21.53	42.511	38	0	0.0000	0.0000	10.107	0.0045	10.094	0.0048	0.0000	0.0000	0.0000	0.6054	0.0004	0.0003	0.6058	0.0004	0.0003	248383
99 #	42.553	21.54	42.812	38	0	0.0000	0.0000	10.241	0.0111	10.234	0.0119	0.0000	0.0000	0.0000	0.6057	0.0005	0.0003	0.6059	0.0005	0.0003	250204
100 $	209.94	22.64	8.6899	173	0	0.0000	0.0000	0.4155	0.0005	0.4156	0.0004	0.0000	0.0000	0.0000	0.6104	0.0030	0.0037	0.6104	0.0035	0.0037	52132
101 $	210.02	22.69	8.6638	173	0	0.0000	0.0000	0.4127	0.0011	0.4128	0.0012	0.0000	0.0000	0.0000	0.6106	0.0031	0.0037	0.6106	0.0036	0.0037	52036
102 $	209.86	22.73	8.6804	173	0	0.0000	0.0000	0.4143	0.0007	0.4143	0.0005	0.0000	0.0000	0.0000	0.6106	0.0030	0.0037	0.6107	0.0035	0.0037	52185
103 $	75.685	22.79	23.228	69	0	0.0000	0.0000	2.9984	0.0121	2.9971	0.0106	0.0000	0.0000	0.0000	0.6074	0.0013	0.0007	0.6075	0.0012	0.0007	139838
104 $	74.683	22.81	23.127	68	0	0.0000	0.0000	2.9724	0.0067	2.9695	0.0074	0.0000	0.0000	0.0000	0.6074	0.0008	0.0007	0.6077	0.0009	0.0007	139301
105 $	74.666	22.83	23.115	68	0	0.0000	0.0000	2.9680	0.0131	2.9675	0.0141	0.0000	0.0000	0.0000	0.6075	0.0014	0.0007	0.6076	0.0015	0.0007	139291
106 $	87.311	22.94	70.711	80	0	0.0000	0.0000	28.019	0.0067	28.001	0.0103	0.0000	0.0000	0.0000	0.6049	0.0001	0.0002	0.6051	0.0002	0.0002	427207
107 $	88.569	22.94	70.707	81	0	0.0000	0.0000	28.032	0.0089	28.012	0.0048	0.0000	0.0000	0.0000	0.6047	0.0001	0.0002	0.6049	0.0001	0.0002	427186
108 $	87.477	22.95	70.743	80	0	0.0000	0.0000	28.045	0.0032	28.027	0.0041	0.0000	0.0000	0.0000	0.6049	0.0001	0.0002	0.6051	0.0001	0.0002	427504
109 @	211.14	23.03	8.5120	174	0	0.0000	0.0000	0.3992	0.0011	0.3983	0.0011	0.0000	0.0000	0.0000	0.6100	0.0032	0.0039	0.6107	0.0031	0.0039	51535
110 @	209.90	23.07	8.5073	173	0	0.0000	0.0000	0.3985	0.0009	0.3978	0.0007	0.0000	0.0000	0.0000	0.6102	0.0031	0.0039	0.6108	0.0030	0.0039	51555
111 @	209.93	23.11	8.5120	173	0	0.0000	0.0000	0.3991	0.0006	0.3979	0.0005	0.0000	0.0000	0.0000	0.6101	0.0031	0.0039	0.6110	0.0030	0.0039	51632

[Test Run Date Codes # - 01/05/87 $ - 02/10/87 @ - 02/11/87]

Table 49D. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-4C Diameter 2.2503 Inches, Beta Ratio = 0.55830

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
112	#	75.733	23.25	23.353	69	0	0.0000	0.0000	3.0358	0.0093	3.0284	0.0077	0.0000	0.0000	0.0000	0.6069	0.0010	0.0007	0.6076	0.0009	0.0007	142116
113	#	74.638	23.27	23.351	68	0	0.0000	0.0000	3.0337	0.0058	3.0277	0.0061	0.0000	0.0000	0.0000	0.6071	0.0007	0.0007	0.6077	0.0008	0.0007	142173
114	#	74.688	23.29	23.351	68	0	0.0000	0.0000	3.0326	0.0065	3.0314	0.0052	0.0000	0.0000	0.0000	0.6072	0.0008	0.0007	0.6073	0.0007	0.0007	142239
115	#	87.507	23.40	70.799	80	0	0.0000	0.0000	28.094	0.0057	28.074	0.0072	0.0000	0.0000	0.0000	0.6048	0.0001	0.0002	0.6051	0.0001	0.0002	432372
116	#	88.672	23.40	70.760	81	0	0.0000	0.0000	28.068	0.0078	28.050	0.0095	0.0000	0.0000	0.0000	0.6048	0.0001	0.0002	0.6050	0.0002	0.0002	432132
118	#	87.403	23.43	70.757	80	0	0.0000	0.0000	28.066	0.0082	28.045	0.0055	0.0000	0.0000	0.0000	0.6048	0.0001	0.0002	0.6050	0.0001	0.0002	432418

[Test Run Date Codes # - 02/11/87]

Table 49E. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-5C Diameter 2.6247 Inches, Beta Ratio = 0.65119

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	64.680	33.73	100.84	102	0	27.996	0.0100	27.985	0.0093	27.930	0.0117	0.6053	0.0002	0.0002	0.6054	0.0002	0.0002	0.6060	0.0002	0.0002	770963
2 #	64.477	33.73	100.86	101	0	27.986	0.0116	27.976	0.0103	27.919	0.0061	0.6055	0.0002	0.0002	0.6056	0.0002	0.0002	0.6062	0.0001	0.0002	771077
3 #	64.556	33.73	100.85	101	0	27.981	0.0085	27.970	0.0107	27.922	0.0085	0.6055	0.0002	0.0002	0.6056	0.0002	0.0002	0.6062	0.0002	0.0002	771021
4 #	99.76	33.74	60.483	155	0	10.024	0.0070	10.025	0.0055	10.009	0.0054	0.6067	0.0003	0.0003	0.6067	0.0002	0.0003	0.6072	0.0002	0.0003	462507
5 #	99.62	33.76	60.438	155	0	10.011	0.0054	10.013	0.0036	9.991	0.0039	0.6067	0.0002	0.0003	0.6066	0.0002	0.0003	0.6073	0.0002	0.0003	462356
6 #	99.85	33.77	60.454	151	0	10.011	0.0047	10.012	0.0051	9.999	0.0061	0.6069	0.0002	0.0003	0.6068	0.0002	0.0003	0.6072	0.0002	0.0003	462567
7 #	132.88	33.79	33.115	200	0	2.9894	0.0034	2.9902	0.0043	2.9830	0.0036	0.6083	0.0005	0.0007	0.6082	0.0006	0.0007	0.6090	0.0005	0.0007	253487
8 #	132.86	33.81	33.033	200	0	2.9720	0.0042	2.9704	0.0060	2.9657	0.0054	0.6086	0.0006	0.0007	0.6088	0.0007	0.0007	0.6093	0.0006	0.0007	252963
9 #	131.81	33.83	33.304	200	0	3.0218	0.0031	3.0227	0.0036	3.0158	0.0040	0.6085	0.0005	0.0007	0.6084	0.0005	0.0007	0.6091	0.0005	0.0007	255136
10 #	54.689	33.86	33.254	85	0	3.0135	0.0037	3.0105	0.0050	3.0043	0.0033	0.6084	0.0006	0.0007	0.6087	0.0007	0.0007	0.6094	0.0005	0.0007	254910
11 #	55.471	33.87	33.219	85	0	3.0013	0.0026	3.0020	0.0044	3.0007	0.0039	0.6090	0.0005	0.0007	0.6090	0.0006	0.0007	0.6091	0.0006	0.0007	254698
12 #	54.732	33.88	33.257	85	0	3.0098	0.0062	3.0093	0.0064	3.0085	0.0069	0.6089	0.0008	0.0007	0.6089	0.0008	0.0007	0.6090	0.0008	0.0007	255035
13 #	96.806	33.92	19.296	147	0	1.0076	0.0020	1.0074	0.0022	1.0044	0.0023	0.6106	0.0011	0.0016	0.6106	0.0012	0.0016	0.6115	0.0012	0.0016	148093
14 #	97.115	33.93	19.330	151	0	1.0122	0.0016	1.0109	0.0018	1.0086	0.0018	0.6103	0.0011	0.0016	0.6106	0.0012	0.0016	0.6113	0.0011	0.0016	148383
15 #	97.195	33.94	19.298	151	0	1.0069	0.0015	1.0078	0.0018	1.0052	0.0014	0.6109	0.0011	0.0016	0.6106	0.0012	0.0016	0.6114	0.0010	0.0016	148173
16 #	128.85	33.95	12.181	200	0	0.3993	0.0008	0.3991	0.0009	0.3975	0.0008	0.6122	0.0025	0.0039	0.6124	0.0027	0.0039	0.6136	0.0024	0.0039	93542
17 #	130.35	33.96	12.185	200	0	0.3995	0.0007	0.3996	0.0009	0.3976	0.0007	0.6123	0.0025	0.0039	0.6122	0.0027	0.0039	0.6138	0.0024	0.0039	93594
18 #	131.55	33.98	12.185	200	0	0.3995	0.0006	0.3995	0.0007	0.3980	0.0006	0.6124	0.0025	0.0039	0.6124	0.0026	0.0039	0.6135	0.0024	0.0039	93635
1 $	127.31	33.31	12.165	200	0	0.3971	0.0009	0.3963	0.0008	0.3960	0.0010	0.6131	0.0030	0.0039	0.6137	0.0029	0.0039	0.6139	0.0028	0.0039	92216
2 $	127.23	33.33	12.195	200	0	0.3985	0.0010	0.3985	0.0010	0.3979	0.0010	0.6135	0.0030	0.0039	0.6136	0.0030	0.0039	0.6140	0.0027	0.0039	92478
3 $	127.27	33.36	12.201	200	0	0.3997	0.0005	0.3990	0.0009	0.3983	0.0006	0.6129	0.0029	0.0039	0.6134	0.0029	0.0039	0.6140	0.0027	0.0039	92582
4 $	54.701	33.43	33.660	86	0	3.0799	0.0032	3.0817	0.0037	3.0773	0.0048	0.6092	0.0006	0.0007	0.6090	0.0006	0.0007	0.6094	0.0007	0.0007	255776
5 $	55.198	33.45	33.644	84	0	3.0822	0.0056	3.0774	0.0061	3.0728	0.0052	0.6086	0.0007	0.0007	0.6091	0.0008	0.0007	0.6096	0.0007	0.0007	255761
6 $	55.322	33.45	33.675	85	0	3.0858	0.0057	3.0858	0.0058	3.0798	0.0046	0.6089	0.0007	0.0007	0.6088	0.0007	0.0007	0.6094	0.0006	0.0007	255998
7 $	96.464	33.48	19.274	152	0	1.0040	0.0011	1.0031	0.0016	1.0017	0.0015	0.6110	0.0012	0.0017	0.6112	0.0013	0.0017	0.6116	0.0012	0.0017	146614
8 $	96.556	33.49	19.285	152	1	1.0049	0.0019	1.0042	0.0018	1.0024	0.0017	0.6110	0.0013	0.0017	0.6112	0.0013	0.0017	0.6118	0.0012	0.0016	146725
9 $	96.483	33.50	19.235	152	0	1.0011	0.0020	0.9995	0.0022	0.9972	0.0022	0.6106	0.0013	0.0017	0.6111	0.0013	0.0017	0.6118	0.0013	0.0017	146376
10 $	128.93	33.55	33.299	200	0	3.0190	0.0027	3.0184	0.0034	3.0121	0.0031	0.6087	0.0005	0.0007	0.6087	0.0005	0.0007	0.6094	0.0005	0.0007	253651
11 $	128.48	33.56	33.252	200	0	3.0106	0.0027	3.0087	0.0036	3.0070	0.0030	0.6087	0.0005	0.0007	0.6088	0.0005	0.0007	0.6090	0.0005	0.0007	253345
12 $	131.24	33.57	33.190	200	0	2.9994	0.0030	2.9968	0.0036	2.9945	0.0043	0.6087	0.0005	0.0007	0.6089	0.0005	0.0007	0.6092	0.0006	0.0007	252927

[Test Run Date Codes # - 06/17/85 $ - 06/20/85]

Table 49E. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-5C Diameter 2.6247 Inches, Beta Ratio = 0.65119

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
13	#	64.766	33.62	100.34	98	0	27.672	0.0268	27.692	0.0297	27.642	0.0264	0.6058	0.0003	0.0002	0.6056	0.0003	0.0002	0.6062	0.0003	0.0002	765460
14	#	64.960	33.61	99.260	103	0	27.075	0.0118	27.083	0.0145	27.035	0.0156	0.6059	0.0002	0.0002	0.6058	0.0002	0.0002	0.6063	0.0002	0.0002	757034
15	#	64.937	33.60	98.993	103	0	26.922	0.0100	26.930	0.0078	26.892	0.0143	0.6060	0.0002	0.0002	0.6059	0.0002	0.0002	0.6063	0.0002	0.0002	754848
16	#	103.94	33.59	60.558	164	0	10.044	0.0072	10.044	0.0048	10.025	0.0041	0.6069	0.0003	0.0003	0.6069	0.0002	0.0003	0.6075	0.0002	0.0003	461677
17	#	104.68	33.61	60.534	165	0	10.040	0.0052	10.039	0.0039	10.016	0.0029	0.6068	0.0002	0.0003	0.6068	0.0002	0.0003	0.6075	0.0002	0.0003	461678
18	#	104.69	33.62	60.532	165	0	10.030	0.0071	10.038	0.0050	10.021	0.0045	0.6071	0.0003	0.0003	0.6068	0.0002	0.0003	0.6073	0.0002	0.0003	461760
1	$	55.658	40.18	33.168	85	0	3.0058	0.0038	3.0067	0.0055	3.0006	0.0045	0.6082	0.0006	0.0007	0.6081	0.0008	0.0007	0.6087	0.0007	0.0007	287499
2	$	54.390	40.20	33.124	83	0	2.9986	0.0063	2.9978	0.0059	2.9956	0.0050	0.6081	0.0008	0.0007	0.6082	0.0008	0.0007	0.6084	0.0007	0.0007	287222
3	$	54.426	40.21	33.151	83	0	3.0052	0.0053	3.0019	0.0055	2.9966	0.0049	0.6080	0.0007	0.0007	0.6083	0.0008	0.0007	0.6088	0.0007	0.0007	287516
4	$	155.48	40.22	12.277	193	0	0.4076	0.0011	0.4066	0.0010	0.4060	0.0010	0.6114	0.0031	0.0038	0.6121	0.0032	0.0038	0.6125	0.0030	0.0038	106492
5	$	154.22	40.25	12.284	191	0	0.4077	0.0011	0.4073	0.0011	0.4064	0.0008	0.6117	0.0030	0.0038	0.6120	0.0032	0.0038	0.6126	0.0030	0.0038	106620
6	$	154.26	40.26	12.323	191	0	0.4102	0.0009	0.4095	0.0007	0.4090	0.0008	0.6118	0.0030	0.0038	0.6122	0.0031	0.0038	0.6126	0.0030	0.0038	106972
7	$	96.675	40.46	19.243	143	0	1.0060	0.0019	1.0051	0.0019	1.0035	0.0018	0.6100	0.0013	0.0016	0.6102	0.0014	0.0016	0.6107	0.0013	0.0016	167670
8	$	97.488	40.47	19.228	149	0	1.0046	0.0017	1.0023	0.0019	1.0014	0.0018	0.6100	0.0013	0.0016	0.6106	0.0014	0.0017	0.6109	0.0013	0.0016	167573
9	$	97.684	40.48	19.235	146	0	1.0060	0.0023	1.0035	0.0018	1.0018	0.0016	0.6097	0.0014	0.0016	0.6105	0.0014	0.0017	0.6110	0.0013	0.0016	167668
10	$	161.50	40.51	33.286	200	0	3.0276	0.0037	3.0286	0.0034	3.0246	0.0034	0.6082	0.0006	0.0007	0.6081	0.0006	0.0007	0.6085	0.0005	0.0007	290309
11	$	161.53	40.51	33.227	200	0	3.0177	0.0051	3.0154	0.0061	3.0112	0.0053	0.6081	0.0007	0.0007	0.6084	0.0008	0.0007	0.6088	0.0007	0.0007	289791
12	$	161.22	40.51	33.630	200	0	3.0923	0.0039	3.0915	0.0044	3.0871	0.0040	0.6080	0.0006	0.0007	0.6081	0.0006	0.0007	0.6085	0.0006	0.0007	293302
13	$	104.66	40.52	60.649	156	0	10.111	0.0060	10.115	0.0038	10.096	0.0036	0.6064	0.0002	0.0003	0.6063	0.0002	0.0003	0.6068	0.0002	0.0003	529048
14	$	104.80	40.52	60.743	156	0	10.144	0.0059	10.146	0.0060	10.133	0.0063	0.6063	0.0002	0.0003	0.6063	0.0002	0.0003	0.6067	0.0002	0.0003	529871
15	$	104.51	40.52	60.438	160	0	10.043	0.0049	10.045	0.0053	10.027	0.0046	0.6063	0.0002	0.0003	0.6063	0.0002	0.0003	0.6068	0.0002	0.0003	527206
16	$	64.164	40.52	100.82	99	0	28.063	0.0124	28.051	0.0105	28.001	0.0093	0.6051	0.0002	0.0002	0.6052	0.0002	0.0002	0.6057	0.0002	0.0002	879461
17	$	65.182	40.51	101.04	100	0	28.178	0.0132	28.157	0.0162	28.122	0.0124	0.6052	0.0002	0.0002	0.6054	0.0002	0.0002	0.6058	0.0002	0.0002	881216
18	$	64.621	40.52	101.06	99	0	28.173	0.0142	28.179	0.0094	28.139	0.0099	0.6053	0.0002	0.0002	0.6053	0.0002	0.0002	0.6057	0.0002	0.0002	881541
19	@	104.86	37.39	60.574	156	0	10.060	0.0038	10.061	0.0047	10.073	0.0036	0.6069	0.0002	0.0003	0.6068	0.0002	0.0003	0.6065	0.0002	0.0003	498000
20	@	104.97	37.41	60.594	161	0	10.064	0.0048	10.066	0.0049	10.074	0.0038	0.6070	0.0002	0.0003	0.6069	0.0002	0.0003	0.6067	0.0002	0.0003	498358
21	@	104.89	37.42	60.378	161	0	10.000	0.0034	10.001	0.0041	10.001	0.0057	0.6067	0.0002	0.0003	0.6067	0.0002	0.0003	0.6067	0.0002	0.0003	496680
22	@	161.82	37.42	33.480	200	0	3.0575	0.0027	3.0570	0.0030	3.0595	0.0032	0.6085	0.0005	0.0007	0.6085	0.0005	0.0007	0.6083	0.0005	0.0007	275415
23	@	161.20	37.43	33.411	200	0	3.0438	0.0035	3.0438	0.0042	3.0454	0.0034	0.6086	0.0005	0.0007	0.6086	0.0006	0.0007	0.6084	0.0005	0.0007	274900
24	@	161.42	37.44	33.425	200	0	3.0466	0.0028	3.0456	0.0033	3.0505	0.0039	0.6085	0.0005	0.0007	0.6086	0.0005	0.0007	0.6081	0.0005	0.0007	275062

[Test Run Date Codes # - 06/20/85 $ - 07/31/85 @ - 08/13/85]

Table 49E. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-5C Diameter 2.6247 Inches, Beta Ratio = 0.65119

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
25	#	64.300	37.51	100.87	99	0	28.003	0.0111	27.999	0.0129	28.022	0.0131	0.6057	0.0002	0.0002	0.6058	0.0002	0.0002	0.6055	0.0002	0.0002	831202
26	#	64.554	37.52	100.80	99	0	27.955	0.0061	27.959	0.0071	27.978	0.0114	0.6058	0.0001	0.0002	0.6058	0.0002	0.0002	0.6056	0.0002	0.0002	830783
27	#	64.494	37.52	100.77	99	0	27.944	0.0127	27.938	0.0115	27.979	0.0117	0.6058	0.0002	0.0002	0.6058	0.0002	0.0002	0.6054	0.0002	0.0002	830527
28	#	154.71	37.48	12.075	192	0	0.3920	0.0008	0.3942	0.0008	0.3935	0.0008	0.6129	0.0030	0.0039	0.6112	0.0031	0.0039	0.6117	0.0029	0.0040	99445
29	#	154.60	37.49	12.018	191	0	0.3881	0.0007	0.3897	0.0010	0.3894	0.0010	0.6131	0.0030	0.0040	0.6118	0.0032	0.0040	0.6120	0.0030	0.0040	98999
30	#	155.08	37.51	12.449	192	0	0.4165	0.0006	0.4191	0.0008	0.4175	0.0008	0.6129	0.0028	0.0037	0.6111	0.0029	0.0037	0.6123	0.0028	0.0037	102584
31	#	96.311	37.55	19.553	145	0	1.0341	0.0015	1.0348	0.0018	1.0357	0.0019	0.6110	0.0012	0.0016	0.6108	0.0013	0.0016	0.6106	0.0012	0.0016	161248
32	#	97.440	37.57	19.575	149	0	1.0368	0.0019	1.0372	0.0021	1.0384	0.0020	0.6109	0.0013	0.0016	0.6108	0.0013	0.0016	0.6105	0.0013	0.0016	161493
33	#	97.498	37.59	19.537	149	0	1.0323	0.0023	1.0329	0.0030	1.0347	0.0027	0.6111	0.0013	0.0016	0.6109	0.0015	0.0016	0.6104	0.0014	0.0016	161248
34	$	96.566	29.91	19.336	136	0	1.0086	0.0025	1.0110	0.0024	1.0066	0.0022	0.6112	0.0013	0.0016	0.6105	0.0013	0.0016	0.6118	0.0012	0.0016	136539
35	$	96.651	29.94	19.264	136	0	1.0028	0.0026	1.0039	0.0021	0.9984	0.0022	0.6107	0.0014	0.0017	0.6104	0.0012	0.0017	0.6121	0.0012	0.0016	136117
36	$	96.456	29.96	19.260	133	0	1.0011	0.0014	1.0018	0.0018	0.9991	0.0023	0.6111	0.0012	0.0017	0.6109	0.0012	0.0017	0.6117	0.0012	0.0017	136143
37	$	155.13	30.00	12.258	192	1	0.4019	0.0006	0.4047	0.0007	0.4014	0.0006	0.6138	0.0027	0.0039	0.6117	0.0026	0.0038	0.6142	0.0025	0.0039	86720
38	$	155.81	30.03	12.225	193	0	0.4008	0.0008	0.4021	0.0009	0.3994	0.0007	0.6131	0.0028	0.0039	0.6121	0.0027	0.0038	0.6141	0.0025	0.0039	86547
39	$	154.88	30.05	12.219	192	0	0.3982	0.0007	0.4017	0.0010	0.3995	0.0008	0.6148	0.0028	0.0039	0.6120	0.0027	0.0038	0.6137	0.0025	0.0039	86538
40	$	55.244	30.11	33.756	77	0	3.0939	0.0129	3.0988	0.0147	3.0913	0.0111	0.6093	0.0014	0.0007	0.6088	0.0015	0.0007	0.6095	0.0012	0.0007	239377
41	$	54.838	30.12	33.489	77	0	3.0462	0.0041	3.0489	0.0041	3.0446	0.0065	0.6092	0.0006	0.0007	0.6089	0.0006	0.0007	0.6093	0.0008	0.0007	237539
42	$	55.517	30.13	33.523	78	0	3.0510	0.0034	3.0537	0.0056	3.0477	0.0054	0.6093	0.0006	0.0007	0.6090	0.0007	0.0007	0.6096	0.0007	0.0007	237827
43	$	64.586	30.20	101.03	91	0	28.008	0.0092	28.018	0.0097	27.957	0.0161	0.6060	0.0002	0.0002	0.6059	0.0002	0.0002	0.6066	0.0002	0.0002	717796
44	$	64.602	30.18	101.02	91	0	28.013	0.0115	28.013	0.0124	27.952	0.0111	0.6060	0.0002	0.0002	0.6060	0.0002	0.0002	0.6066	0.0002	0.0002	717479
45	$	64.610	30.17	100.93	91	0	27.947	0.0099	27.949	0.0083	27.916	0.0091	0.6061	0.0002	0.0002	0.6061	0.0002	0.0002	0.6064	0.0002	0.0002	716633
46	$	105.11	30.13	60.639	148	0	10.050	0.0042	10.053	0.0042	10.040	0.0047	0.6072	0.0002	0.0003	0.6072	0.0002	0.0003	0.6076	0.0002	0.0003	430204
47	$	104.40	30.15	60.696	147	0	10.073	0.0056	10.074	0.0040	10.054	0.0041	0.6071	0.0002	0.0003	0.6071	0.0002	0.0003	0.6077	0.0002	0.0003	430791
48	$	105.09	30.17	60.734	148	0	10.090	0.0058	10.085	0.0051	10.065	0.0040	0.6070	0.0002	0.0003	0.6071	0.0002	0.0003	0.6077	0.0002	0.0003	431239
49	@	155.18	27.01	12.306	192	0	0.4047	0.0006	0.4050	0.0007	0.4037	0.0007	0.6139	0.0026	0.0038	0.6136	0.0030	0.0038	0.6146	0.0026	0.0038	81585
50	@	155.75	27.05	12.284	193	0	0.4032	0.0008	0.4036	0.0009	0.4024	0.0010	0.6140	0.0026	0.0038	0.6137	0.0031	0.0038	0.6146	0.0027	0.0038	81513
51	@	155.68	27.08	12.303	193	0	0.4047	0.0007	0.4047	0.0009	0.4031	0.0007	0.6138	0.0026	0.0038	0.6138	0.0031	0.0038	0.6150	0.0026	0.0038	81693
52	@	97.055	27.13	19.456	129	0	1.0204	0.0015	1.0196	0.0017	1.0175	0.0024	0.6113	0.0011	0.0016	0.6115	0.0013	0.0016	0.6121	0.0013	0.0016	129328
53	@	97.254	27.16	19.467	134	0	1.0209	0.0022	1.0199	0.0028	1.0181	0.0022	0.6115	0.0012	0.0016	0.6118	0.0015	0.0016	0.6123	0.0012	0.0016	129492
54	@	97.279	27.18	19.511	134	0	1.0255	0.0013	1.0245	0.0015	1.0226	0.0015	0.6115	0.0011	0.0016	0.6117	0.0013	0.0016	0.6123	0.0011	0.0016	129838

[Test Run Date Codes # - 08/13/85 $ - 09/24/85 @ - 10/24/85]

Table 49E. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-5C Diameter 2.6247 Inches, Beta Ratio = 0.65119

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
55	#	54.553	27.22	33.308	75	0	3.0108	0.0061	3.0086	0.0071	3.0043	0.0065	0.6092	0.0008	0.0007	0.6094	0.0009	0.0007	0.6099	0.0008	0.0007	221853
56	#	55.292	27.23	33.248	76	0	2.9973	0.0048	2.9978	0.0038	2.9913	0.0029	0.6095	0.0007	0.0007	0.6094	0.0006	0.0007	0.6101	0.0005	0.0007	221502
57	#	55.371	27.25	33.126	76	1	2.9769	0.0040	2.9754	0.0040	2.9699	0.0058	0.6093	0.0006	0.0007	0.6095	0.0007	0.0007	0.6100	0.0008	0.0007	220788
58	#	104.47	27.30	60.411	144	0	9.957	0.0039	9.957	0.0036	9.943	0.0050	0.6076	0.0002	0.0003	0.6076	0.0002	0.0003	0.6080	0.0002	0.0003	403087
59	#	105.15	27.31	60.405	143	0	9.957	0.0045	9.954	0.0055	9.940	0.0049	0.6076	0.0002	0.0003	0.6076	0.0002	0.0003	0.6080	0.0002	0.0003	403138
60	#	104.60	27.31	60.407	144	0	9.959	0.0049	9.959	0.0051	9.941	0.0062	0.6075	0.0002	0.0003	0.6075	0.0002	0.0003	0.6080	0.0002	0.0003	403150
61	#	64.429	27.36	101.30	89	0	28.115	0.0228	28.121	0.0186	28.078	0.0153	0.6063	0.0003	0.0002	0.6062	0.0002	0.0002	0.6067	0.0002	0.0002	676793
62	#	64.424	27.36	101.06	86	0	28.002	0.0105	27.997	0.0099	27.940	0.0134	0.6061	0.0002	0.0002	0.6062	0.0002	0.0002	0.6068	0.0002	0.0002	675228
63	#	64.556	27.37	101.05	89	0	27.972	0.0110	27.968	0.0113	27.934	0.0060	0.6064	0.0002	0.0002	0.6064	0.0002	0.0002	0.6068	0.0001	0.0002	675297
65	$	54.530	28.82	33.227	73	0	2.9961	0.0025	2.9944	0.0021	2.9936	0.0021	0.6093	0.0005	0.0007	0.6095	0.0005	0.0007	0.6096	0.0005	0.0007	229194
66	$	55.323	28.83	33.165	77	0	2.9842	0.0035	2.9832	0.0038	2.9844	0.0039	0.6094	0.0006	0.0007	0.6095	0.0006	0.0007	0.6094	0.0006	0.0007	228820
67	$	54.625	28.84	33.191	76	0	2.9913	0.0041	2.9865	0.0050	2.9863	0.0049	0.6092	0.0006	0.0007	0.6096	0.0007	0.0007	0.6097	0.0007	0.0007	229049
68	$	96.917	28.86	19.311	132	0	1.0029	0.0022	1.0030	0.0022	1.0032	0.0015	0.6121	0.0013	0.0017	0.6121	0.0013	0.0017	0.6120	0.0011	0.0017	133322
69	$	97.445	28.88	19.331	131	1	1.0071	0.0015	1.0047	0.0014	1.0055	0.0016	0.6115	0.0012	0.0016	0.6122	0.0012	0.0017	0.6119	0.0011	0.0016	133519
70	$	96.449	28.89	19.319	130	0	1.0057	0.0018	1.0037	0.0023	1.0042	0.0026	0.6115	0.0012	0.0017	0.6121	0.0013	0.0017	0.6119	0.0013	0.0016	133460
71	$	155.12	28.92	12.266	192	0	0.4022	0.0009	0.4005	0.0011	0.4009	0.0010	0.6139	0.0028	0.0039	0.6153	0.0028	0.0039	0.6149	0.0026	0.0038	84791
72	$	155.02	28.96	12.300	192	0	0.4041	0.0007	0.4021	0.0009	0.4033	0.0009	0.6142	0.0027	0.0038	0.6157	0.0027	0.0039	0.6147	0.0026	0.0038	85098
73	$	155.01	28.98	12.305	192	2	0.4047	0.0007	0.4026	0.0008	0.4037	0.0006	0.6141	0.0027	0.0038	0.6156	0.0027	0.0039	0.6148	0.0025	0.0038	85175
74	$	104.62	29.05	60.666	146	0	10.043	0.0045	10.040	0.0046	10.035	0.0047	0.6077	0.0002	0.0003	0.6077	0.0002	0.0003	0.6079	0.0002	0.0003	420552
75	$	104.78	29.07	60.649	146	0	10.032	0.0043	10.034	0.0038	10.030	0.0029	0.6078	0.0002	0.0003	0.6077	0.0002	0.0003	0.6079	0.0002	0.0003	420614
76	$	104.81	29.09	60.648	146	0	10.032	0.0038	10.034	0.0034	10.023	0.0036	0.6078	0.0002	0.0003	0.6077	0.0002	0.0003	0.6081	0.0002	0.0003	420786
77	$	64.424	29.11	99.55	90	0	27.171	0.0583	27.176	0.0783	27.167	0.0704	0.6062	0.0007	0.0002	0.6062	0.0009	0.0002	0.6063	0.0008	0.0002	691013
78	$	64.432	29.11	98.965	90	0	26.812	0.0683	26.804	0.0696	26.785	0.0830	0.6067	0.0008	0.0002	0.6068	0.0008	0.0002	0.6070	0.0009	0.0002	686937
79	$	64.567	29.09	99.478	90	0	27.087	0.0170	27.093	0.0181	27.078	0.0229	0.6067	0.0002	0.0002	0.6067	0.0002	0.0002	0.6068	0.0003	0.0002	690199

[Test Run Date Codes # - 10/24/85 $ - 12/10/85]

Table 49F. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-6C Diameter 2.9998 Inches, Beta Ratio = 0.74426

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
4	#	69.842	32.97	27.171	110	0	0.9929	0.0018	0.9912	0.0016	0.9891	0.0017	0.6095	0.0011	0.0017	0.6100	0.0012	0.0017	0.6106	0.0011	0.0017	204537
5	#	69.801	32.98	27.222	110	0	0.9956	0.0019	0.9951	0.0013	0.9923	0.0013	0.6098	0.0012	0.0017	0.6099	0.0011	0.0017	0.6108	0.0010	0.0017	204965
12	#	39.509	33.09	46.813	62	0	2.9652	0.0068	2.9654	0.0044	2.9603	0.0057	0.6076	0.0009	0.0007	0.6076	0.0007	0.0007	0.6081	0.0008	0.0007	353264
13	#	127.79	33.14	47.404	200	0	3.0441	0.0029	3.0433	0.0029	3.0386	0.0035	0.6073	0.0004	0.0007	0.6074	0.0005	0.0007	0.6078	0.0005	0.0007	358091
14	#	127.52	33.16	47.280	200	0	3.0272	0.0033	3.0261	0.0031	3.0239	0.0030	0.6074	0.0005	0.0007	0.6075	0.0005	0.0007	0.6077	0.0004	0.0007	357300
16	#	43.941	33.46	142.85	70	0	27.988	0.0106	27.990	0.0099	27.961	0.0119	0.6036	0.0002	0.0003	0.6035	0.0002	0.0003	0.6038	0.0002	0.0003	1086172
17	#	45.248	33.48	142.72	71	0	27.928	0.0131	27.947	0.0113	27.892	0.0246	0.6036	0.0002	0.0003	0.6034	0.0002	0.0003	0.6040	0.0003	0.0003	1085604
18	#	44.568	33.52	142.60	70	0	27.869	0.0223	27.875	0.0126	27.845	0.0242	0.6038	0.0003	0.0003	0.6037	0.0002	0.0003	0.6041	0.0003	0.0003	1085601
19	#	74.070	33.56	85.399	116	0	9.956	0.0055	9.969	0.0040	9.945	0.0049	0.6050	0.0002	0.0004	0.6046	0.0002	0.0004	0.6053	0.0002	0.0004	650655
20	#	74.922	33.59	85.169	117	0	9.898	0.0033	9.911	0.0032	9.891	0.0062	0.6051	0.0002	0.0004	0.6047	0.0002	0.0004	0.6053	0.0002	0.0004	649305
21	#	74.975	33.63	85.588	117	0	10.000	0.0057	10.014	0.0051	9.985	0.0054	0.6050	0.0002	0.0004	0.6046	0.0002	0.0004	0.6054	0.0002	0.0004	653026
1	$	104.66	33.50	17.374	160	0	0.4041	0.0011	0.4008	0.0012	0.3996	0.0009	0.6109	0.0030	0.0038	0.6135	0.0030	0.0039	0.6143	0.0027	0.0038	132210
2	$	104.25	33.52	17.316	165	1	0.4021	0.0007	0.3982	0.0008	0.3966	0.0006	0.6104	0.0029	0.0039	0.6134	0.0029	0.0039	0.6146	0.0027	0.0038	131821
3	$	104.36	33.54	17.352	165	0	0.4030	0.0008	0.3992	0.0009	0.3986	0.0011	0.6110	0.0029	0.0038	0.6139	0.0029	0.0039	0.6143	0.0028	0.0038	132148
4	$	40.102	33.61	47.464	63	0	3.0517	0.0035	3.0517	0.0058	3.0412	0.0067	0.6073	0.0007	0.0007	0.6073	0.0008	0.0007	0.6084	0.0009	0.0007	361995
5	$	39.446	33.62	47.601	59	0	3.0746	0.0041	3.0663	0.0054	3.0596	0.0061	0.6068	0.0007	0.0007	0.6076	0.0008	0.0007	0.6083	0.0008	0.0007	363115
6	$	39.580	33.62	47.770	62	1	3.0921	0.0029	3.0890	0.0046	3.0827	0.0045	0.6072	0.0006	0.0007	0.6075	0.0007	0.0007	0.6082	0.0007	0.0007	364409
7	$	70.308	33.64	27.211	106	0	0.9974	0.0029	0.9926	0.0030	0.9900	0.0023	0.6091	0.0015	0.0017	0.6105	0.0015	0.0017	0.6113	0.0013	0.0017	207661
8	$	69.890	33.65	27.483	110	0	1.0174	0.0019	1.0129	0.0019	1.0106	0.0016	0.6091	0.0013	0.0016	0.6104	0.0013	0.0017	0.6111	0.0012	0.0016	209775
9	$	70.079	33.66	27.478	105	0	1.0160	0.0016	1.0126	0.0020	1.0103	0.0016	0.6094	0.0013	0.0016	0.6104	0.0013	0.0017	0.6111	0.0012	0.0016	209785
10	$	126.31	33.73	47.406	200	0	3.0481	0.0027	3.0423	0.0042	3.0339	0.0032	0.6070	0.0005	0.0007	0.6075	0.0006	0.0007	0.6084	0.0005	0.0007	362435
11	$	129.80	33.74	47.459	195	0	3.0578	0.0033	3.0516	0.0031	3.0407	0.0039	0.6067	0.0005	0.0007	0.6073	0.0005	0.0007	0.6084	0.0005	0.0007	362920
12	$	127.55	33.74	47.294	200	0	3.0321	0.0027	3.0283	0.0026	3.0205	0.0024	0.6071	0.0005	0.0007	0.6075	0.0005	0.0007	0.6083	0.0004	0.0007	361656
13	$	74.102	33.75	85.747	117	1	10.037	0.0050	10.034	0.0036	10.009	0.0032	0.6050	0.0002	0.0004	0.6051	0.0002	0.0004	0.6059	0.0002	0.0004	655839
14	$	74.598	33.74	85.767	114	0	10.046	0.0051	10.042	0.0027	10.009	0.0036	0.6049	0.0002	0.0004	0.6050	0.0002	0.0004	0.6060	0.0002	0.0004	655857
15	$	74.748	33.74	85.842	118	0	10.064	0.0048	10.057	0.0039	10.026	0.0035	0.6049	0.0002	0.0004	0.6051	0.0002	0.0004	0.6060	0.0002	0.0004	656430
16	$	44.437	33.81	142.83	71	0	27.991	0.0222	27.995	0.0225	27.907	0.0144	0.6035	0.0003	0.0003	0.6034	0.0003	0.0003	0.6044	0.0002	0.0003	1093750
17	$	44.540	33.83	142.79	71	0	27.966	0.0178	27.963	0.0214	27.872	0.0100	0.6036	0.0003	0.0003	0.6036	0.0003	0.0003	0.6046	0.0002	0.0003	1093926
18	$	44.535	33.85	142.66	71	0	27.936	0.0105	27.945	0.0116	27.843	0.0147	0.6034	0.0002	0.0003	0.6033	0.0002	0.0003	0.6044	0.0002	0.0003	1093383

[Test Run Date Codes # - 06/17/85 $ - 06/19/85]

Table 49F. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-6C Diameter 2.9998 Inches, Beta Ratio = 0.74426

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
19	#	74.918	33.33	85.570	118	0	9.984	0.0038	9.990	0.0051	9.968	0.0049	0.6053	0.0002	0.0004	0.6051	0.0002	0.0004	0.6058	0.0002	0.0004	648911
20	#	74.720	33.33	85.507	118	0	9.982	0.0048	9.978	0.0045	9.944	0.0030	0.6049	0.0002	0.0004	0.6051	0.0002	0.0004	0.6061	0.0002	0.0004	648439
21	#	74.840	33.24	85.732	118	0	10.031	0.0073	10.030	0.0066	9.995	0.0026	0.6050	0.0003	0.0004	0.6051	0.0003	0.0004	0.6061	0.0002	0.0004	648948
22	#	75.359	33.36	85.959	119	0	10.054	0.0043	10.057	0.0040	10.079	0.0037	0.6059	0.0002	0.0004	0.6058	0.0002	0.0004	0.6052	0.0002	0.0004	652261
23	#	74.831	33.37	86.103	118	0	10.082	0.0066	10.081	0.0060	10.123	0.0046	0.6061	0.0003	0.0004	0.6061	0.0002	0.0004	0.6049	0.0002	0.0004	653486
24	#	74.803	33.38	86.059	118	0	10.070	0.0053	10.077	0.0042	10.104	0.0054	0.6062	0.0002	0.0004	0.6060	0.0002	0.0004	0.6051	0.0002	0.0004	653287
25	$	44.520	41.38	142.50	69	0	27.949	0.0125	27.954	0.0077	27.874	0.0280	0.6032	0.0002	0.0003	0.6031	0.0002	0.0003	0.6040	0.0003	0.0003	1262984
26	$	44.826	41.39	142.41	69	0	27.929	0.0143	27.922	0.0158	27.846	0.0146	0.6030	0.0002	0.0003	0.6031	0.0002	0.0003	0.6039	0.0002	0.0003	1262430
27	$	44.922	41.39	142.78	69	0	28.089	0.0216	28.084	0.0155	27.998	0.0118	0.6029	0.0003	0.0003	0.6029	0.0002	0.0003	0.6039	0.0002	0.0003	1265749
28	$	129.28	41.40	47.487	194	0	3.0730	0.0021	3.0734	0.0025	3.0613	0.0029	0.6062	0.0005	0.0007	0.6062	0.0005	0.0007	0.6074	0.0005	0.0007	421048
29	$	130.06	41.41	47.369	192	0	3.0590	0.0025	3.0591	0.0024	3.0484	0.0027	0.6061	0.0005	0.0007	0.6061	0.0005	0.0007	0.6071	0.0005	0.0007	420078
30	$	129.92	41.41	47.290	198	0	3.0449	0.0030	3.0465	0.0030	3.0364	0.0029	0.6065	0.0005	0.0007	0.6063	0.0005	0.0007	0.6073	0.0005	0.0007	419375
31	$	74.854	41.43	85.494	115	0	10.030	0.0083	10.026	0.0050	9.994	0.0040	0.6041	0.0003	0.0004	0.6042	0.0002	0.0004	0.6052	0.0002	0.0004	758456
32	$	74.916	41.42	85.491	112	0	10.023	0.0042	10.023	0.0028	9.988	0.0030	0.6043	0.0002	0.0004	0.6043	0.0002	0.0004	0.6054	0.0002	0.0004	758285
33	$	74.304	41.42	85.528	114	0	10.037	0.0076	10.039	0.0049	9.993	0.0041	0.6042	0.0003	0.0004	0.6041	0.0002	0.0004	0.6055	0.0002	0.0004	758616
34	$	105.25	41.39	17.187	161	0	0.3955	0.0008	0.3964	0.0007	0.3940	0.0009	0.6117	0.0031	0.0039	0.6109	0.0032	0.0039	0.6127	0.0031	0.0039	152361
35	$	104.93	41.40	17.183	157	0	0.3958	0.0008	0.3957	0.0008	0.3937	0.0008	0.6113	0.0031	0.0039	0.6113	0.0032	0.0039	0.6129	0.0031	0.0039	152354
36	$	105.20	41.41	17.199	161	0	0.3955	0.0009	0.3962	0.0010	0.3943	0.0008	0.6120	0.0031	0.0039	0.6115	0.0033	0.0039	0.6130	0.0031	0.0039	152523
37	$	69.886	41.46	27.251	107	0	1.0028	0.0026	1.0019	0.0024	0.9987	0.0025	0.6090	0.0015	0.0017	0.6093	0.0015	0.0017	0.6103	0.0014	0.0017	241885
38	$	69.860	41.47	27.239	107	0	1.0014	0.0017	1.0019	0.0019	0.9983	0.0022	0.6092	0.0013	0.0017	0.6090	0.0014	0.0017	0.6101	0.0014	0.0017	241828
39	$	70.518	41.47	27.221	108	0	1.0008	0.0026	0.9994	0.0030	0.9961	0.0018	0.6089	0.0015	0.0017	0.6094	0.0016	0.0017	0.6104	0.0013	0.0017	241663
40	@	74.574	38.44	85.433	115	0	9.982	0.0051	9.980	0.0094	9.994	0.0066	0.6049	0.0002	0.0004	0.6049	0.0003	0.0004	0.6045	0.0003	0.0004	716742
41	@	74.990	38.44	85.153	115	0	9.909	0.0079	9.911	0.0070	9.915	0.0080	0.6051	0.0003	0.0004	0.6050	0.0003	0.0004	0.6049	0.0003	0.0004	714388
42	@	75.019	38.45	85.718	115	0	10.040	0.0059	10.041	0.0066	10.052	0.0112	0.6051	0.0002	0.0004	0.6051	0.0003	0.0004	0.6047	0.0004	0.0004	719271
44	@	44.900	38.55	142.36	69	0	27.843	0.0088	27.840	0.0103	27.868	0.0263	0.6035	0.0002	0.0003	0.6035	0.0002	0.0003	0.6032	0.0003	0.0003	1196830
45	@	44.855	38.60	142.37	69	0	27.845	0.0147	27.845	0.0157	27.878	0.0174	0.6035	0.0002	0.0003	0.6035	0.0002	0.0003	0.6032	0.0003	0.0003	1198068
46	@	44.844	38.65	142.28	69	0	27.808	0.0130	27.807	0.0175	27.851	0.0251	0.6035	0.0002	0.0003	0.6036	0.0003	0.0003	0.6031	0.0003	0.0003	1198480
47	@	130.01	38.69	47.742	198	0	3.0980	0.0033	3.0977	0.0035	3.0992	0.0039	0.6068	0.0005	0.0007	0.6068	0.0005	0.0007	0.6066	0.0005	0.0007	402449
48	@	129.36	38.69	47.752	196	0	3.0994	0.0031	3.0975	0.0035	3.0976	0.0038	0.6067	0.0005	0.0007	0.6069	0.0005	0.0007	0.6069	0.0005	0.0007	402533
49	@	129.97	38.70	47.840	198	0	3.1096	0.0046	3.1083	0.0052	3.1141	0.0048	0.6069	0.0006	0.0007	0.6070	0.0006	0.0007	0.6064	0.0006	0.0007	403355

[Test Run Date Codes # - 06/20/85 $ - 07/31/85 @ - 08/13/85]

Table 49F. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-6C Diameter 2.9998 Inches, Beta Ratio = 0.74426

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
50	#	39.982	38.72	47.396	59	0	3.0544	0.0039	3.0513	0.0034	3.0492	0.0033	0.6066	0.0007	0.0007	0.6069	0.0007	0.0007	0.6072	0.0006	0.0007	399764
51	#	40.026	38.73	47.392	61	0	3.0510	0.0077	3.0476	0.0069	3.0481	0.0080	0.6069	0.0009	0.0007	0.6073	0.0009	0.0007	0.6072	0.0010	0.0007	399811
52	#	40.408	38.73	47.404	61	0	3.0494	0.0042	3.0477	0.0039	3.0494	0.0058	0.6072	0.0007	0.0007	0.6074	0.0007	0.0007	0.6072	0.0008	0.0007	399910
53	#	104.93	38.74	17.430	161	0	0.4065	0.0009	0.4068	0.0011	0.4060	0.0009	0.6115	0.0029	0.0038	0.6113	0.0031	0.0038	0.6119	0.0028	0.0038	147071
54	#	105.44	38.76	17.508	161	0	0.4103	0.0009	0.4102	0.0010	0.4092	0.0007	0.6114	0.0029	0.0038	0.6115	0.0030	0.0038	0.6123	0.0028	0.0038	147786
55	#	105.07	38.79	17.477	161	0	0.4099	0.0008	0.4087	0.0010	0.4080	0.0008	0.6106	0.0029	0.0038	0.6116	0.0030	0.0038	0.6120	0.0028	0.0038	147606
56	#	70.088	38.84	27.679	107	0	1.0347	0.0023	1.0325	0.0024	1.0323	0.0026	0.6087	0.0013	0.0016	0.6093	0.0014	0.0016	0.6094	0.0014	0.0016	233996
57	#	70.097	38.85	27.675	107	0	1.0322	0.0020	1.0322	0.0022	1.0313	0.0023	0.6094	0.0013	0.0016	0.6094	0.0014	0.0016	0.6096	0.0013	0.0016	234010
58	#	69.491	38.86	27.671	106	0	1.0325	0.0017	1.0310	0.0019	1.0314	0.0019	0.6092	0.0012	0.0016	0.6096	0.0013	0.0016	0.6095	0.0012	0.0016	234014
59	$	129.83	28.70	47.169	183	0	3.0078	0.0028	3.0063	0.0031	2.9973	0.0028	0.6076	0.0005	0.0007	0.6077	0.0005	0.0007	0.6086	0.0004	0.0007	324522
60	$	129.70	28.72	46.771	182	0	2.9560	0.0037	2.9541	0.0044	2.9439	0.0036	0.6077	0.0005	0.0007	0.6079	0.0006	0.0007	0.6090	0.0005	0.0007	321921
61	$	129.64	28.75	47.033	182	0	2.9887	0.0024	2.9876	0.0023	2.9790	0.0025	0.6078	0.0004	0.0007	0.6079	0.0004	0.0007	0.6087	0.0004	0.0007	323934
62	$	74.329	28.77	85.789	105	0	10.023	0.0061	10.025	0.0041	9.982	0.0041	0.6054	0.0002	0.0004	0.6053	0.0002	0.0004	0.6066	0.0002	0.0004	591121
63	$	74.443	28.76	85.698	105	0	10.000	0.0054	9.995	0.0035	9.960	0.0037	0.6054	0.0002	0.0004	0.6056	0.0002	0.0004	0.6066	0.0002	0.0004	590368
64	$	74.507	28.76	85.705	105	0	10.005	0.0063	9.998	0.0075	9.966	0.0076	0.6053	0.0003	0.0004	0.6055	0.0003	0.0004	0.6065	0.0003	0.0004	590414
65	$	44.774	28.86	143.38	62	0	28.118	0.0335	28.126	0.0249	28.019	0.0332	0.6040	0.0004	0.0003	0.6039	0.0003	0.0003	0.6051	0.0004	0.0003	989846
66	$	44.650	28.90	142.96	63	0	27.956	0.0247	27.968	0.0221	27.866	0.0111	0.6040	0.0003	0.0003	0.6039	0.0003	0.0003	0.6050	0.0002	0.0003	987823
67	$	44.696	28.94	143.01	63	0	27.982	0.0177	27.988	0.0164	27.875	0.0120	0.6040	0.0003	0.0003	0.6039	0.0002	0.0003	0.6051	0.0002	0.0003	989054
68	$	39.898	29.35	47.747	56	0	3.0837	0.0028	3.0801	0.0036	3.0686	0.0042	0.6075	0.0006	0.0007	0.6078	0.0006	0.0007	0.6089	0.0007	0.0007	333141
69	$	39.471	29.37	46.868	54	0	2.9750	0.0059	2.9688	0.0054	2.9543	0.0054	0.6071	0.0008	0.0007	0.6077	0.0008	0.0007	0.6092	0.0008	0.0007	327147
70	$	39.895	29.38	46.913	56	0	2.9800	0.0038	2.9745	0.0054	2.9622	0.0033	0.6071	0.0007	0.0007	0.6077	0.0008	0.0007	0.6090	0.0006	0.0007	327529
71	$	69.692	29.40	27.768	98	0	1.0354	0.0019	1.0316	0.0015	1.0299	0.0011	0.6097	0.0012	0.0016	0.6108	0.0011	0.0016	0.6113	0.0010	0.0016	193949
72	$	69.644	29.42	27.798	95	0	1.0391	0.0014	1.0350	0.0013	1.0320	0.0016	0.6093	0.0011	0.0016	0.6104	0.0011	0.0016	0.6113	0.0011	0.0016	194241
73	$	69.708	29.44	27.766	98	0	1.0334	0.0012	1.0326	0.0018	1.0291	0.0013	0.6102	0.0011	0.0016	0.6104	0.0012	0.0016	0.6115	0.0011	0.0016	194101
74	$	104.90	29.49	17.402	148	0	0.4036	0.0009	0.4009	0.0010	0.4005	0.0007	0.6120	0.0028	0.0038	0.6140	0.0027	0.0039	0.6143	0.0025	0.0038	121780
75	$	105.04	29.51	17.397	148	0	0.4031	0.0008	0.4005	0.0008	0.4004	0.0008	0.6121	0.0028	0.0039	0.6142	0.0027	0.0039	0.6143	0.0025	0.0038	121798
76	$	104.99	29.54	17.393	148	0	0.4025	0.0007	0.4000	0.0009	0.4000	0.0009	0.6125	0.0027	0.0039	0.6144	0.0027	0.0039	0.6144	0.0025	0.0038	121848
77	@	44.656	26.53	142.90	62	0	27.912	0.0226	27.913	0.0233	27.801	0.0171	0.6041	0.0003	0.0003	0.6041	0.0003	0.0003	0.6053	0.0002	0.0003	937311
78	@	44.924	26.57	142.95	60	0	27.940	0.0212	27.939	0.0240	27.830	0.0188	0.6040	0.0003	0.0003	0.6040	0.0003	0.0003	0.6052	0.0003	0.0003	938478
79	@	44.849	26.57	142.91	62	0	27.884	0.0095	27.895	0.0054	27.816	0.0162	0.6044	0.0002	0.0003	0.6043	0.0002	0.0003	0.6052	0.0002	0.0003	938203

[Test Run Date Codes # - 08/13/85 $ - 09/24/85 @ - 10/23/85]

Table 49F. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-6C Diameter 2.9998 Inches, Beta Ratio = 0.74426

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Ruska Mean (psid)	Ruska SD (psid)	Upper Mean (psid)	Upper SD (psid)	Lower Mean (psid)	Lower SD (psid)	Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
80	#	75.378	26.69	85.825	104	0	10.020	0.0036	10.024	0.0034	9.979	0.0036	0.6055	0.0002	0.0004	0.6054	0.0002	0.0004	0.6068	0.0002	0.0004	564963
81	#	75.063	26.68	85.865	103	0	10.019	0.0022	10.028	0.0033	9.996	0.0030	0.6059	0.0002	0.0004	0.6056	0.0002	0.0004	0.6066	0.0002	0.0004	565100
82	#	74.867	26.67	85.864	103	0	10.025	0.0033	10.027	0.0027	9.991	0.0040	0.6057	0.0002	0.0004	0.6056	0.0002	0.0004	0.6067	0.0002	0.0004	564967
83	#	129.24	26.65	47.591	178	0	3.0595	0.0026	3.0606	0.0029	3.0461	0.0023	0.6077	0.0004	0.0007	0.6076	0.0005	0.0007	0.6090	0.0004	0.0007	313000
84	#	129.92	26.68	47.571	179	0	3.0561	0.0024	3.0577	0.0025	3.0440	0.0034	0.6078	0.0004	0.0007	0.6076	0.0004	0.0007	0.6090	0.0005	0.0007	313075
85	#	129.70	26.72	47.623	173	0	3.0598	0.0024	3.0632	0.0026	3.0505	0.0022	0.6081	0.0004	0.0007	0.6077	0.0004	0.0007	0.6090	0.0004	0.0007	313697
86	#	105.28	26.74	17.259	145	0	0.3958	0.0008	0.3987	0.0011	0.3949	0.0009	0.6127	0.0024	0.0039	0.6105	0.0027	0.0039	0.6134	0.0025	0.0039	113740
87	#	105.26	26.77	17.309	145	0	0.3982	0.0007	0.4008	0.0009	0.3967	0.0010	0.6126	0.0024	0.0039	0.6106	0.0027	0.0039	0.6138	0.0025	0.0039	114143
88	#	104.68	26.79	17.329	142	0	0.3990	0.0009	0.4018	0.0011	0.3978	0.0009	0.6128	0.0024	0.0039	0.6106	0.0027	0.0039	0.6137	0.0025	0.0039	114327
89	#	69.570	26.84	27.387	93	0	1.0020	0.0019	1.0046	0.0025	1.0023	0.0021	0.6111	0.0011	0.0017	0.6103	0.0013	0.0017	0.6110	0.0012	0.0017	180883
90	#	70.247	26.87	27.314	95	0	0.9982	0.0015	1.0004	0.0018	0.9963	0.0023	0.6106	0.0011	0.0017	0.6099	0.0012	0.0017	0.6112	0.0012	0.0017	180519
91	#	70.403	26.89	27.277	97	0	0.9944	0.0011	0.9967	0.0012	0.9935	0.0013	0.6109	0.0010	0.0017	0.6102	0.0011	0.0017	0.6112	0.0011	0.0017	180359
92	#	104.39	26.92	17.304	139	0	0.3981	0.0011	0.4006	0.0010	0.3966	0.0009	0.6126	0.0025	0.0039	0.6107	0.0027	0.0039	0.6137	0.0025	0.0039	114492
93	#	105.50	26.95	17.289	145	0	0.3968	0.0009	0.3992	0.0010	0.3963	0.0008	0.6131	0.0025	0.0039	0.6112	0.0027	0.0039	0.6134	0.0025	0.0039	114469
94	#	105.42	26.97	17.334	145	0	0.3981	0.0006	0.4013	0.0008	0.3982	0.0007	0.6136	0.0024	0.0039	0.6111	0.0026	0.0039	0.6135	0.0024	0.0039	114816
98	$	70.521	27.96	27.716	98	0	1.0281	0.0017	1.0276	0.0020	1.0250	0.0018	0.6106	0.0012	0.0016	0.6107	0.0012	0.0016	0.6115	0.0012	0.0016	187638
99	$	70.450	27.98	27.720	98	0	1.0281	0.0029	1.0271	0.0036	1.0244	0.0025	0.6107	0.0014	0.0016	0.6110	0.0015	0.0016	0.6118	0.0013	0.0016	187743
100	$	69.676	28.00	27.717	93	0	1.0287	0.0024	1.0268	0.0024	1.0252	0.0027	0.6104	0.0013	0.0016	0.6110	0.0012	0.0016	0.6115	0.0014	0.0016	187810
101	$	104.53	28.24	17.643	147	0	0.4134	0.0009	0.4135	0.0010	0.4118	0.0010	0.6130	0.0026	0.0038	0.6129	0.0026	0.0038	0.6142	0.0027	0.0038	120178
102	$	104.36	28.25	17.596	146	0	0.4110	0.0009	0.4109	0.0010	0.4098	0.0008	0.6131	0.0026	0.0038	0.6132	0.0026	0.0038	0.6140	0.0027	0.0038	119885
103	$	105.78	28.27	17.590	149	1	0.4105	0.0007	0.4109	0.0007	0.4095	0.0006	0.6133	0.0026	0.0038	0.6130	0.0025	0.0038	0.6140	0.0027	0.0038	119892
104	$	40.532	28.32	47.340	55	0	3.0281	0.0051	3.0254	0.0069	3.0187	0.0106	0.6077	0.0007	0.0007	0.6080	0.0009	0.0007	0.6086	0.0012	0.0007	323019
105	$	40.651	28.32	47.433	57	0	3.0404	0.0029	3.0417	0.0027	3.0319	0.0017	0.6077	0.0006	0.0007	0.6075	0.0006	0.0007	0.6085	0.0006	0.0007	323653
106	$	39.872	28.32	47.405	56	0	3.0339	0.0057	3.0338	0.0030	3.0298	0.0017	0.6080	0.0008	0.0007	0.6080	0.0006	0.0007	0.6084	0.0006	0.0007	323462
107	$	75.590	28.36	85.883	107	0	10.038	0.0050	10.033	0.0056	9.992	0.0043	0.6055	0.0002	0.0004	0.6057	0.0002	0.0004	0.6069	0.0002	0.0004	586524
108	$	74.603	28.35	85.877	102	0	10.039	0.0038	10.035	0.0026	9.991	0.0060	0.6054	0.0002	0.0004	0.6056	0.0002	0.0004	0.6069	0.0002	0.0004	586355
109	$	74.786	28.34	87.601	106	0	10.433	0.0059	10.430	0.0067	10.402	0.0062	0.6058	0.0002	0.0003	0.6059	0.0002	0.0003	0.6067	0.0002	0.0003	597996
110	$	44.712	28.39	143.04	64	0	27.971	0.0152	27.980	0.0121	27.889	0.0148	0.6042	0.0002	0.0003	0.6041	0.0002	0.0003	0.6051	0.0002	0.0003	977524
111	$	44.449	28.50	142.97	63	0	27.931	0.0166	27.931	0.0142	27.872	0.0140	0.6043	0.0002	0.0003	0.6043	0.0002	0.0003	0.6049	0.0002	0.0003	979343
112	$	44.645	28.52	143.08	63	0	28.012	0.0131	27.993	0.0144	27.886	0.0185	0.6039	0.0002	0.0003	0.6041	0.0002	0.0003	0.6052	0.0003	0.0003	980534

[Test Run Date Codes # - 10/23/85 $ - 12/09/85]

Table 49G. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-7C Diameter 0.3754 Inches, Beta Ratio = 0.09314

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	406.00	33.62	0.6044	144	0	3.0217	0.0157	3.0272	0.0132	3.0274	0.0133	0.5964	0.0016	0.0012	0.5956	0.0013	0.0012	0.5956	0.0013	0.0012	4611
2 #	406.12	33.70	0.6039	144	0	3.0201	0.0170	3.0218	0.0108	3.0197	0.0108	0.5960	0.0017	0.0012	0.5957	0.0011	0.0012	0.5959	0.0011	0.0012	4614
3 #	405.97	33.75	0.6038	144	0	2.9919	0.0137	3.0123	0.0124	3.0128	0.0125	0.5987	0.0014	0.0012	0.5965	0.0013	0.0012	0.5965	0.0013	0.0012	4618
4 #	723.18	33.67	0.3500	138	0	1.0429	0.0090	1.0385	0.0040	1.0371	0.0035	0.5881	0.0027	0.0020	0.5889	0.0015	0.0021	0.5893	0.0013	0.0020	2673
5 #	722.99	33.65	0.3525	138	0	1.0493	0.0079	1.0536	0.0034	1.0528	0.0031	0.5906	0.0024	0.0020	0.5889	0.0013	0.0020	0.5891	0.0012	0.0020	2691
6 #	723.16	33.68	0.3522	138	2	1.0417	0.0067	1.0473	0.0024	1.0467	0.0030	0.5920	0.0021	0.0021	0.5901	0.0012	0.0020	0.5903	0.0012	0.0021	2690
7 #	241.11	34.13	1.5495	164	0	19.890	0.0201	19.893	0.0144	19.892	0.0165	0.5957	0.0003	0.0008	0.5956	0.0002	0.0008	0.5957	0.0003	0.0008	11943
8 #	239.35	34.17	1.5450	164	1	19.761	0.0159	19.765	0.0216	19.764	0.0232	0.5959	0.0003	0.0008	0.5958	0.0003	0.0008	0.5958	0.0004	0.0008	11918
9 #	239.78	34.20	1.5534	161	0	19.976	0.0182	19.978	0.0161	19.976	0.0168	0.5959	0.0003	0.0008	0.5959	0.0003	0.0008	0.5959	0.0003	0.0008	11990
10 #	351.17	34.18	1.1059	146	0	10.112	0.0194	10.097	0.0131	10.095	0.0130	0.5963	0.0006	0.0008	0.5967	0.0004	0.0008	0.5968	0.0004	0.0008	8532
11 #	351.80	34.21	1.1025	146	0	10.008	0.0181	10.041	0.0186	10.041	0.0183	0.5975	0.0006	0.0008	0.5965	0.0006	0.0008	0.5965	0.0006	0.0008	8511
12 #	349.94	34.24	1.1030	145	0	10.061	0.0123	10.052	0.0123	10.051	0.0124	0.5962	0.0004	0.0008	0.5965	0.0004	0.0008	0.5965	0.0004	0.0008	8520
13 #	1208.0	33.82	0.2030	136	0	0.3832	0.0051	0.3865	0.0036	0.3873	0.0035	0.5636	0.0044	0.0042	0.5602	0.0036	0.0041	0.5595	0.0034	0.0042	1555
14 #	1206.7	33.68	0.1999	136	2	0.3794	0.0032	0.3773	0.0015	0.3776	0.0013	0.5578	0.0034	0.0042	0.5583	0.0027	0.0042	0.5580	0.0025	0.0042	1527
15 #	1206.5	33.68	0.1994	136	0	0.3861	0.0049	0.3774	0.0025	0.3788	0.0020	0.5516	0.0042	0.0041	0.5568	0.0031	0.0042	0.5558	0.0027	0.0040	1523
1 $	406.04	40.81	0.6132	144	0	3.1093	0.0129	3.1131	0.0089	3.1153	0.0090	0.5970	0.0013	0.0012	0.5965	0.0009	0.0012	0.5963	0.0009	0.0012	5378
2 $	406.31	40.83	0.6092	144	0	3.0691	0.0185	3.0730	0.0195	3.0753	0.0205	0.5970	0.0018	0.0012	0.5965	0.0019	0.0012	0.5963	0.0020	0.0012	5345
3 $	406.28	40.87	0.6763	144	0	3.7919	0.0506	3.7888	0.0551	3.7835	0.0556	0.5968	0.0040	0.0011	0.5970	0.0044	0.0011	0.5974	0.0044	0.0011	5938
4 $	722.81	40.51	0.3444	138	0	0.9966	0.0067	0.9945	0.0021	0.9959	0.0021	0.5925	0.0022	0.0021	0.5927	0.0013	0.0021	0.5923	0.0012	0.0021	3004
5 $	723.06	40.38	0.3452	138	0	0.9922	0.0077	0.9971	0.0027	0.9990	0.0024	0.5952	0.0025	0.0021	0.5933	0.0014	0.0021	0.5927	0.0013	0.0021	3003
6 $	723.17	40.40	0.3487	138	0	1.0107	0.0066	1.0171	0.0029	1.0191	0.0032	0.5956	0.0022	0.0021	0.5934	0.0014	0.0021	0.5928	0.0014	0.0021	3035
7 $	240.40	41.50	1.5538	195	0	20.074	0.0226	20.057	0.0293	20.060	0.0295	0.5952	0.0003	0.0008	0.5955	0.0004	0.0008	0.5954	0.0005	0.0008	13802
8 $	240.50	41.54	1.5524	192	0	20.014	0.0218	20.024	0.0227	20.026	0.0245	0.5956	0.0003	0.0008	0.5955	0.0004	0.0008	0.5954	0.0004	0.0008	13800
9 $	240.36	41.57	1.5518	194	0	19.987	0.0214	20.007	0.0253	20.009	0.0260	0.5958	0.0003	0.0008	0.5955	0.0004	0.0008	0.5955	0.0004	0.0008	13802
10 $	351.61	41.49	1.1090	151	0	10.187	0.0169	10.197	0.0198	10.198	0.0205	0.5964	0.0005	0.0008	0.5961	0.0006	0.0008	0.5961	0.0006	0.0008	9849
11 $	351.48	41.51	1.1074	150	0	10.171	0.0227	10.169	0.0219	10.171	0.0219	0.5960	0.0007	0.0008	0.5960	0.0007	0.0008	0.5960	0.0007	0.0008	9839
12 $	351.45	41.53	1.1081	151	0	10.171	0.0272	10.180	0.0245	10.180	0.0252	0.5964	0.0008	0.0008	0.5961	0.0007	0.0008	0.5961	0.0008	0.0008	9849
13 $	964.05	40.72	0.2230	140	0	0.4325	0.0052	0.4328	0.0021	0.4339	0.0021	0.5830	0.0042	0.0039	0.5818	0.0029	0.0039	0.5811	0.0028	0.0039	1953
14 $	966.30	40.18	0.2212	140	0	0.4331	0.0022	0.4293	0.0019	0.4310	0.0018	0.5776	0.0027	0.0039	0.5795	0.0028	0.0039	0.5783	0.0027	0.0039	1917
15 $	960.18	40.05	0.2205	139	1	0.4293	0.0041	0.4207	0.0010	0.4237	0.0008	0.5782	0.0036	0.0039	0.5834	0.0027	0.0040	0.5814	0.0025	0.0039	1907

[Test Run Date Codes # - 07/09/85 $ - 08/01/85]

Table 49G. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-7C Diameter 0.3754 Inches, Beta Ratio = 0.09314

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
16	#	1206.1	29.47	0.2238	136	0	0.4123	0.0007	0.4110	0.0002	0.4119	0.0002	0.5974	0.0133	0.0042	0.5982	0.0024	0.0042	0.5976	0.0022	0.0042	1566
17	#	1206.2	29.49	0.2240	136	1	0.4127	0.0004	0.4106	0.0001	0.4116	0.0001	0.5977	0.0133	0.0042	0.5991	0.0024	0.0042	0.5984	0.0022	0.0042	1568
18	#	1206.3	29.49	0.2240	136	0	0.4105	0.0005	0.4095	0.0002	0.4107	0.0002	0.5991	0.0134	0.0042	0.5998	0.0024	0.0042	0.5989	0.0022	0.0042	1568
19	#	240.36	29.99	1.5403	195	0	19.611	0.0063	19.605	0.0060	19.607	0.0072	0.5960	0.0003	0.0008	0.5961	0.0001	0.0008	0.5961	0.0001	0.0008	10895
20	#	240.98	29.93	1.5342	192	0	19.453	0.0030	19.445	0.0015	19.446	0.0020	0.5961	0.0003	0.0008	0.5962	0.0001	0.0008	0.5962	0.0001	0.0008	10838
21	#	241.09	29.94	1.5503	193	0	19.857	0.0033	19.848	0.0017	19.850	0.0020	0.5962	0.0003	0.0008	0.5963	0.0001	0.0008	0.5963	0.0001	0.0008	10954
22	#	723.23	29.66	0.3503	138	0	0.9985	0.0005	0.9970	0.0004	0.9974	0.0004	0.6008	0.0055	0.0021	0.6012	0.0010	0.0022	0.6011	0.0009	0.0021	2460
23	#	723.21	29.63	0.3497	138	3	0.9971	0.0005	0.9962	0.0002	0.9969	0.0002	0.6001	0.0055	0.0021	0.6003	0.0010	0.0022	0.6001	0.0009	0.0021	2455
24	#	723.10	29.62	0.3497	138	0	0.9982	0.0006	0.9963	0.0002	0.9970	0.0002	0.5998	0.0055	0.0021	0.6004	0.0010	0.0022	0.6002	0.0009	0.0021	2454
25	#	406.04	29.70	0.6023	144	0	2.9769	0.0027	2.9746	0.0019	2.9770	0.0019	0.5982	0.0019	0.0012	0.5985	0.0004	0.0012	0.5982	0.0004	0.0012	4234
26	#	406.37	29.70	0.6029	144	7	2.9862	0.0024	2.9832	0.0014	2.9853	0.0011	0.5979	0.0019	0.0012	0.5982	0.0004	0.0012	0.5980	0.0003	0.0012	4238
27	#	406.31	29.70	0.5999	144	0	2.9566	0.0013	2.9514	0.0010	2.9533	0.0009	0.5978	0.0019	0.0012	0.5983	0.0004	0.0012	0.5982	0.0003	0.0012	4217
28	#	350.01	29.78	1.1065	146	5	10.089	0.0030	10.086	0.0029	10.088	0.0030	0.5969	0.0006	0.0008	0.5970	0.0002	0.0008	0.5969	0.0002	0.0008	7792
29	#	351.18	29.76	1.0993	147	3	9.961	0.0018	9.958	0.0011	9.960	0.0011	0.5968	0.0006	0.0008	0.5969	0.0001	0.0008	0.5969	0.0001	0.0008	7738
30	#	350.41	29.78	1.0979	147	0	9.939	0.0173	9.933	0.0157	9.934	0.0152	0.5968	0.0008	0.0008	0.5970	0.0005	0.0008	0.5969	0.0005	0.0008	7731
31	#	723.23	24.26	0.3567	138	3	1.0351	0.0032	1.0344	0.0024	1.0356	0.0023	0.6005	0.0054	0.0021	0.6007	0.0012	0.0021	0.6004	0.0011	0.0021	2222
32	#	723.00	27.65	0.3614	138	2	1.0601	0.0024	1.0574	0.0023	1.0586	0.0022	0.6014	0.0052	0.0021	0.6022	0.0011	0.0021	0.6018	0.0011	0.0021	2430
33	#	722.99	24.78	0.3575	138	4	1.0415	0.0025	1.0403	0.0027	1.0422	0.0027	0.6000	0.0053	0.0021	0.6004	0.0012	0.0021	0.5998	0.0012	0.0021	2254
34	#	1206.1	24.26	0.2242	136	4	0.4034	0.0010	0.4014	0.0009	0.4033	0.0010	0.6046	0.0138	0.0043	0.6061	0.0026	0.0043	0.6047	0.0024	0.0043	1397
35	#	1206.0	24.13	0.2213	136	6	0.3926	0.0010	0.3901	0.0012	0.3919	0.0012	0.6049	0.0141	0.0044	0.6068	0.0027	0.0044	0.6055	0.0025	0:0044	1375
36	#	1206.3	24.10	0.2209	136	5	0.3918	0.0008	0.3894	0.0008	0.3912	0.0008	0.6045	0.0142	0.0044	0.6064	0.0026	0.0044	0.6050	0.0024	0.0044	1371
37	$	723.21	22.80	0.3737	138	0	1.1310	0.0028	1.1281	0.0025	1.1289	0.0024	0.6018	0.0012	0.0020	0.6026	0.0011	0.0020	0.6023	0.0011	0.0020	2250
38	$	723.28	22.86	0.3726	138	3	1.1290	0.0025	1.1295	0.0023	1.1302	0.0022	0.6005	0.0012	0.0020	0.6004	0.0011	0.0020	0.6002	0.0011	0.0020	2247
39	$	723.14	22.96	0.3743	138	2	1.1420	0.0027	1.1394	0.0026	1.1392	0.0027	0.6000	0.0012	0.0020	0.6006	0.0011	0.0020	0.6007	0.0011	0.0020	2262
40	$	1206.1	23.06	0.2239	136	1	0.4034	0.0018	0.4027	0.0014	0.4024	0.0012	0.6038	0.0030	0.0043	0.6043	0.0027	0.0043	0.6046	0.0026	0.0043	1357
41	$	1206.0	23.13	0.2268	136	2	0.4149	0.0014	0.4146	0.0012	0.4143	0.0010	0.6031	0.0028	0.0042	0.6033	0.0025	0.0042	0.6035	0.0025	0.0042	1376
42	$	1206.3	23.25	0.2220	136	4	0.3961	0.0024	0.3942	0.0021	0.3941	0.0021	0.6043	0.0033	0.0044	0.6057	0.0030	0.0044	0.6058	0.0030	0.0044	1351
43	$	400.76	23.26	0.6030	150	0	2.9674	0.0114	2.9678	0.0115	2.9690	0.0128	0.5995	0.0012	0.0012	0.5994	0.0012	0.0012	0.5993	0.0013	0.0012	3671
44	$	402.21	23.26	0.5991	150	8	2.9804	0.0147	2.9700	0.0177	2.9711	0.0150	0.5944	0.0015	0.0012	0.5954	0.0018	0.0012	0.5953	0.0015	0.0012	3647
45	$	400.63	23.13	0.6016	148	0	2.9554	0.0067	2.9534	0.0063	2.9543	0.0068	0.5993	0.0008	0.0012	0.5995	0.0007	0.0012	0.5994	0.0008	0.0012	3651

[Test Run Date Codes # - 09/25/85 $ - 09/26/85]

Table 49G. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-7C Diameter 0.3754 Inches, Beta Ratio = 0.09314

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
46 #	230.20	23.08	0.9273	190	0	7.0569	0.0721	7.0622	0.0848	7.0644	0.0863	0.5979	0.0031	0.0009	0.5976	0.0036	0.0009	0.5975	0.0037	0.0009	5621
47 #	230.27	23.06	0.9310	190	5	7.1586	0.0620	7.1554	0.0740	7.1567	0.0626	0.5959	0.0026	0.0009	0.5960	0.0031	0.0009	0.5960	0.0026	0.0009	5641
48 #	230.22	23.02	0.9344	190	3	7.1743	0.0290	7.1716	0.0263	7.1691	0.0341	0.5974	0.0012	0.0009	0.5975	0.0011	0.0009	0.5976	0.0014	0.0009	5656
49 #	239.94	28.82	1.5447	194	0	19.716	0.0059	19.713	0.0039	19.712	0.0040	0.5960	0.0001	0.0008	0.5961	0.0001	0.0008	0.5961	0.0001	0.0008	10655
50 #	240.38	28.79	1.5427	192	7	19.644	0.0040	19.647	0.0031	19.648	0.0032	0.5964	0.0001	0.0008	0.5963	0.0001	0.0008	0.5963	0.0001	0.0008	10634
51 #	240.29	28.76	1.5494	189	1	19.814	0.0033	19.813	0.0024	19.812	0.0025	0.5964	0.0001	0.0008	0.5964	0.0001	0.0008	0.5964	0.0001	0.0008	10674
52 #	199.75	28.64	1.1017	165	3	9.996	0.0059	9.998	0.0055	9.998	0.0053	0.5970	0.0002	0.0008	0.5970	0.0002	0.0008	0.5970	0.0002	0.0008	7570
53 #	200.68	28.64	1.1001	166	0	9.961	0.0050	9.967	0.0052	9.967	0.0058	0.5972	0.0002	0.0008	0.5970	0.0002	0.0008	0.5970	0.0002	0.0008	7559
54 #	200.92	28.62	1.0757	166	0	9.521	0.0057	9.529	0.0054	9.529	0.0057	0.5973	0.0002	0.0009	0.5971	0.0002	0.0009	0.5970	0.0002	0.0009	7388
55 $	239.94	26.71	1.5445	196	0	19.696	0.0057	19.696	0.0066	19.695	0.0068	0.5961	0.0001	0.0008	0.5961	0.0001	0.0008	0.5962	0.0001	0.0008	10172
56 $	240.43	26.77	1.5391	192	0	19.550	0.0048	19.548	0.0035	19.547	0.0030	0.5963	0.0001	0.0008	0.5963	0.0001	0.0008	0.5963	0.0001	0.0008	10150
57 $	240.34	26.76	1.5423	193	1	19.632	0.0031	19.627	0.0022	19.626	0.0022	0.5962	0.0001	0.0008	0.5963	0.0001	0.0008	0.5963	0.0001	0.0008	10168
58 $	1206.1	26.44	0.2207	136	0	0.3926	0.0004	0.3925	0.0002	0.3921	0.0002	0.6035	0.0034	0.0044	0.6036	0.0031	0.0044	0.6039	0.0026	0.0044	1445
59 $	1206.1	26.41	0.2195	136	0	0.3917	0.0003	0.3906	0.0001	0.3910	0.0001	0.6009	0.0034	0.0044	0.6017	0.0031	0.0044	0.6015	0.0026	0.0044	1436
60 $	1206.0	26.39	0.2195	136	0	0.3914	0.0003	0.3903	0.0001	0.3909	0.0001	0.6010	0.0034	0.0044	0.6018	0.0031	0.0044	0.6014	0.0026	0.0044	1435
61 $	723.25	26.47	0.3541	138	1	1.0191	0.0006	1.0184	0.0002	1.0188	0.0002	0.6008	0.0013	0.0021	0.6011	0.0012	0.0021	0.6010	0.0010	0.0021	2320
62 $	723.58	26.48	0.3540	138	0	1.0196	0.0005	1.0189	0.0002	1.0188	0.0001	0.6006	0.0013	0.0021	0.6008	0.0012	0.0021	0.6009	0.0010	0.0021	2319
63 $	723.09	26.49	0.3540	138	0	1.0196	0.0004	1.0187	0.0002	1.0185	0.0002	0.6006	0.0013	0.0021	0.6008	0.0012	0.0021	0.6009	0.0010	0.0021	2320
64 $	351.57	26.59	1.1003	149	0	9.973	0.0060	9.977	0.0076	9.977	0.0075	0.5968	0.0002	0.0008	0.5967	0.0003	0.0008	0.5967	0.0003	0.0008	7227
65 $	350.97	26.59	1.1008	147	1	9.983	0.0026	9.982	0.0018	9.982	0.0017	0.5968	0.0002	0.0008	0.5968	0.0002	0.0008	0.5968	0.0001	0.0008	7230
66 $	350.62	26.60	1.0982	147	0	9.933	0.0025	9.933	0.0014	9.933	0.0015	0.5969	0.0002	0.0008	0.5969	0.0002	0.0008	0.5969	0.0001	0.0008	7215
67 $	406.42	26.55	0.6087	144	1	3.0304	0.0007	3.0299	0.0005	3.0302	0.0006	0.5990	0.0005	0.0012	0.5991	0.0004	0.0012	0.5990	0.0004	0.0012	3994
68 $	406.09	26.55	0.6068	144	15	3.0274	0.0007	3.0263	0.0004	3.0267	0.0004	0.5974	0.0005	0:0012	0.5975	0.0004	0.0012	0.5974	0.0004	0.0012	3982
69 $	406.31	26.55	0.6081	144	0	3.0286	0.0007	3.0268	0.0006	3.0274	0.0006	0.5985	0.0005	0.0012	0.5987	0.0004	0.0012	0.5987	0.0004	0.0012	3990
70 @	723.22	17.67	0.3587	138	2	1.0426	0.0020	1.0393	0.0018	1.0394	0.0018	0.6014	0.0044	0.0021	0.6024	0.0011	0.0021	0.6024	0.0011	0.0021	1905
71 @	723.09	18.73	0.3579	138	0	1.0365	0.0020	1.0330	0.0023	1.0334	0.0024	0.6018	0.0044	0.0021	0.6028	0.0012	0.0021	0.6027	0.0012	0.0021	1953
72 @	722.92	17.85	0.3590	138	1	1.0436	0.0019	1.0397	0.0013	1.0401	0.0014	0.6016	0.0044	0.0021	0.6028	0.0010	0.0021	0.6027	0.0010	0.0021	1916
75 &	239.95	29.15	1.5556	195	0	19.978	0.0085	19.978	0.0074	19.981	0.0076	0.5963	0.0002	0.0008	0.5963	0.0001	0.0008	0.5963	0.0002	0.0008	10807
76 &	240.63	29.04	1.5592	191	1	20.064	0.0049	20.065	0.0027	20.067	0.0029	0.5964	0.0001	0.0008	0.5964	0.0001	0.0008	0.5964	0.0001	0.0008	10806
77 &	240.74	29.10	1.5575	191	0	20.028	0.0046	20.022	0.0050	20.023	0.0049	0.5963	0.0001	0.0008	0.5964	0.0001	0.0008	0.5964	0.0001	0.0008	10809

[Test Run Date Codes # - 09/26/85 $ - 10/22/85 @ - 11/06/85 & - 12/09/85]

Table 49G. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-7C Diameter 0.3754 Inches, Beta Ratio = 0.09314

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
81 #	352.03	28.97	1.1004	147	0	9.977	0.0031	9.978	0.0017	9.980	0.0020	0.5969	0.0002	0.0008	0.5969	0.0001	0.0008	0.5968	0.0001	0.0008	7615
82 #	352.39	28.98	1.1076	147	0	10.113	0.0085	10.112	0.0085	10.113	0.0083	0.5967	0.0003	0.0008	0.5968	0.0003	0.0008	0.5968	0.0003	0.0008	7667
83 #	350.78	28.97	1.1025	146	0	10.019	0.0027	10.016	0.0014	10.017	0.0015	0.5968	0.0002	0.0008	0.5969	0.0001	0.0008	0.5969	0.0001	0.0008	7630
84 #	406.47	28.89	0.6083	144	17	3.0230	0.0013	3.0209	0.0005	3.0218	0.0006	0.5994	0.0004	0.0012	0.5996	0.0004	0.0012	0.5996	0.0004	0.0012	4202
85 #	406.09	28.85	0.6083	144	21	3.0212	0.0017	3.0176	0.0006	3.0198	0.0006	0.5996	0.0004	0.0012	0.6000	0.0004	0.0012	0.5998	0.0004	0.0012	4199
86 #	406.41	28.83	0.6087	144	24	3.0217	0.0020	3.0205	0.0004	3.0225	0.0006	0.5999	0.0004	0.0012	0.6001	0.0004	0.0012	0.5999	0.0004	0.0012	4200
87 #	406.45	15.94	0.6178	144	0	3.1065	0.0101	3.1053	0.0098	3.1059	0.0101	0.6000	0.0010	0.0012	0.6001	0.0010	0.0012	0.6001	0.0010	0.0012	3139
88 #	406.45	13.14	0.6122	144	0	3.0457	0.0019	3.0447	0.0019	3.0458	0.0020	0.6003	0.0004	0.0012	0.6004	0.0004	0.0012	0.6003	0.0004	0.0012	2886
89 #	406.31	11.60	0.6171	144	4	3.0950	0.0034	3.0922	0.0036	3.0937	0.0037	0.6003	0.0005	0.0012	0.6006	0.0005	0.0012	0.6005	0.0005	0.0012	2788
90 #	723.23	11.01	0.3628	138	1	1.0575	0.0009	1.0580	0.0008	1.0585	0.0007	0.6037	0.0010	0.0021	0.6036	0.0010	0.0021	0.6035	0.0010	0.0021	1612
91 #	723.14	10.86	0.3627	138	4	1.0593	0.0006	1.0592	0.0006	1.0596	0.0005	0.6031	0.0010	0.0021	0.6031	0.0010	0.0021	0.6030	0.0010	0.0021	1605
92 #	723.10	10.87	0.3639	138	3	1.0666	0.0010	1.0665	0.0011	1.0670	0.0011	0.6031	0.0010	0.0021	0.6031	0.0010	0.0021	0.6030	0.0011	0.0021	1610
93 #	1206.1	11.23	0.2297	136	0	0.4203	0.0004	0.4213	0.0004	0.4211	0.0004	0.6065	0.0025	0.0042	0.6058	0.0024	0.0042	0.6059	0.0026	0.0042	1027
94 #	1206.0	11.37	0.2289	136	1	0.4181	0.0002	0.4188	0.0002	0.4189	0.0003	0.6059	0.0025	0.0042	0.6054	0.0024	0.0042	0.6053	0.0026	0.0042	1027
95 #	1206.2	11.51	0.2295	136	2	0.4202	0.0003	0.4212	0.0003	0.4214	0.0004	0.6061	0.0025	0.0042	0.6053	0.0024	0.0042	0.6051	0.0026	0.0042	1034
121 $	1206.5	22.74	0.2270	136	4	0.0000	0.0000	0.4123	0.0001	0.4126	0.0001	0.0000	0.0000	0.0000	0.6054	0.0030	0.0042	0.6052	0.0035	0.0042	1365
122 $	1206.6	22.73	0.2273	136	5	0.0000	0.0000	0.4133	0.0002	0.4136	0.0002	0.0000	0.0000	0.0000	0.6056	0.0030	0.0042	0.6054	0.0035	0.0042	1366
123 $	1206.5	22.74	0.2274	136	6	0.0000	0.0000	0.4133	0.0002	0.4134	0.0002	0.0000	0.0000	0.0000	0.6059	0.0030	0.0042	0.6058	0.0035	0.0042	1367
124 $	325.24	22.71	0.6136	161	13	0.0000	0.0000	3.0573	0.0029	3.0620	0.0033	0.0000	0.0000	0.0000	0.6010	0.0005	0.0012	0.6005	0.0006	0.0012	3687
125 $	325.05	22.72	0.6136	161	16	0.0000	0.0000	3.0547	0.0025	3.0611	0.0036	0.0000	0.0000	0.0000	0.6012	0.0005	0.0012	0.6005	0.0006	0.0012	3688
126 $	327.38	22.71	0.6120	162	12	0.0000	0.0000	3.0484	0.0010	3.0496	0.0014	0.0000	0.0000	0.0000	0.6002	0.0004	0.0012	0.6001	0.0005	0.0012	3678
127 $	125.19	22.39	1.5684	114	0	0.0000	0.0000	20.274	0.0204	20.271	0.0274	0.0000	0.0000	0.0000	0.5964	0.0003	0.0008	0.5965	0.0004	0.0008	9354
128 $	125.22	22.41	1.5697	114	2	0.0000	0.0000	20.308	0.0152	20.303	0.0180	0.0000	0.0000	0.0000	0.5964	0.0003	0.0008	0.5965	0.0003	0.0008	9366
129 $	125.17	22.43	1.5684	114	0	0.0000	0.0000	20.273	0.0285	20.273	0.0277	0.0000	0.0000	0.0000	0.5965	0.0005	0.0008	0.5964	0.0004	0.0008	9362
130 @	1206.5	23.10	0.2243	136	1	0.0000	0.0000	0.4024	0.0001	0.4030	0.0001	0.0000	0.0000	0.0000	0.6056	0.0030	0.0043	0.6051	0.0029	0.0043	1360
131 @	1206.5	23.11	0.2248	136	0	0.0000	0.0000	0.4041	0.0002	0.4046	0.0002	0.0000	0.0000	0.0000	0.6056	0.0030	0.0043	0.6052	0.0029	0.0043	1364
132 @	1206.5	23.11	0.2260	136	0	0.0000	0.0000	0.4086	0.0004	0.4088	0.0004	0.0000	0.0000	0.0000	0.6056	0.0030	0.0043	0.6054	0.0029	0.0043	1371
133 @	325.22	23.10	0.6054	161	0	0.0000	0.0000	2.9943	0.0099	2.9955	0.0115	0.0000	0.0000	0.0000	0.5992	0.0011	0.0012	0.5990	0.0012	0.0012	3671
134 @	325.22	23.11	0.6059	161	0	0.0000	0.0000	2.9960	0.0131	2.9977	0.0128	0.0000	0.0000	0.0000	0.5994	0.0014	0.0012	0.5993	0.0013	0.0012	3675
135 @	325.08	23.11	0.6058	161	0	0.0000	0.0000	2.9969	0.0114	2.9985	0.0108	0.0000	0.0000	0.0000	0.5992	0.0012	0.0012	0.5991	0.0012	0.0012	3675

[Test Run Date Codes # - 12/09/85 $ - 02/10/87 @ - 02/11/87]

Table 49G. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-7C Diameter 0.3754 Inches, Beta Ratio = 0.09314

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
136 #	125.25	22.80	1.5548	114	0	0.0000	0.0000	19.935	0.0353	19.930	0.0361	0.0000	0.0000	0.0000	0.5963	0.0006	0.0008	0.5964	0.0006	0.0008	9363
137 #	125.28	22.83	1.5554	114	0	0.0000	0.0000	19.934	0.0223	19.933	0.0254	0.0000	0.0000	0.0000	0.5965	0.0004	0.0008	0.5965	0.0004	0.0008	9373
138 #	125.27	22.86	1.5521	114	0	0.0000	0.0000	19.843	0.0343	19.845	0.0413	0.0000	0.0000	0.0000	0.5966	0.0005	0.0008	0.5966	0.0006	0.0008	9360

[Test Run Date Codes # - 02/11/87]

Table 49H. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-8A Diameter 0.2513 Inches, Beta Ratio = 0.06235

Run No.		Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1	#	501.90	24.12	0.4847	148	36	9.972	0.0078	9.970	0.0094	9.970	0.0086	0.5866	0.0006	0.0011	0.5866	0.0003	0.0011	0.5866	0.0003	0.0011	3010
2	#	502.75	24.10	0.4804	148	20	9.927	0.0249	9.926	0.0126	9.922	0.0167	0.5827	0.0009	0.0011	0.5827	0.0004	0.0011	0.5829	0.0005	0.0011	2982
3	#	500.10	23.92	0.4807	152	4	9.897	0.0152	9.894	0.0167	9.894	0.0157	0.5840	0.0007	0.0011	0.5841	0.0005	0.0011	0.5841	0.0005	0.0011	2971
4	#	1206.1	23.87	0.0975	136	6	0.3917	0.0009	0.3917	0.0009	0.3909	0.0009	0.5956	0.0140	0.0047	0.5956	0.0026	0.0047	0.5962	0.0025	0.0047	602
5	#	1206.2	23.94	0.0972	136	5	0.3900	0.0011	0.3898	0.0008	0.3893	0.0008	0.5950	0.0140	0.0047	0.5952	0.0026	0.0047	0.5955	0.0024	0.0047	601
6	#	1206.1	23.97	0.0988	136	0	0.4034	0.0029	0.4032	0.0030	0.4032	0.0030	0.5948	0.0137	0.0045	0.5949	0.0033	0.0046	0.5949	0.0032	0.0045	611
7	#	1206.1	24.01	0.1553	136	0	1.0047	0.0018	1.0030	0.0018	1.0048	0.0017	0.5923	0.0054	0.0024	0.5928	0.0011	0.0024	0.5923	0.0010	0.0024	962
8	#	1206.2	24.15	0.1555	136	1	1.0068	0.0030	1.0055	0.0028	1.0072	0.0028	0.5923	0.0055	0.0024	0.5926	0.0013	0.0024	0.5921	0.0012	0.0024	966
9	#	1206.3	24.28	0.1561	136	0	1.0145	0.0033	1.0133	0.0034	1.0148	0.0033	0.5923	0.0054	0.0024	0.5926	0.0014	0.0024	0.5922	0.0013	0.0024	973
10	#	802.43	24.25	0.2711	142	0	3.1021	0.0090	3.1004	0.0087	3.1011	0.0084	0.5883	0.0019	0.0015	0.5884	0.0009	0.0015	0.5884	0.0009	0.0015	1689
11	#	801.56	24.24	0.2697	142	1	3.0686	0.0080	3.0665	0.0112	3.0678	0.0107	0.5884	0.0019	0.0015	0.5886	0.0011	0.0015	0.5885	0.0011	0.0015	1679
12	#	801.72	24.12	0.2703	142	0	3.0812	0.0076	3.0808	0.0078	3.0809	0.0078	0.5886	0.0019	0.0015	0.5886	0.0008	0.0015	0.5886	0.0008	0.0015	1679
13	$	499.93	23.24	0.4834	148	2	9.992	0.0463	9.994	0.0485	9.995	0.0510	0.5845	0.0014	0.0011	0.5844	0.0014	0.0011	0.5844	0.0015	0.0011	2941
14	$	500.83	23.25	0.4845	147	1	10.022	0.0234	10.013	0.0252	10.018	0.0301	0.5849	0.0007	0.0011	0.5852	0.0007	0.0011	0.5851	0.0009	0.0011	2949
15	$	502.32	23.37	0.4844	148	3	10.040	0.0169	10.050	0.0133	10.041	0.0180	0.5842	0.0005	0.0011	0.5839	0.0004	0.0011	0.5842	0.0005	0.0011	2956
16	$	802.04	23.30	0.2704	142	1	3.0904	0.0154	3.0917	0.0142	3.0914	0.0138	0.5880	0.0015	0.0015	0.5879	0.0014	0.0015	0.5879	0.0014	0.0015	1647
17	$	802.20	23.33	0.2643	142	3	2.9680	0.0074	2.9676	0.0084	2.9689	0.0091	0.5864	0.0008	0.0015	0.5864	0.0009	0.0015	0.5863	0.0010	0.0015	1611
18	$	802.76	23.37	0.2646	142	4	2.9727	0.0094	2.9692	0.0091	2.9684	0.0126	0.5867	0.0010	0.0015	0.5870	0.0010	0.0015	0.5871	0.0013	0.0015	1615
19	$	1206.5	23.47	0.1006	136	1	0.4183	0.0011	0.4175	0.0011	0.4168	0.0011	0.5947	0.0027	0.0044	0.5952	0.0025	0.0044	0.5957	0.0025	0.0044	615
20	$	1206.0	23.59	0.0992	136	4	0.4103	0.0013	0.4093	0.0014	0.4100	0.0012	0.5924	0.0028	0.0045	0.5931	0.0026	0.0045	0.5926	0.0025	0.0045	609
21	$	1206.0	23.66	0.0992	136	3	0.4076	0.0010	0.4066	0.0008	0.4067	0.0008	0.5941	0.0027	0.0045	0.5948	0.0025	0.0045	0.5947	0.0025	0.0045	609
22	$	1206.1	23.65	0.1586	136	1	1.0504	0.0018	1.0487	0.0019	1.0499	0.0018	0.5916	0.0011	0.0024	0.5921	0.0011	0.0024	0.5917	0.0011	0.0024	974
23	$	1206.2	23.75	0.1579	136	1	1.0414	0.0019	1.0401	0.0020	1.0413	0.0020	0.5916	0.0012	0.0024	0.5920	0.0011	0.0024	0.5916	0.0011	0.0024	972
24	$	1206.3	24.00	0.1576	136	2	1.0335	0.0024	1.0316	0.0026	1.0337	0.0028	0.5925	0.0012	0.0024	0.5930	0.0012	0.0024	0.5924	0.0012	0.0024	976
25	@	502.28	11.56	0.4889	148	1	10.100	0.0135	10.100	0.0129	10.171	0.0125	0.5875	0.0004	0.0011	0.5875	0.0004	0.0011	0.5854	0.0004	0.0011	2206
26	@	502.38	11.40	0.4878	148	8	10.070	0.0081	10.069	0.0099	10.138	0.0081	0.5871	0.0003	0.0011	0.5871	0.0003	0.0011	0.5851	0.0003	0.0011	2191
27	@	500.87	11.14	0.4878	147	1	10.036	0.0064	10.036	0.0070	10.128	0.0075	0.5881	0.0002	0.0011	0.5881	0.0002	0.0011	0.5854	0.0003	0.0011	2175
28	@	802.84	11.58	0.2692	142	6	3.0500	0.0024	3.0506	0.0024	3.0505	0.0025	0.5888	0.0004	0.0015	0.5887	0.0004	0.0015	0.5887	0.0004	0.0015	1215
29	@	801.74	11.83	0.2693	142	6	3.0568	0.0016	3.0568	0.0019	3.0552	0.0017	0.5884	0.0004	0.0015	0.5884	0.0004	0.0015	0.5885	0.0004	0.0015	1224
30	@	801.74	11.95	0.2695	142	6	3.0618	0.0022	3.0634	0.0029	3.0620	0.0026	0.5882	0.0004	0.0015	0.5881	0.0004	0.0015	0.5882	0.0004	0.0015	1229

[Test Run Date Codes # - 09/25/85 $ - 09/26/85 @ - 12/10/85]

Table 49H. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-8A Diameter 0.2513 Inches, Beta Ratio = 0.06235

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD.	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
31 #	1206.1	12.70	0.1581	136	2	1.0388	0.0013	1.0392	0.0013	1.0390	0.0011	0.5924	0.0011	0.0024	0.5923	0.0011	0.0024	0.5923	0.0010	0.0024	736
32 #	1206.2	13.32	0.1577	136	8	1.0362	0.0009	1.0365	0.0009	1.0364	0.0009	0.5920	0.0011	0.0024	0.5919	0.0010	0.0024	0.5919	0.0010	0.0024	747
33 #	1205.9	13.58	0.1581	136	6	1.0406	0.0009	1.0409	0.0008	1.0407	0.0008	0.5922	0.0010	0.0024	0.5921	0.0010	0.0024	0.5922	0.0010	0.0024	754
34 #	1206.1	13.96	0.1023	136	3	0.4308	0.0007	0.4315	0.0005	0.4312	0.0004	0.5956	0.0025	0.0043	0.5951	0.0024	0.0043	0.5953	0.0023	0.0043	493
35 #	1206.3	14.59	0.1027	136	6	0.4337	0.0004	0.4344	0.0003	0.4341	0.0004	0.5956	0.0024	0.0043	0.5951	0.0024	0.0043	0.5953	0.0022	0.0043	503
36 #	1206.0	15.02	0.1030	136	0	0.4371	0.0008	0.4379	0.0007	0.4377	0.0007	0.5951	0.0025	0.0043	0.5945	0.0024	0.0043	0.5946	0.0023	0.0043	511
37 $	802.43	7.98	0.2747	142	1	3.1706	0.0034	3.1672	0.0040	3.1664	0.0035	0.5893	0.0005	0.0014	0.5896	0.0005	0.0014	0.5897	0.0005	0.0014	1118
38 $	803.77	8.15	0.2752	142	5	3.1915	0.0035	3.1863	0.0027	3.1867	0.0027	0.5884	0.0005	0.0014	0.5889	0.0004	0.0014	0.5889	0.0004	0.0014	1125
39 $	801.83	8.24	0.2750	142	10	3.2024	0.0032	3.1965	0.0037	3.1952	0.0043	0.5869	0.0005	0.0014	0.5874	0.0005	0.0014	0.5876	0.0005	0.0014	1128
40 $	1206.1	9.04	0.1573	136	11	1.0297	0.0009	1.0276	0.0010	1.0283	0.0011	0.5922	0.0011	0.0024	0.5928	0.0009	0.0024	0.5926	0.0010	0.0024	660
41 $	1205.9	9.79	0.1549	136	0	0.9966	0.0014	0.9943	0.0011	0.9951	0.0011	0.5926	0.0012	0.0024	0.5933	0.0010	0.0024	0.5931	0.0010	0.0024	665
42 $	1206.1	10.15	0.1541	136	7	0.9871	0.0014	0.9852	0.0012	0.9857	0.0011	0.5926	0.0012	0.0024	0.5931	0.0010	0.0025	0.5930	0.0010	0.0024	668
43 $	1206.1	11.33	0.0999	136	9	0.4106	0.0007	0.4091	0.0006	0.4101	0.0005	0.5953	0.0027	0.0045	0.5964	0.0022	0.0045	0.5957	0.0024	0.0045	448
44 $	1206.0	11.89	0.0994	136	5	0.4064	0.0006	0.4048	0.0008	0.4059	0.0007	0.5958	0.0027	0.0045	0.5969	0.0023	0.0046	0.5962	0.0025	0.0045	453
45 $	1206.1	12.23	0.0993	136	6	0.4047	0.0004	0.4033	0.0003	0.4045	0.0003	0.5961	0.0027	0.0045	0.5971	0.0022	0.0046	0.5962	0.0024	0.0045	457
46 $	501.89	11.24	0.4845	148	4	9.996	0.0120	9.993	0.0105	9.994	0.0113	0.5853	0.0004	0.0011	0.5854	0.0003	0.0011	0.5853	0.0004	0.0011	2167
47 $	502.22	10.92	0.4838	147	3	9.962	0.0082	9.959	0.0100	9.960	0.0103	0.5854	0.0003	0.0011	0.5855	0.0003	0.0011	0.5855	0.0003	0.0011	2144
48 $	503.33	10.32	0.4840	147	0	9.968	0.0125	9.965	0.0123	9.965	0.0121	0.5855	0.0004	0.0011	0.5856	0.0004	0.0011	0.5855	0.0004	0.0011	2109

[Test Run Date Codes # - 12/10/85 $ - 12/30/85]

Table 491. Orifice Discharge Coefficient Values - Meter Tube DAN-4SS

Meter Tube DAN-4SS Diameter 4.0306 Inches -- Orifice Plate FE-5/6-8B Diameter 0.2476 Inches, Beta Ratio = 0.06143

Run No.	Div. Time (sec.)	Flow Temp. (Deg.C)	Flow Rate (lb/s)	Number Obs.	Number Rej.	Differential Pressure (psid) Ruska Mean	Ruska SD	Upper Mean	Upper SD	Lower Mean	Lower SD	Discharge Coefficients Ruska CD	Ruska Rand.	Ruska Syst.	Upper CD	Upper Rand.	Upper Syst.	Lower CD	Lower Rand.	Lower Syst.	Reynolds Number
1 #	500.73	16.29	0.4930	148	0	9.804	0.0125	9.801	0.0116	9.802	0.0118	0.6196	0.0004	0.0012	0.6197	0.0004	0.0012	0.6197	0.0004	0.0012	2527
2 #	499.74	16.19	0.4805	146	1	9.3355	0.0679	9.3399	0.0723	9.3350	0.0731	0.6190	0.0023	0.0012	0.6189	0.0024	0.0012	0.6190	0.0024	0.0012	2457
3 #	502.80	16.17	0.4813	147	1	9.3748	0.0757	9.3539	0.0787	9.3675	0.0675	0.6187	0.0025	0.0012	0.6194	0.0026	0.0012	0.6189	0.0022	0.0012	2460
4 #	801.63	16.42	0.2757	142	1	3.0307	0.0047	3.0314	0.0048	3.0286	0.0052	0.6232	0.0006	0.0016	0.6231	0.0006	0.0016	0.6234	0.0007	0.0016	1418
5 #	801.81	16.63	0.2726	142	3	2.9638	0.0046	2.9617	0.0051	2.9641	0.0050	0.6230	0.0006	0.0016	0.6233	0.0007	0.0016	0.6230	0.0007	0.0016	1410
6 #	801.91	16.70	0.2692	142	6	2.8942	0.0043	2.8924	0.0037	2.8925	0.0043	0.6226	0.0006	0.0016	0.6228	0.0006	0.0016	0.6228	0.0006	0.0016	1395
7 #	1206.1	17.23	0.1080	136	24	0.4572	0.0005	0.4589	0.0006	0.4557	0.0007	0.6286	0.0026	0.0044	0.6275	0.0024	0.0044	0.6297	0.0024	0.0044	567
8 #	1206.0	17.56	0.1083	136	11	0.4590	0.0009	0.4604	0.0007	0.4576	0.0006	0.6293	0.0026	0.0044	0.6283	0.0024	0.0044	0.6303	0.0024	0.0044	574
9 #	1206.1	17.80	0.1067	136	21	0.4457	0.0011	0.4473	0.0009	0.4456	0.0010	0.6292	0.0027	0.0045	0.6281	0.0025	0.0045	0.6293	0.0025	0.0045	569
10 #	1206.1	18.04	0.1628	136	3	1.0465	0.0012	1.0471	0.0012	1.0456	0.0008	0.6263	0.0012	0.0025	0.6261	0.0011	0.0025	0.6265	0.0011	0.0025	873
11 #	1206.1	18.18	0.1627	136	12	1.0466	0.0014	1.0466	0.0014	1.0465	0.0013	0.6261	0.0012	0.0025	0.6260	0.0011	0.0025	0.6261	0.0011	0.0025	875
12 #	1206.2	18.27	0.1625	136	6	1.0439	0.0012	1.0440	0.0011	1.0430	0.0011	0.6261	0.0012	0.0025	0.6261	0.0011	0.0025	0.6264	0.0011	0.0025	876

[Test Run Date Codes # - 11/13/85]

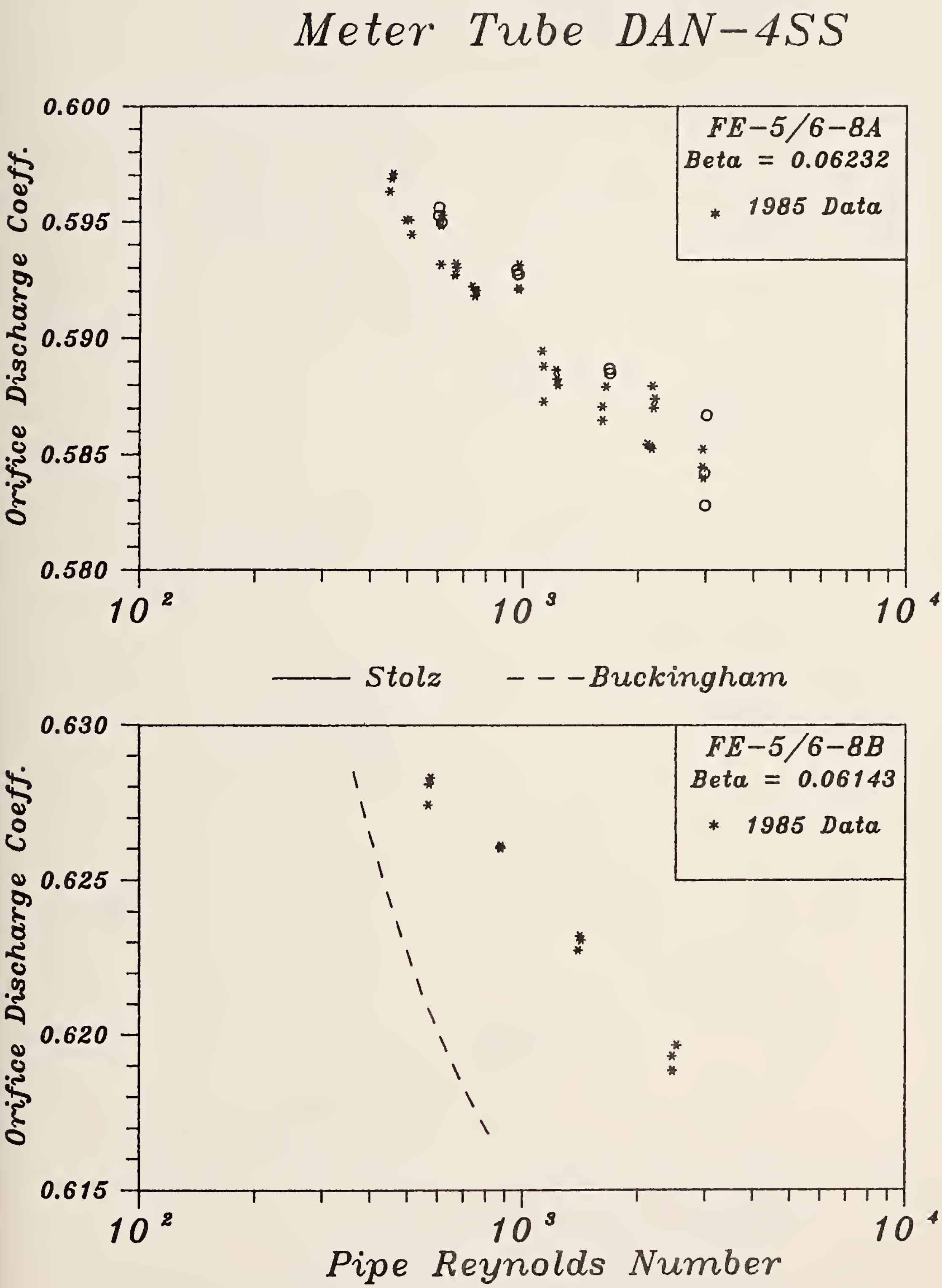


Figure 35A. Discharge Coefficient/Reynolds Number Plots, DAN-4SS 4-Inch, Stainless Steel Meter Tube, 8 Orifice Plates, Final Data Base

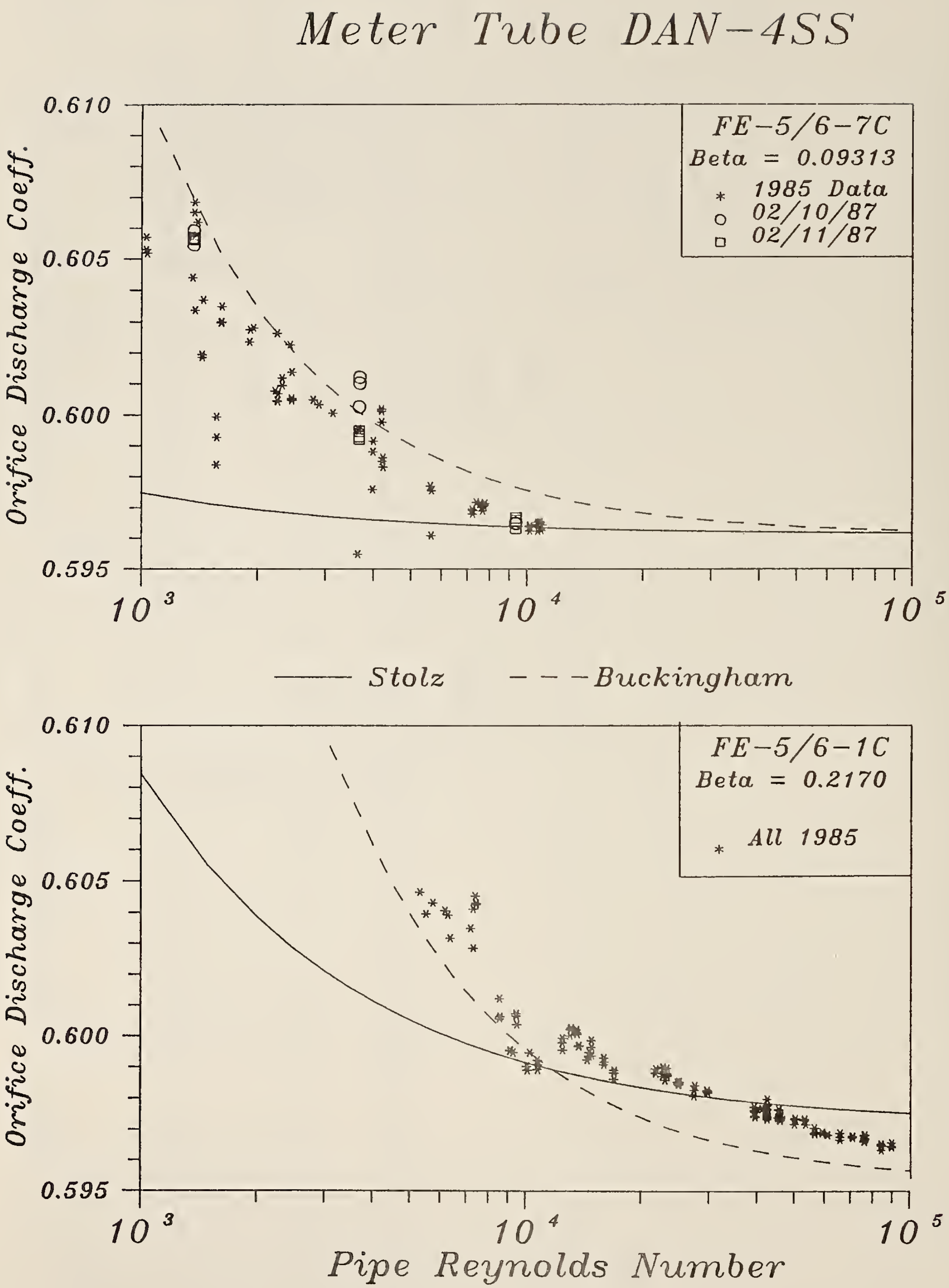


Figure 35B. Discharge Coefficient/Reynolds Number Plots, DAN-4SS 4-Inch, Stainless Steel Meter Tube, 8 Orifice Plates, Final Data Base

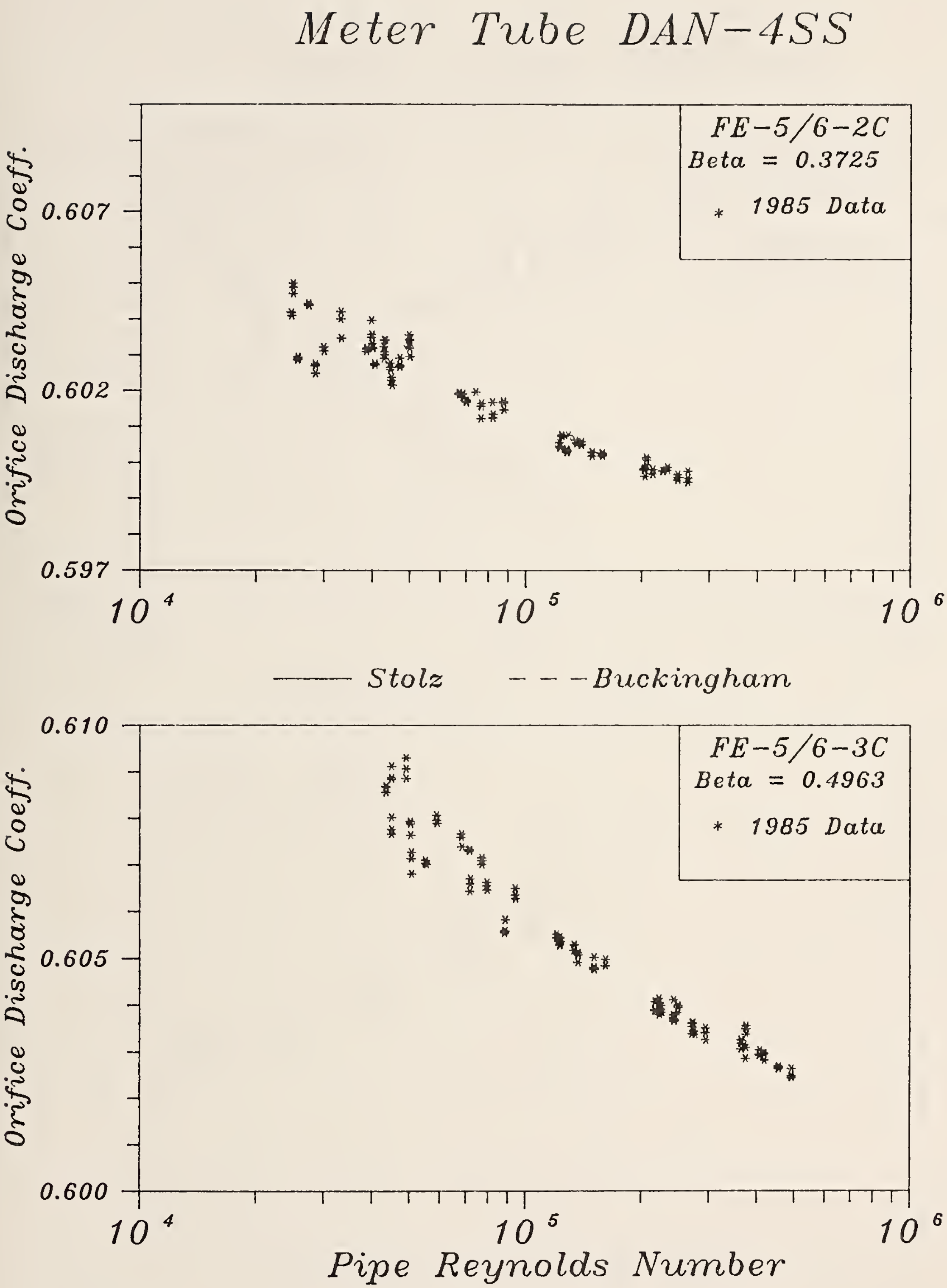


Figure 35C. Discharge Coefficient/Reynolds Number Plots, DAN-4SS 4-Inch, Stainless Steel Meter Tube, 8 Orifice Plates, Final Data Base

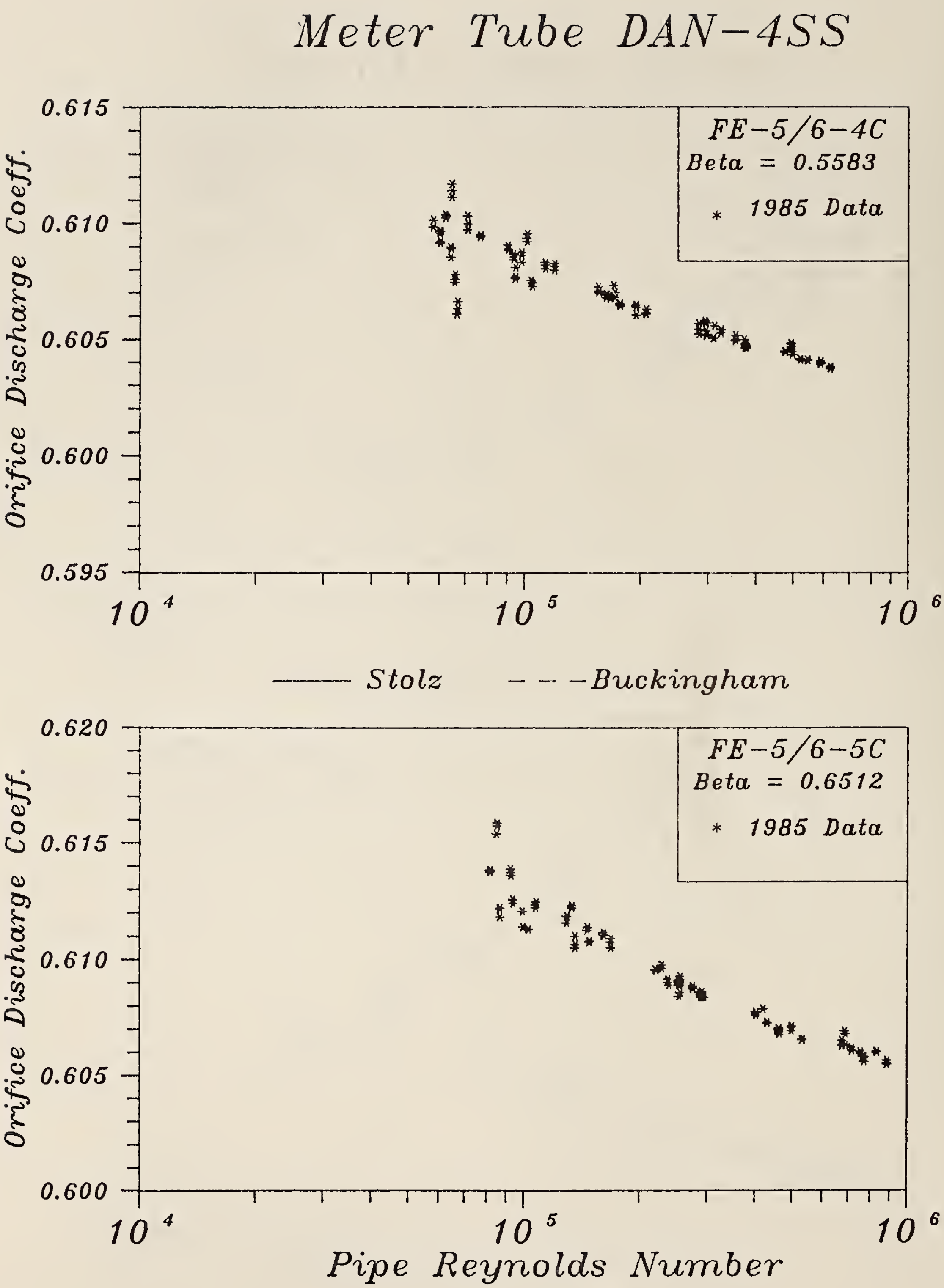


Figure 35D. Discharge Coefficient/Reynolds Number Plots, DAN-4SS 4-Inch, Stainless Steel Meter Tube, 8 Orifice Plates, Final Data Base

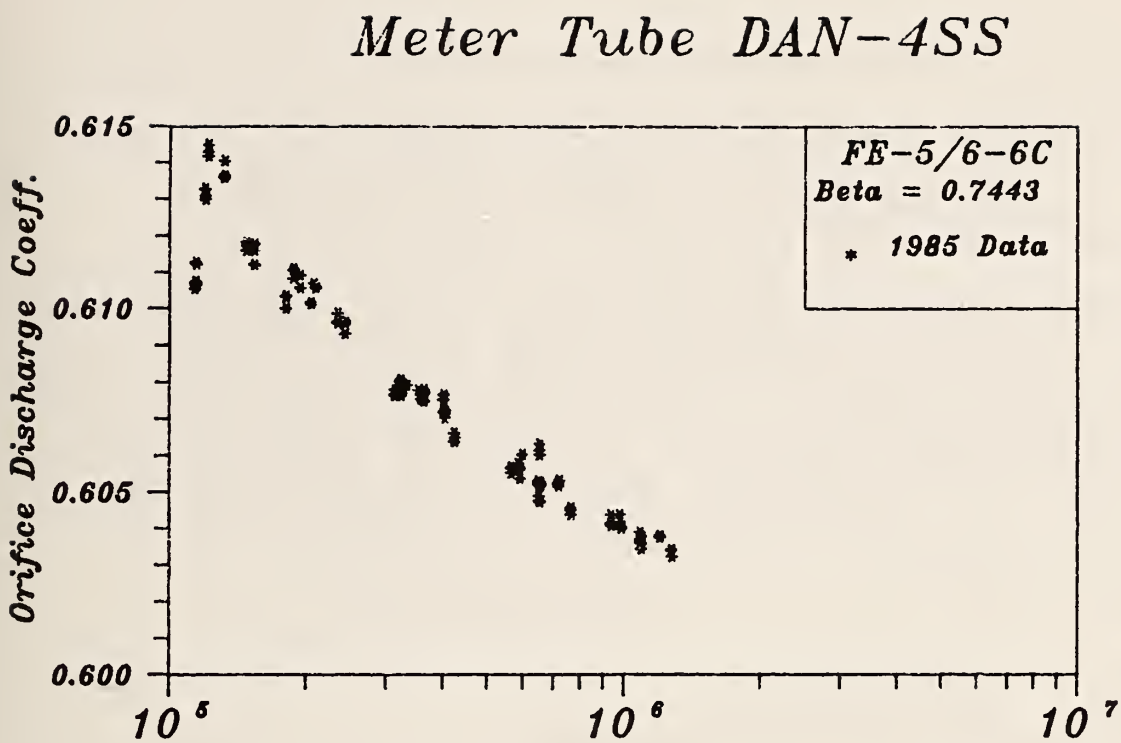


Figure 35E. Discharge Coefficient/Reynolds Number Plots, DAN-4SS 4-Inch, Stainless Steel Meter Tube, 8 Orifice Plates, Final Data Base

D. Statistical Analysis of the Final Data Base

Statistical Analysis of Data Collected in 1985 and 1986

A statistical analysis of the results obtained from the test run data has been performed to develop the statement of uncertainty in the measurements and to document and review the procedures leading to this statement. In the course of the analysis, the data base relating the dimensionless quantity, discharge coefficient, to pipe Reynolds number for the final data base is examined for abnormal flow conditions and outliers. Plate and pipe designations are shown in table 50 in two groupings by type of pump used. Since the effects of pump type (capacity) were evident in the results for specific condition ranges, an analysis of the results taken from the final data base was made. Table 50 segregates the orifice plates run in each meter tube into two general groups. The large pump column contains plates which were run using the 1000- and/or 3000-gpm pumps, either singly or in combination. Similarly, the small pump column lists plots for which the 20- and 100-gpm pumps were used. The following designations are used,

Pump A - 20-gpm capacity pump
Pump B - 100-gpm capacity pump
Pump C - 1000- or 3000-gpm capacity pump

Table 50. Meter Tube and Plate Configurations

Pipe ID	Steel type	Pipe diameter	Plates: Small Pumps	Plates: Large Pumps
PE-1	Plated	2"	1A, 2A, 7A	3A, 4A, 5A, 6A
PE-2	Plated	2"	1B, 2B, 7B	3B, 4B, 5B, 6B
PE-3	Plated	3"	1B 2B, 7B, 8B	3B, 4B, 5B, 6B
PE-4	Plated	3"	1A, 2A, 7A, 8A	3A, 4A, 5A, 6A
PE-5	Plated	4"	1B, 2B, 2C, 7B, 8B	3B, 4B, 5B, 6B
PE-6	Plated	4"	1C, 2C, 7C, 8A	3C, 4C, 5C, 6C
PE-7	Plated	6"	1C, 2B, 8B	3C, 4B, 5B, 6B
PE-8	Plated	6"	2A, 7A, 8A	3A, 4A, 5C, 6A
PE-9	Plated	10"	1B, 2B, 7B	3B, 4B, 5B, 6B
PE-0	Plated	10"	1A, 2A, 7A	3A, 4A, 5A, 6A
DAN	Stainless	4"	1C, 2C, 7C, 8A, 8B	3C, 4C, 5C, 6C

The following notation describes the data base for a single orifice plate/meter tube combination.

y_{ijk} - discharge coefficient from the upper Paros transducer

z_{ijk} - discharge coefficient from the lower Paros transducer

r_{ijk} - natural logarithm of the pipe Reynolds number

where the index j (j=1,...,3) refers to run number,
the index i (i=1,...,n) refers to repetition, and
the index k (k=1,...,5) refers to nominal differential pressures of 0.4, 1, 3, 10, and 27 psid respectively.

The data base was subjected to an initial screening based on the mean differential pressure values for the top and bottom orifice meter taps. These values are expected to agree within the random error of the measurement system. Thus, a large difference between the two discharge coefficients computed from upper and lower transducer mean values is indicative of abnormal flow conditions. In preliminary experiments on the 4-inch, stainless steel meter tube, control limits of $\pm$ 0.002 were established for differences of that type. Differences

$$d_{ijk} = y_{ijk} - z_{ijk} \qquad \begin{array}{l} i = 1,\ldots,n \\ j = 1,\ldots,3 \\ k = 1,\ldots,5 \end{array}$$

were computed for all data from the API experiment, and the control limits of $\pm$ 0.002 were verified for data taken with the large pump. For the two smaller pumps, tighter control limits of $\pm$ 0.0015 proved to be more appropriate. Consequently, the following statistical control procedure was implemented. Where

$$d_{ijk} < -0.0020 \quad \text{or} \quad d_{ijk} > 0.0020 \text{ for pump C}$$

or

$$d_{ijk} < -0.0015 \quad \text{or} \quad d_{ijk} > 0.0015 \text{ for pumps A \& B}$$

the run was flagged as being out-of-control and subsequently was excluded in any further analysis of the data base. In most cases where all three runs at a single flow rate were out-of-control, reruns at a later date completed the data base. Data taken on August 1, 1985 for plate 6A on meter tube PE-1ABC were considered to be outlying because 9 of the 15 runs for that day were out-of-control based on the criterion cited above and because the other 6 runs were very close to being out-of-control.

Based on analyses of the test run results from the orifice plate set used with the 4-inch, stainless steel meter tube, it is assumed that the discharge coefficients are influenced by random errors of two types: i.e., short-term random errors which account for differences among runs and long term random errors which account for differences among repetitions. Where the same pipe Reynolds number can be achieved from run to run for each nominal differential pressure or equivalently for each nominal flow rate, the resulting discharge coefficients can be compared directly using an analysis of variance technique. This technique allows estimation of the components of variance of the measurement process at each nominal differential pressure from the model

$$y_{ijk} = \mu_k + \gamma_{ik} + \epsilon_{ijk} \qquad \begin{matrix} i=1,\ldots,n \\ j=1,\ldots,3 \\ k=1,\ldots,5 \end{matrix} \qquad (47)$$

where for a particular differential pressure, μ_k is a constant to be determined; the ϵ_{ijk} are short-term random errors; and the γ_{ik} are long-term random errors. It is assumed that the ϵ_{ijk} are independent and identically distributed with mean zero and standard deviation s_w that depends on the differential pressure; that the γ_{ik} are independent and identically distributed with mean zero and standard deviation s_b that depends on differential pressure and that ϵ_{ijk} and γ_{ik} are mutually independent. Examples of the standard deviations from a one-way analysis of variance are shown in table 51 for two cases utilizing differing pump sources. The number of degrees of freedom, ν, associated with the within-group standard deviation for a given nominal flow rate are also shown. (All analyses are performed on upper quartz oscillator-type transducer data with the lower quartz oscillator-type data being used for control purposes. Quartz bourdon tube-type transducer data are not analyzed.)

Table 51. Within and Between Standard Deviations from One-Way Analysis of Variance

Pipe ID	Plate ID	Nominal Diff. Press.	Within SD s_w	DF ν	Between SD s_b	Repetitions n
PUMP C in OPERATION						
PE-0	4A	0.4	0.000264	13	.000758	4
		1.0	0.000278	8	.000413	4
		3.0	0.000286	14	.000225	4
		10.0	0.000076	6	.000103	3
		27.0	0.000077	6	.000110	3
PUMP B in OPERATION						
PE-2	1B	0.4	0.001120	7	0.000782	2
		1.0	0.000548	7	0.000391	2
		3.0	0.000159	6	0.000307	2
		10.0	0.000055	4	0.000074	2
		27.0	0.000065	4	0.000086	2

In general, it is not possible to obtain estimates of the variance components in this manner because even at the same nominal flow rate, the pipe Reynolds number is not always repeated from repetition to repetition because of fluctuations in water temperature or other system changes. Typically, the pipe Reynolds numbers, r_{ijk}, are spread across a regime as shown in the previous figures of discharge coefficient vs. Reynolds number. Thus, the discharge coefficients cannot be compared from repetition to repetition without imposing a model which describes the functional relationship between discharge coefficient and pipe Reynolds number. The following quadratic model is used to describe the data on a single meter tube/plate configuration:

$$y_{ijk} = A + B\, r_{ijk} + C\, r_{ijk}^2 + \gamma_{ik} + \epsilon_{ijk} \qquad \begin{matrix} i=1,\ldots,n \\ j=1,\ldots,3 \\ k=1,\ldots,5 \end{matrix} \tag{48}$$

where A, B, and C are unknown parameters to be determined, and the other quantities are as previously defined.

The data will not satisfy the statistical requirement for independence in the measurements if the long-term random errors γ_{ik} are large compared to the short-term random errors ϵ_{ijk}. Therefore, we compute averages of the three runs for the discharge coefficients and Reynolds numbers, thereby reducing the model to

$$y_{i.k} = A + B\, r_{i.k} + C\, r_{i.k}^2 + \gamma_{ik} + \epsilon_{i.k} \qquad \begin{matrix} i=1,\ldots,n \\ k=1,\ldots,5 \end{matrix} \tag{49}$$

where the dot (.) in the subscript signifies an average over three runs at a given flow rate. Then the random error term, $\gamma_{ik} + \epsilon_{i.k}$, which is associated with an average discharge coefficient can be assumed to come from a distribution with mean zero and standard deviation s_t. The quantity s_t depends on the differential pressure and is functionally of the form

$$s_t = (s_b^2 + \frac{1}{3} s_w^2)^{1/2}. \tag{50}$$

The assertion that the random errors do not come from a single distribution but, rather, from distributions whose standard deviations depend upon differential pressure can be verified from the data. For example, see figure 25A, where the spread in the discharge coefficients is much larger at low Reynolds numbers than at high Reynolds numbers. In the presence of heterogeneous variance, as in this case, a weighted least-squares analysis can be used in conjunction with the model of eq (49). The most successful analysis, from the point of view of simplicity and effectiveness, assumes that the variation among discharge coefficients, for a given differential pressure, is inversely related to differential pressure. Specifically, we impose weights in such a way that the residual standard deviation from the least-squares fit is the proper estimate of s_t for discharge coefficients at a differential pressure of 27 psi.

Then the standard deviation $s_{\Delta P}$ at a specific differential pressure, ΔP, can be computed by

$$s_{\Delta P} = s_t \, (27/\Delta P)^{1/2} \tag{51}$$

where s_t is the residual standard deviation from the weighted least-squares fit. The quantity $s_{\Delta P}$ correctly estimates the standard deviation of an average discharge coefficient at ΔP and is functionally of form (50).

Weighted least-squares analyses were performed for all plate/meter tube combinations, and the standardized residuals were examined graphically for randomness and independence in order to judge model appropriateness. The standardized residual is a normalized difference between a discharge coefficient and its corresponding value from the fitted curve [26]. The examples in figures 36A-D show standardized residuals plotted versus the pipe Reynolds number for all plates run in the DAN-4SS meter tube except plate 8B which had observations at only four flow rate settings.

In the analysis of the discharge coefficient/pipe Reynolds number data, any single point which was obviously not consonant with the other data was considered an outlier. Any average discharge coefficient which was far removed from the fitted curve was identified via its standardized residual. The standardized residual is distributed approximately as a Student's t statistic. Therefore,

a standardized residual < -3 or a standardized residual > 3

is indicative of an outlier. Whenever an outlying discharge coefficient was discovered, it was deleted from the data base and the analysis was repeated to obtain a more representative estimate of the standard deviation.

Table 52 lists the test runs deleted from the data base either because of abnormal flow conditions recorded at the upper and lower taps on the orifice plate or because of outlying discharge coefficients as discussed in the previous paragraph or in graphical analysis of the results.

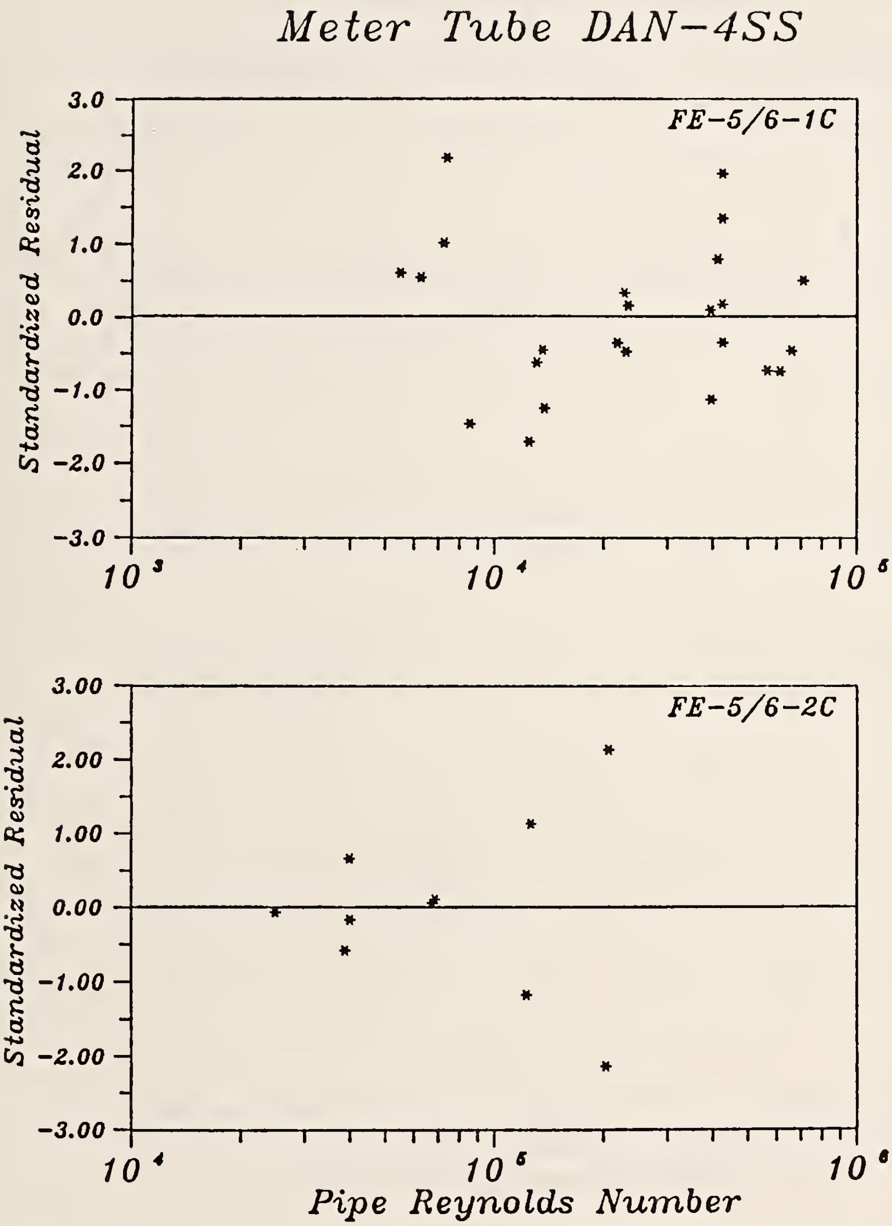


Figure 36A. Standardized Residuals vs. Pipe Reynolds Number for DAN-4SS, 8 Orifice Plates

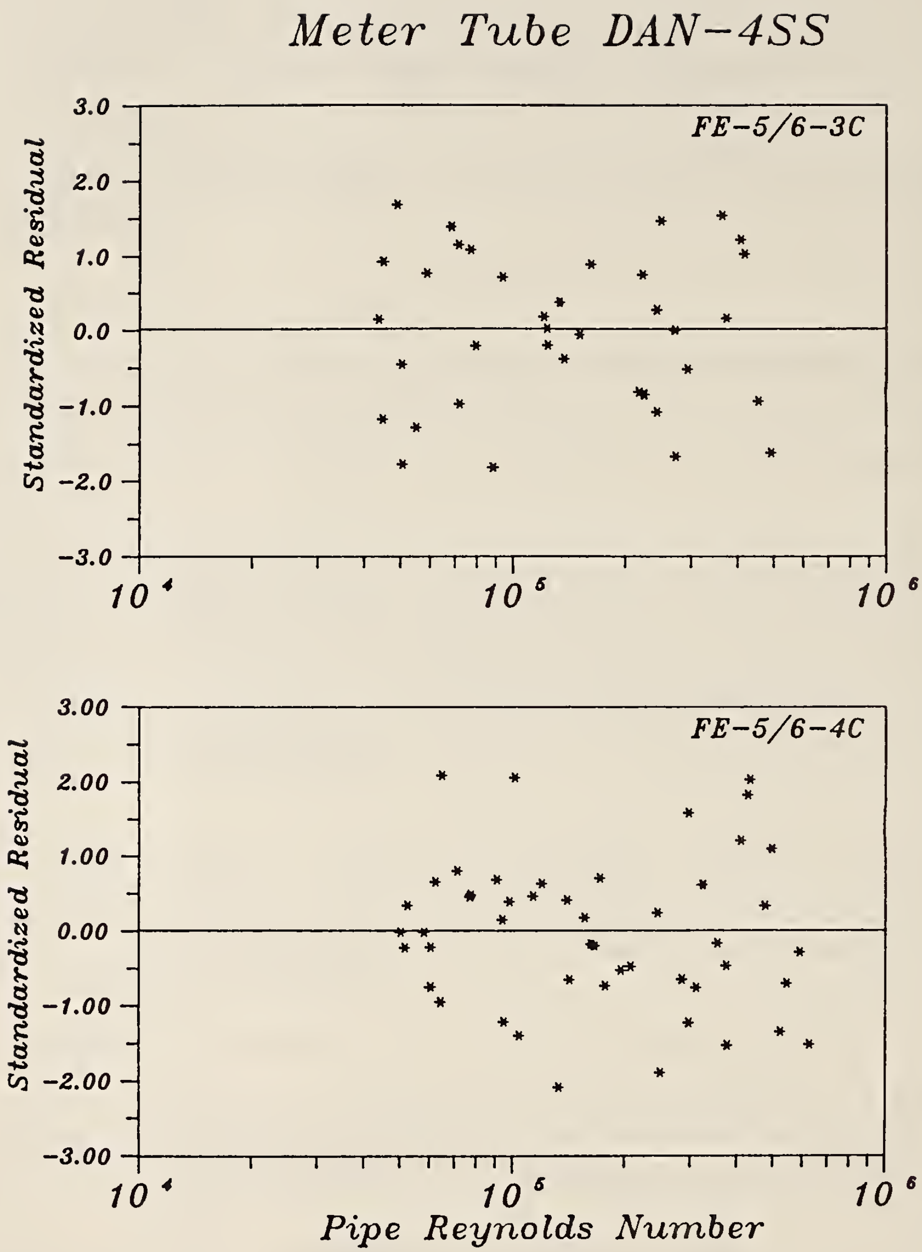


Figure 36B. Standardized Residuals vs. Pipe Reynolds Number for DAN-4SS, 8 Orifice Plates

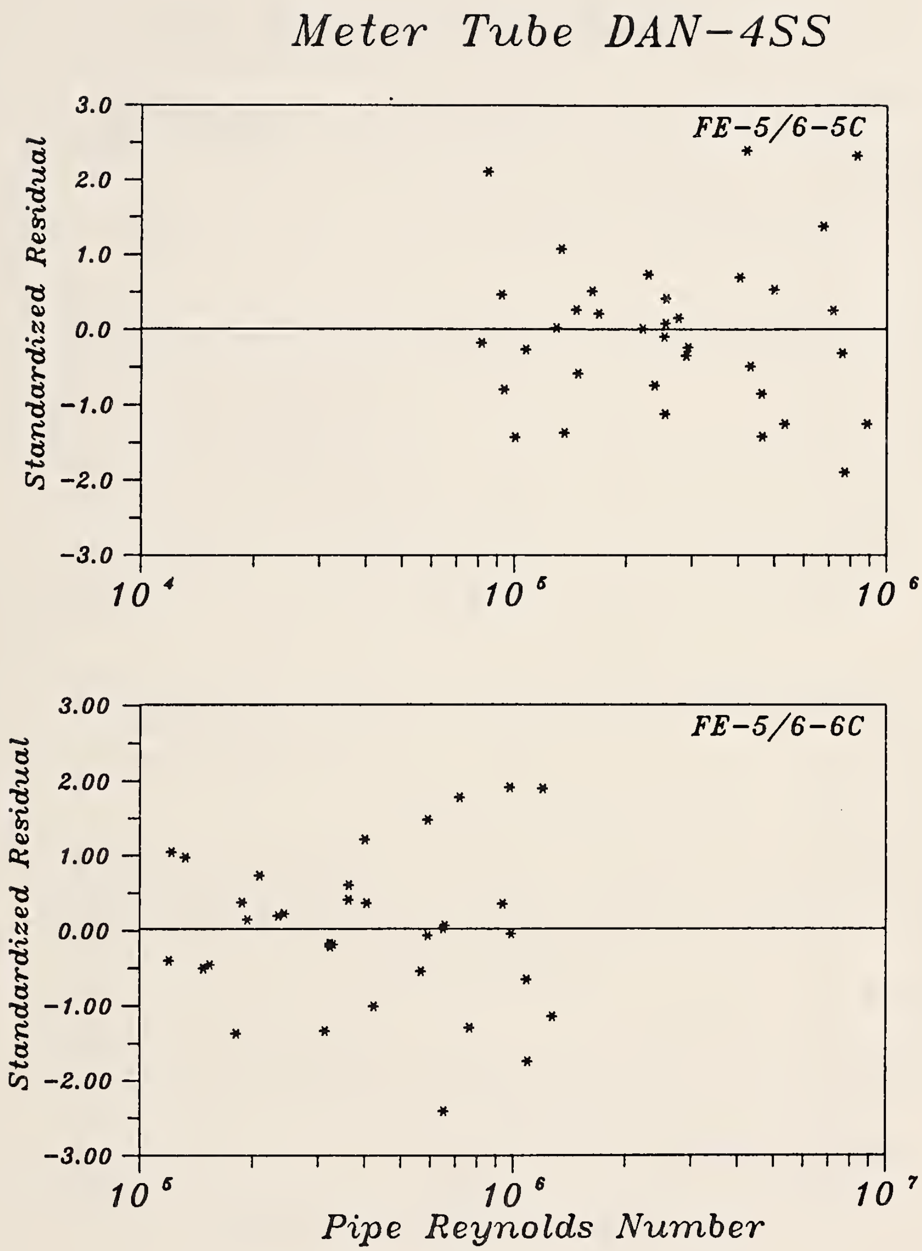


Figure 36C. Standardized Residuals vs. Pipe Reynolds Number for DAN-4SS, 8 Orifice Plates

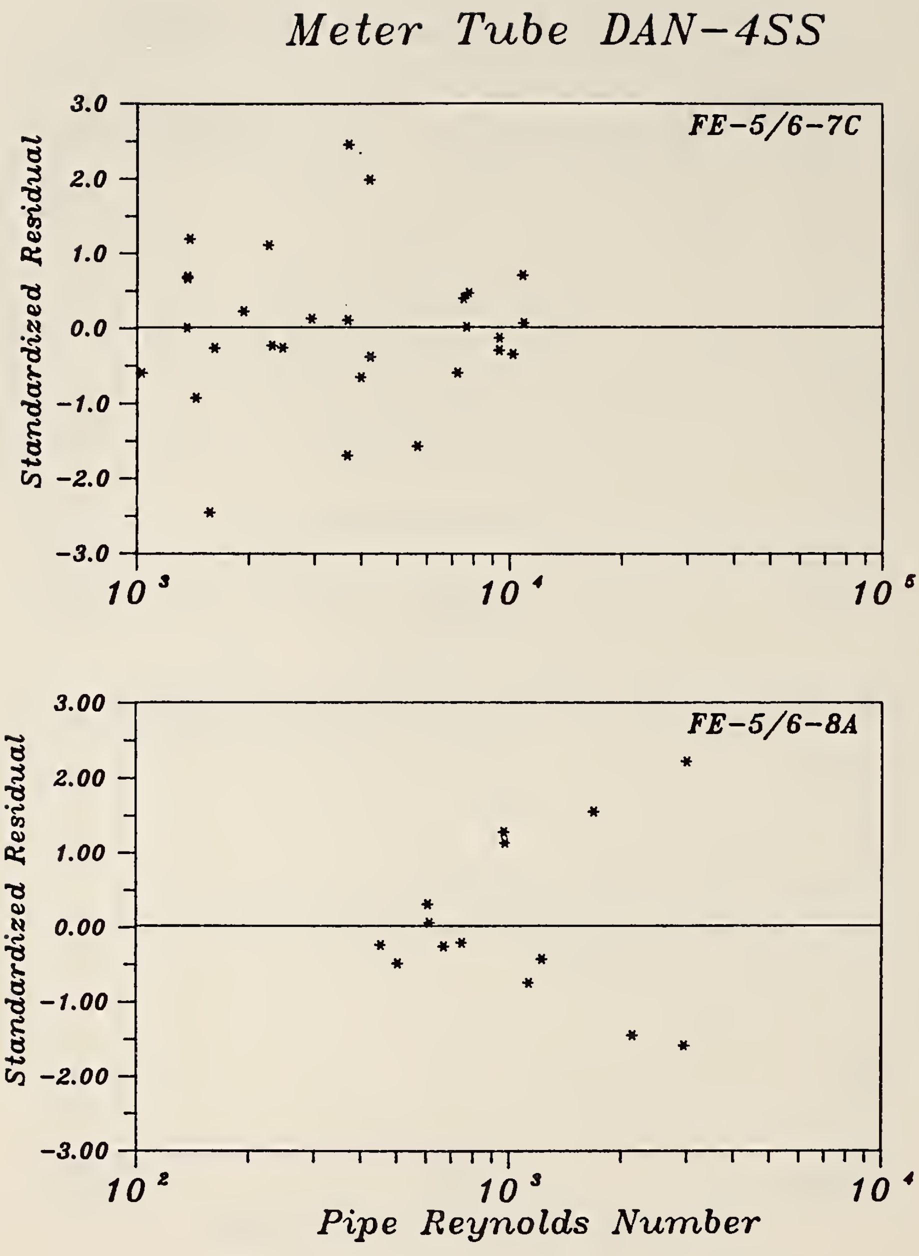


Figure 36D. Standardized Residuals vs. Pipe Reynolds Number for DAN-4SS, 8 Orifice Plates

Table 52. Tabulation of Test Runs Marked as Outliers

Outlier Identification Criteria

2 -- Absolute value of the standardized residuals to the model eq (49) greater than 3,

3 -- Abnormal flow conditions, and

4 -- Entire day(s) out-of-control

5 -- Obvious outlier from graphical analysis.

Meter Tube	Orifice Plate	Date	-- Test Runs -- Begin	End	Total	Criterion
PE-1ABC	FE-1/2-1A	09/03/85	32	32	1	3
	FE-1/2-5A	01/07/86	47	47	1	3
	FE-1/2-5A	01/07/86	53	55	3	3
	FE-1/2-6A	07/29/85	13	13	1	3
	FE-1/2-6A	07/29/85	15	15	1	3
	FE-1/2-6A	08/07/85	16	30	15	4
	FE-1/2-7A	09/04/85	60	60	1	3
			Total Outliers		23	
PE-2ABC	FE-1/2-6B	08/09/85	19	21	3	3
			Total Outliers		3	
PE-3ABC	FE-3/4-2B	09/11/85	39	39	1	3
			Total Outliers		1	
PE-4ABC	FE-3/4-6A	09/05/85	31	32	2	4
			Total Outliers		2	
PE-5ABC	FE-5/6-1B	10/15/85	20	20	1	3
	FE-5/6-4B	10/16/85	34	34	1	3
	FE-5/6-5B	10/17/85	21	21	1	3
	FE-5/6-6B	10/10/85	29	31	3	3
			Total Outliers		6	
PE-6ABC	FE-5/6-3C	06/26/85	6	6	1	3
	FE-5/6-6C	06/26/85	19	21	3	3
			Total Outliers		4	

Table 52 . Tabulation of Test Runs Marked as Outliers -- Continued

Outlier Identification Criteria

2 -- Absolute value of the standardized residuals to the model eq (49) greater than 3,
3 -- Abnormal flow conditions, and
4 -- Entire day(s) out-of-control
5 -- Obvious outlier from graphical analysis.

Meter Tube	Orifice Plate	Date	-- Test Runs -- Begin	End	Total	Criterion
PE-7ABC	FE-7/8-1C	12/06/85	30	30	1	2
	FE-7/8-4B	12/04/85	16	16	1	3
	FE-7/8-6B	12/05/85	10	10	1	3
			Total	Outliers	3	
PE-8ABC	FE-7/8-3A	08/26/85	2	2	1	3
	FE-7/8-7A	08/30/85	13	30	18	4
			Total	Outliers	19	
PE-9ABC	FE-9/0-1B	11/12/85	10	12	3	5
	FE-9/0-1B	11/12/85	20	20	1	3
	FE-9/0-2B	11/07/85	34	34	1	3
	FE-9/0-3B	11/07/85	13	13	1	3
	FE-9/0-5B	11/12/85	20	20	1	3
			Total	Outliers	7	
PE-0ABC	FE-9/0-4A	11/18/85	23	23	1	2
	FE-9/0-5A	11/21/85	58	58	1	3
	FE-9/0-7A	11/15/85	16	16	1	2
	FE-9/0-7A	11/18/85	28	28	1	2
	FE-9/0-7A	11/21/85	49	49	1	3
			Total	Outliers	5	
DAN-4SS	FE-5/6-1C	09/26/85	112	112	1	2
	FE-5/6-3C	12/10/85	120	122	3	2
	FE-5/6-4C	07/05/85	31	33	3	3
	FE-5/6-4C	07/05/85	37	39	3	3
	FE-5/6-4C	12/10/85	64	66	3	2
	FE-5/6-5C	09/24/85	37	38	2	3
	FE-5/6-5C	12/10/85	77	79	3	2
	FE-5/6-6C	06/20/85	22	24	3	2
	FE-5/6-6C	10/23/85	86	88	3	3
	FE-5/6-6C	10/23/85	92	94	3	3
	FE-5/6-7C	09/26/85	50	50	1	3
	FE-5/6-7C	10/22/85	63	63	1	3
	FE-5/6-8A	09/26/85	17	17	1	3
	FE-5/6-8A	12/10/85	25	27	3	3
	FE-5/6-8B	11/13/85	7	7	1	3
			Total	Outliers	34	

Statistical Analysis of Data Collected in Early 1987

The major part of the experiment on orifice meters was conducted during the latter half of 1985 and January 1986. A much smaller experiment covering selected pipes and plates was conducted during the first 2 months of 1987. Because of the time lag and change in operational procedures between the two experiments, we attempt to identify pipe/plate configurations for which results of the first experiment are not corroborated by the results of the second. We test for a significant change in the relationship between discharge coefficients and Reynolds numbers by comparing the empirical curve derived from the first experiment with the empirical curve from the second experiment.

The quantities needed for this test include a residual standard deviation, s_f, for the full model

$$y_{i.k} = A_1 + A_2 x^*_{ik} + B_1 r_{i.k} + B_2 r_{i.k} x^*_{ik} + C_1 r_{i.k}^2 + C_2 r_{i.k}^2 x^*_{ik} \tag{52}$$

which allows for a change in the empirical curve in 1987 where x^*_{ik} is an indicator variable such that

$$x^*_{ik} = \begin{cases} 1 & \text{for 1987 data} \\ 0 & \text{for all other data} \end{cases}$$

and a residual standard deviation, s_r, for the reduced model

$$y_{i.k} = A_o + B_o r_{i.k} + C_o r_{i.k}^2 \tag{53}$$

which assumes the same empirical curve for the two time periods.

The coefficients A_o, B_o, C_o and A_1, A_2, B_1, B_2, C_1, C_2 are estimated in the usual way by weighted least-squares for the combined data from the two experiments as are the residual standard deviations, s_r and s_f. The experiments are said to give comparable results if

$$F < F_\alpha\ (n-6,\ 3)$$

where the F statistic is computed as

$$F = \frac{(n-3)s_r^2 - (n-6)s_f^2}{3s_f^2}, \qquad (54)$$

for n, the total number of repetitions for the two experiments, and F(n-6,3) is the upper α percent point of the F distribution with (n-6) and 3 degrees of freedom in the numerator and denominator respectively. Results are shown in table 53.

Table 53. Statistics for Testing for a Difference Between the 1987 Experiment and 1985 Experiment

Meter Tube	Orifice Plate	F Statistic	Degrees of Freedom ν_1	ν_2
PE-1ABC	6A	24.8	15	3
PE-3ABC	7B	7.7	14	3
PE-4ABC	7A	10.8	6	3
	8A	145.2[a]	25	3
PE-5ABC	7B	0.6	6	3
PE-6ABC	2C	8.8	21	3
	8A	4.2	13	3
DAN-4SS	4C	Insufficient 1987 data		
DAN-4SS	7C	0.6	26	3

[a]Indicates significance at the 99% probability level.

Plate 8A for meter tube PE-4ABC is the only configuration for which the 1987 results are significantly different from the 1985 results at the 99% probability level. Therefore, the 1985 results are treated as outliers. The 1987 results and 1985 results for the other plate/pipe configurations are consistent. Thus, there is no basis for preferring one data set over the other, and the data are combined for the statistical analyses.

Comparison of Discharge Coefficients for Unplated and Plated Pipes

The original experimental design called for three runs at five flow rates on each meter tube using the #2 (Beta = 0.375) and #6 (Beta = 0.75) plates before the meter tube was plated. These results were to be compared with runs made on the plated tubes at a later time. Because operational procedures for small Beta ratio plates were changed at NBS on August 23, 1985, i.e., the 100 gallon/minute pump was operational after that date, unplated and plated meter tubes are not comparable for data taken on the #2 plates prior to that date.

Graphical comparison of the discharge coefficients for the unplated versus plated tubes (see figs. 37A through J) and statistical analyses similar to those outlined in the last section indicate no differences between unplated and plated tubes for the majority of meter tubes. However, large differences for the #6 plates in the 10-inch-diameter tubes at high flow rates are apparent. The appropriate F statistics are shown in table 54.

Table 54. F Statistics for Testing for Differences Between Unplated and Plated Meter Tubes

Meter Tubes			Tube Diameter	Plate	F Statistic F	Degrees of Freedom ν_1	ν_2
FE1	vs.	PE1	2"	2A	0.08	3	9
FE1	vs.	PE1	2"	6A	4.24	3	20
FE2	vs.	PE2	2"	6B	0.54	3	10
FE3	vs.	PE3	3"	6B	14.21	3	11
FE4	vs.	PE4	3"	6A	63.29*	3	9
FE5	vs.	PE5	4"	2B	33.08*	3	12
FE5	vs.	PE5	4"	6B	46.97*	3	16
FE6	vs.	PE6	4"	6C	10.90	3	18
FE7	vs.	PE7	6"	6B	4.62	3	12
FE7	vs.	PE7	6"	2B	7.33	3	12
FE8	vs.	PE8	6"	2A	4.67	3	8
FE8	vs.	PE8	6"	6A	8.61	3	11
FE9	vs.	PE9	10"	2B	4.72	3	12
FE9	vs.	PE9	10"	6B	169.11*	3	12
FEO	vs.	PEO	10"	2A	5.52	3	12
FEO	vs.	PEO	10"	6A	94.38*	3	11

* Indicates a significant difference between unplated and plated pipes at the 99% probability level

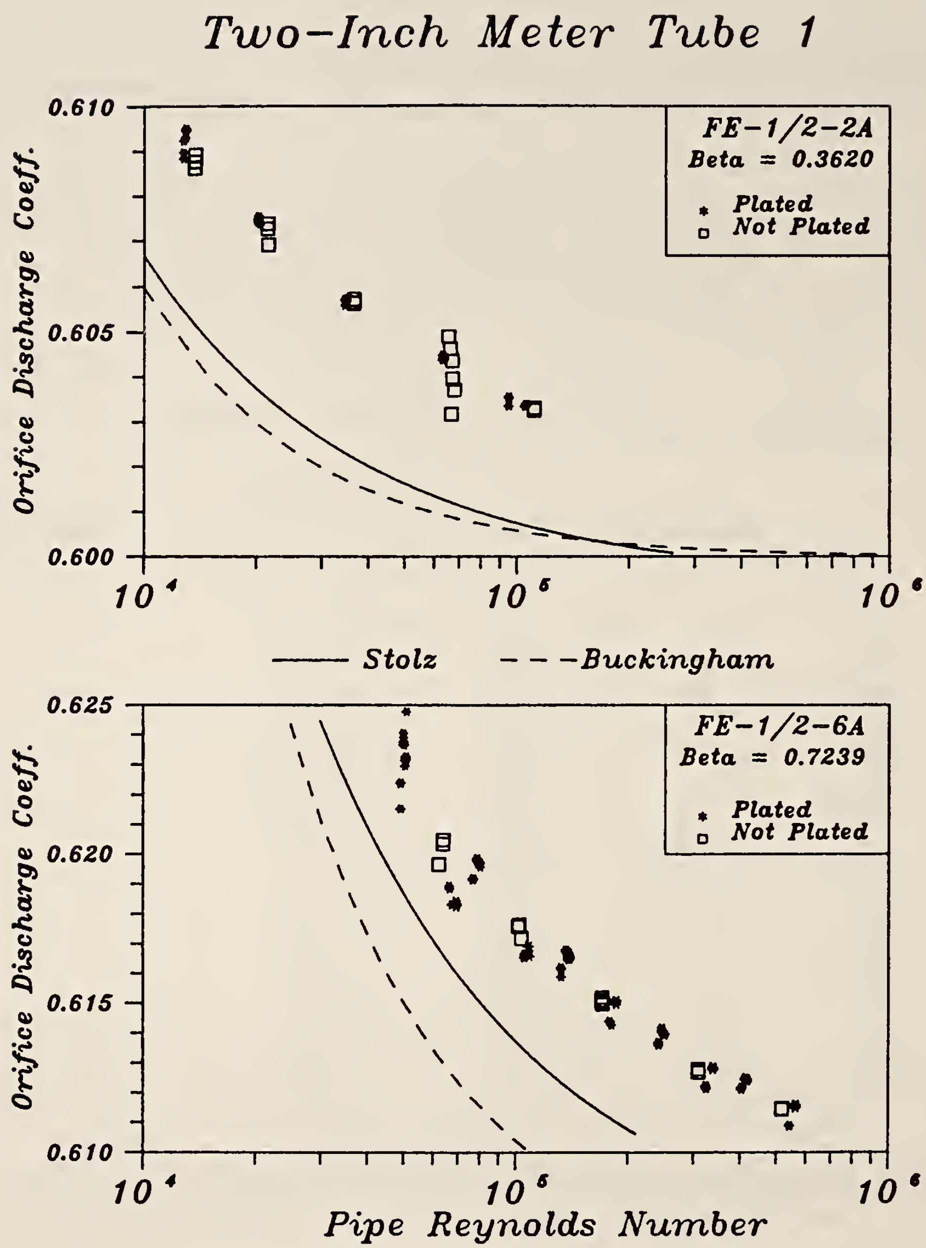


Figure 37A. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

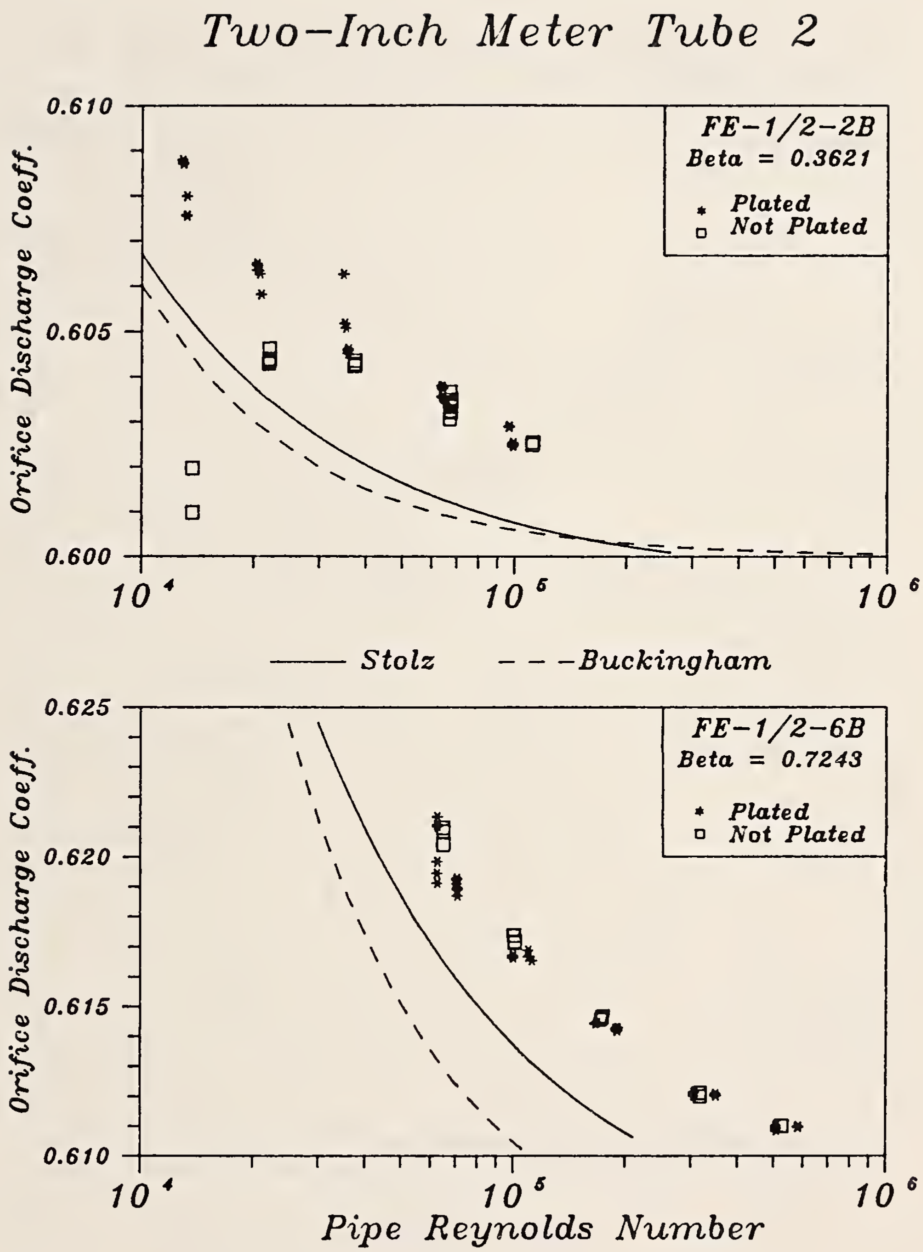


Figure 37B. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

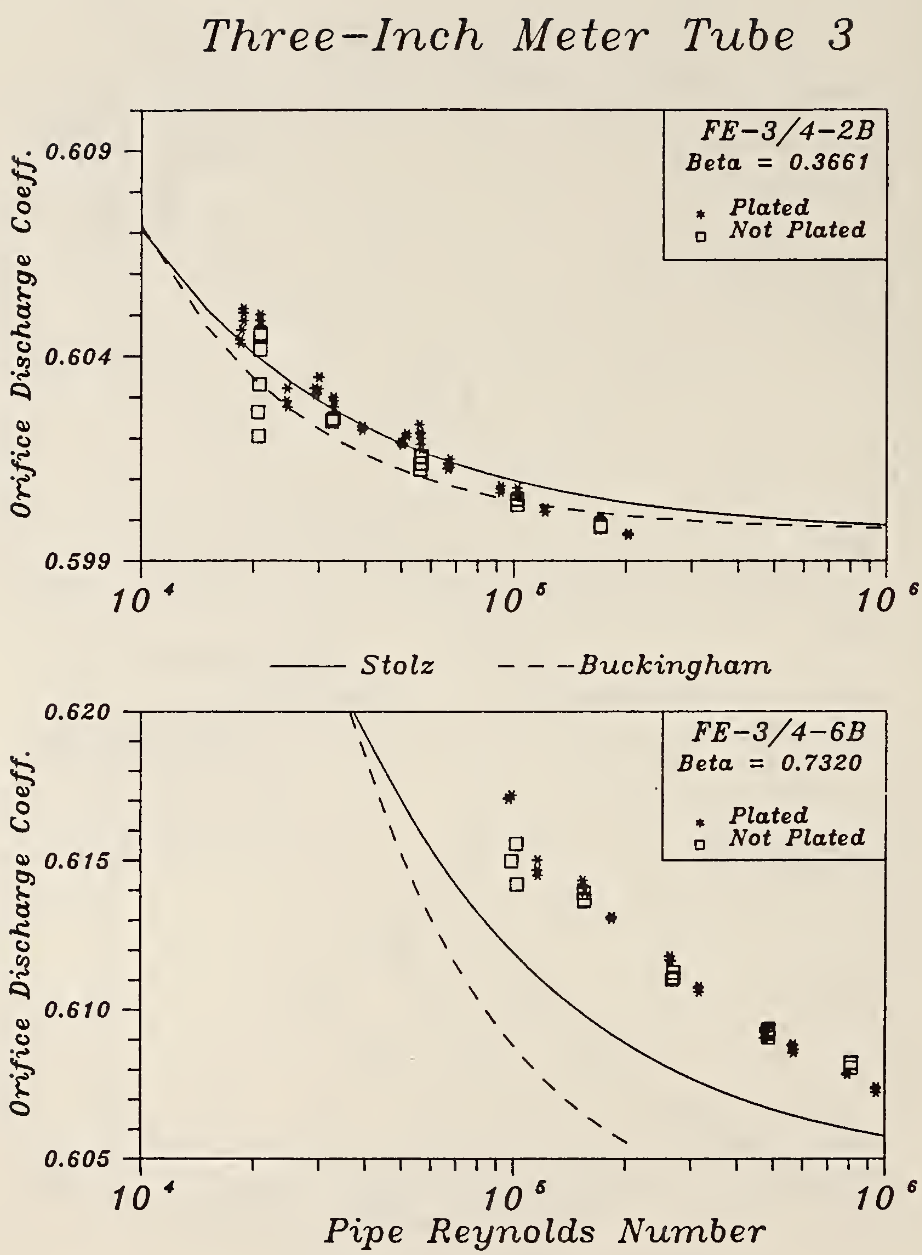


Figure 37C. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

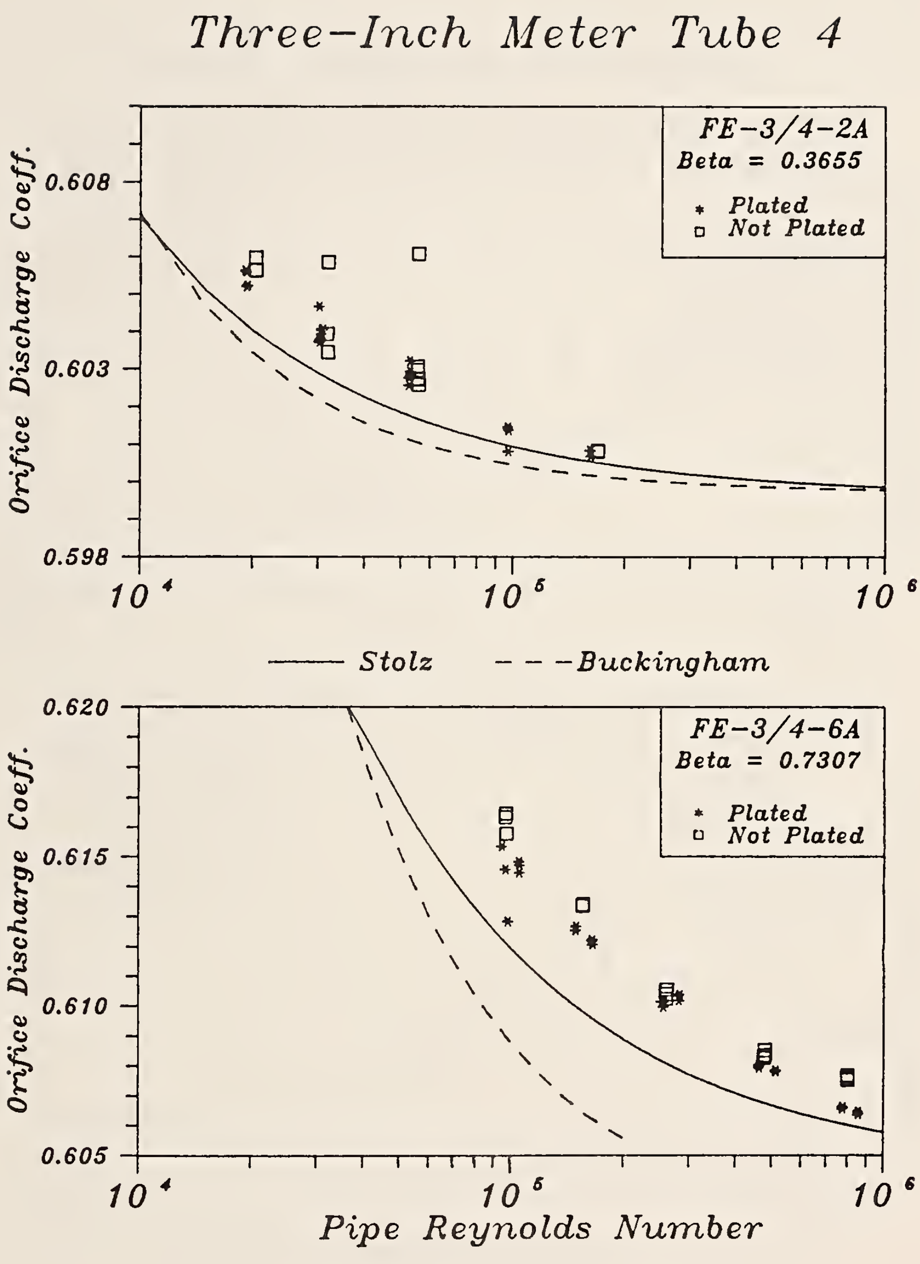


Figure 37D. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

Four-Inch Meter Tube 5

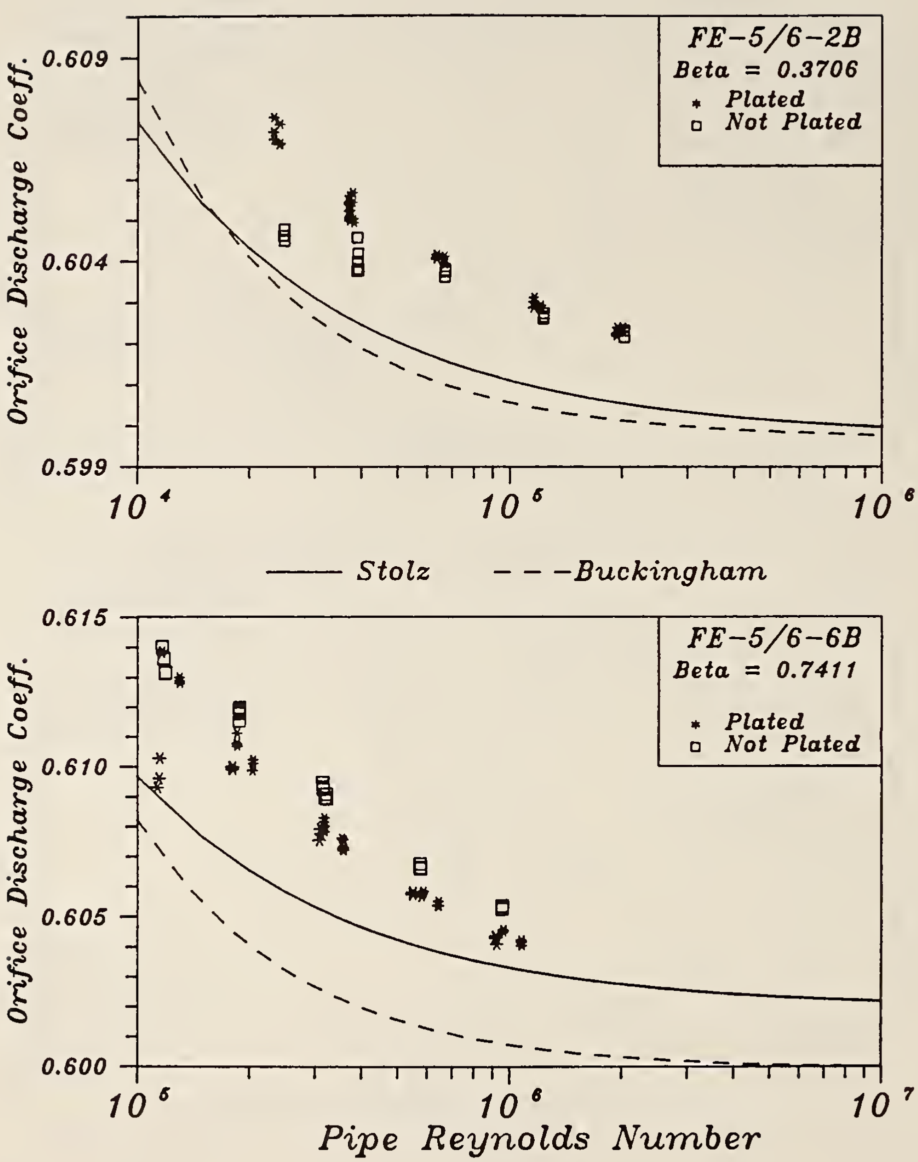


Figure 37E. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

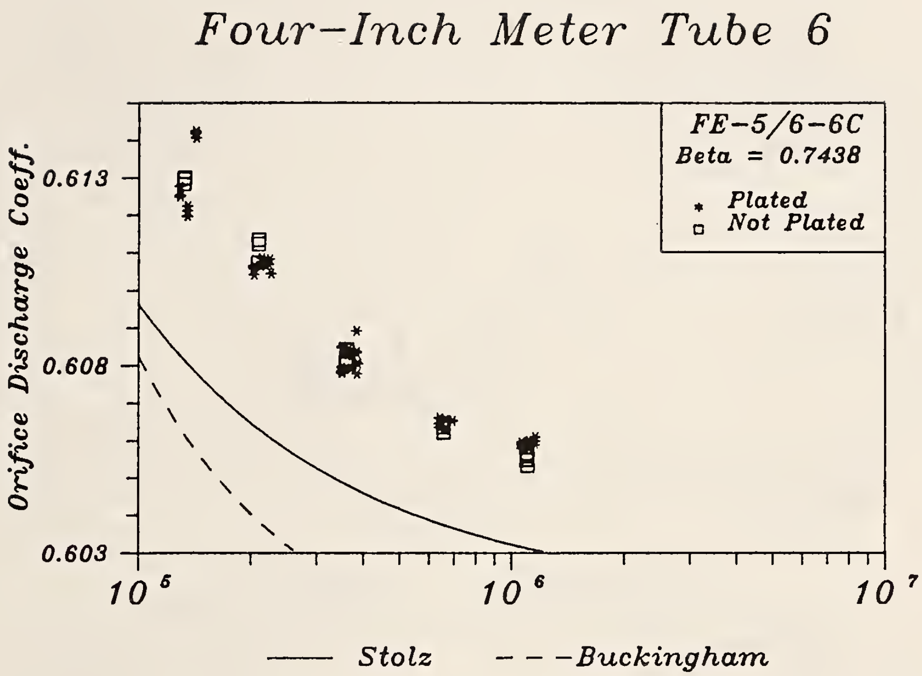


Figure 37F. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

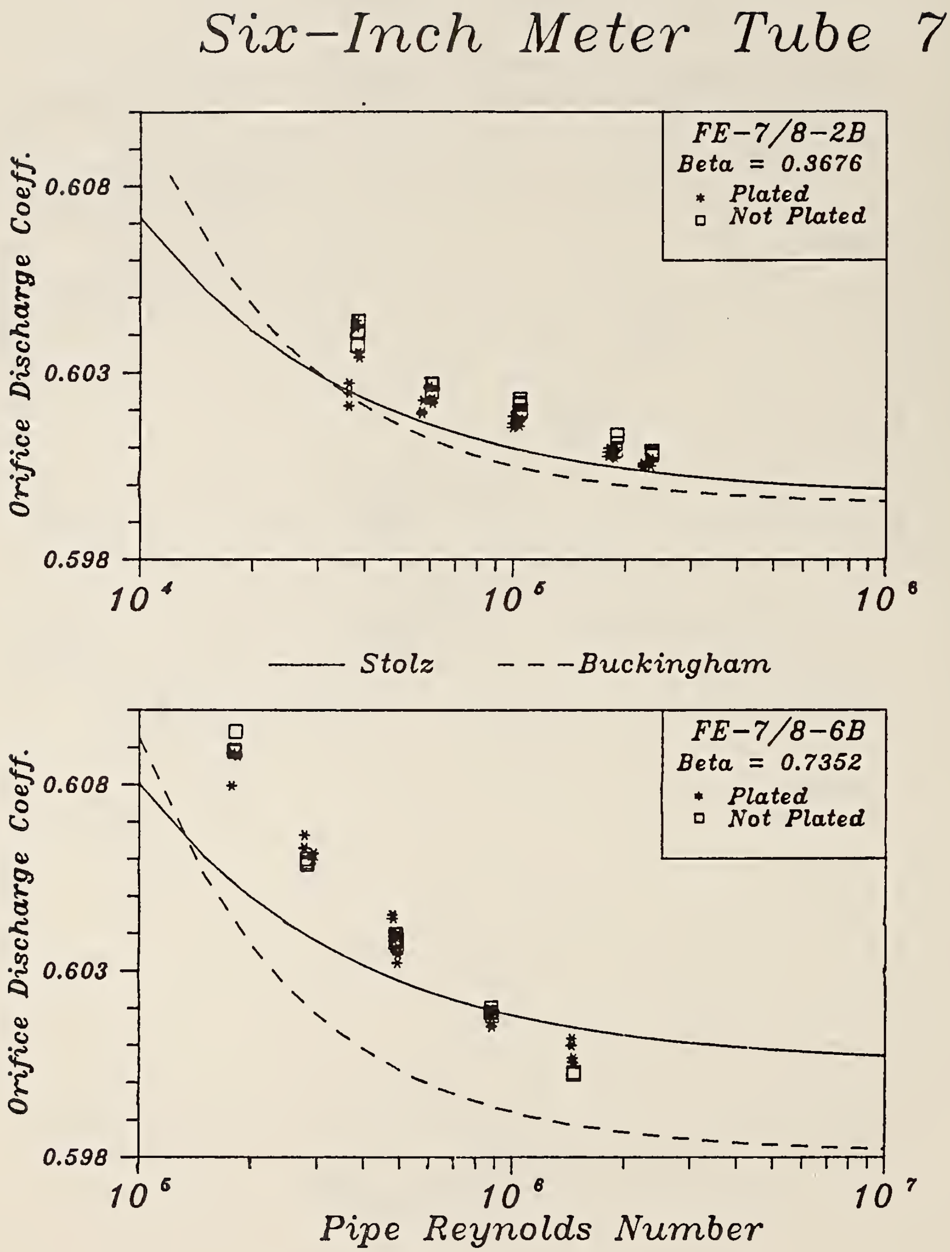


Figure 37G. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

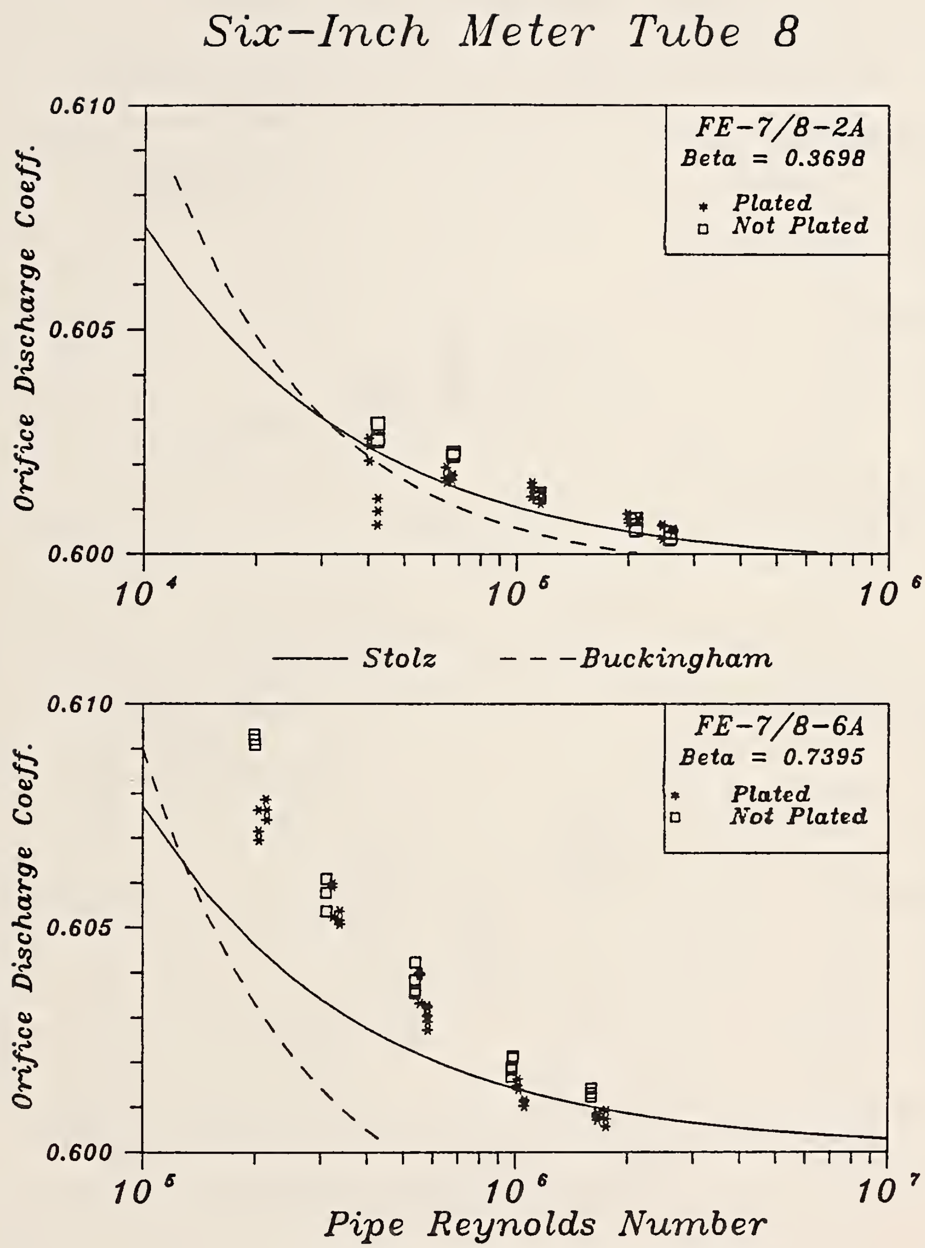


Figure 37H. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

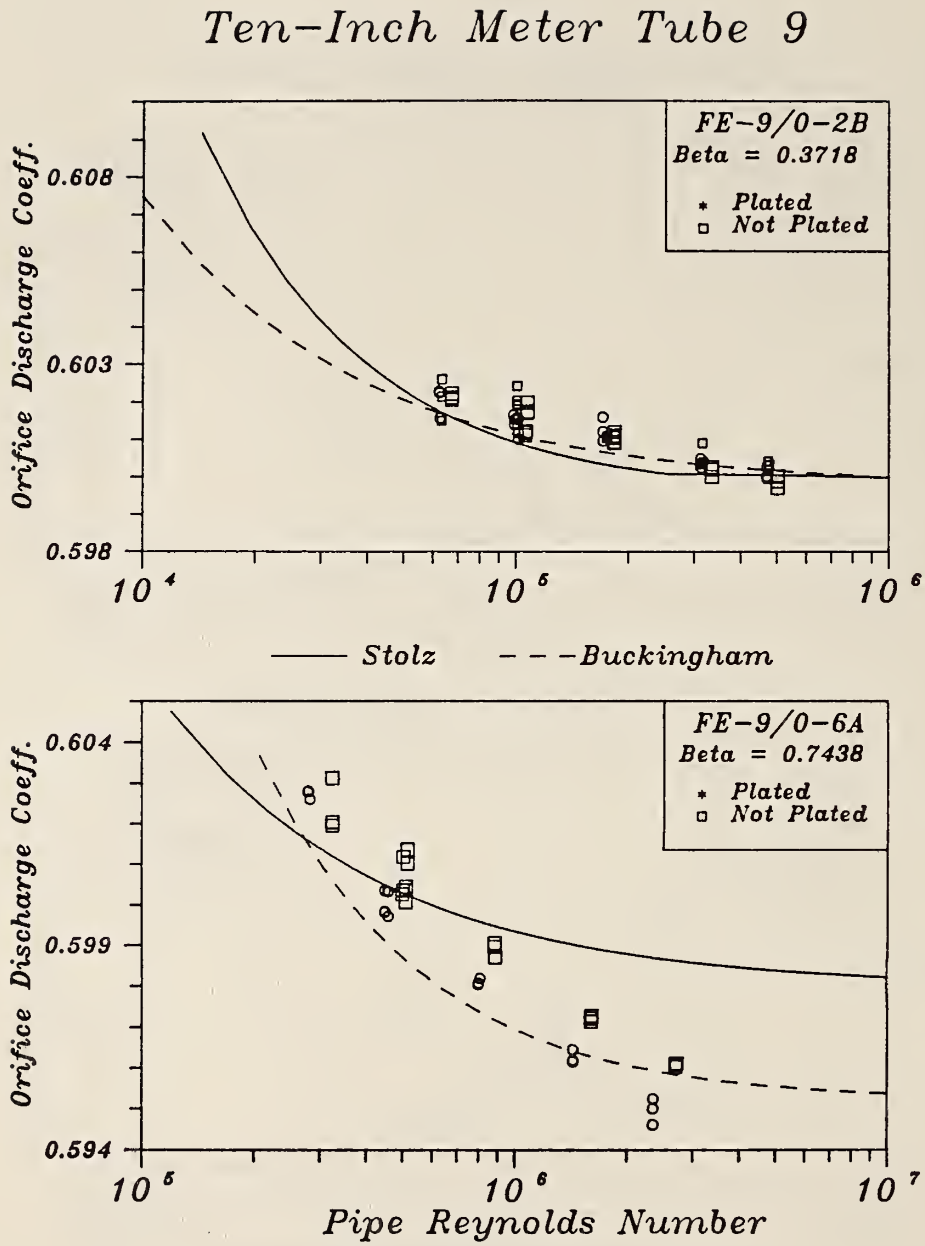


Figure 37I. Discharge Coefficient/Reynolds Number Plots, Plated and and Unplated Results for 2 and 6 Plates

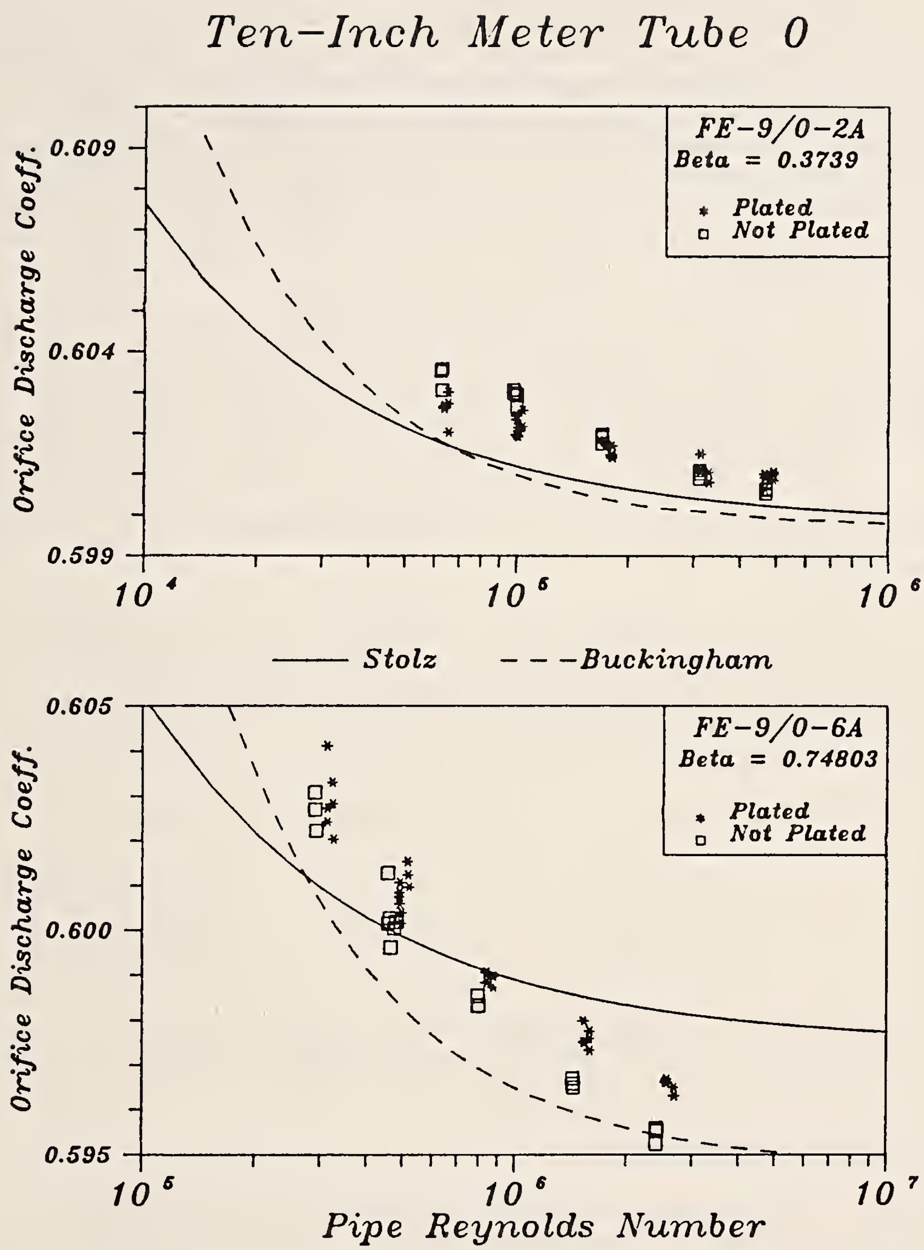


Figure 37J. Discharge Coefficient/Reynolds Number Plots, Plated and Unplated Results for 2 and 6 Plates

Analysis of the Combined Final Data Base

We have examined the data for each plate/pipe configuration in detail in order to identify anomalous individual points or groups of points and assess the effect of system changes between 1985 and 1987. Now we examine the data across all plates for pipes of the same nominal diameter in order to identify anomalous plates. For this purpose we make use of the Stolz equation derived in [23] which is of the form

$$y_{ijk} = 0.5959 + 0.0312\,\beta^{2.1} - 0.184\,\beta^{8} + 0.039\,\frac{\beta^{4}}{1-\beta^{4}} - 0.0337\,\frac{\beta^{3}}{D}$$

$$+ 0.0029\,\beta^{2.5}(10^{6}/R_{Dijk})^{0.75} \qquad (55)$$

where β refers to beta ratio, D refers to pipe diameter, and R_D is the pipe Reynolds number.

Differences, identified by plate number, between observed discharge coefficients and discharge coefficient calculated from the Stolz correlation are shown in figures 38A through E plotted versus pipe Reynolds number. The plots show egregious departure from the Stolz equation for small Beta ratio plates as follows:

Beta Ratio	Plates	Pipe Diameter	Pipes
0.12	7A & 7B	2"	PE-1 & PE-2
0.12	7B & 7A	3"	PE-3 & PE-4
0.06	8A & 8A	4"	PE-5 & PE-6
0.06	8A & 8B	4"	DAN-4SS

The plots also confirm the disagreement between the 1985 and 1987 data on plate 8A with meter tube PE-4ABC and support the exclusion of the 1985 data for this plate/pipe configuration.

Analysis of Process Performance

Table 55 contains the residual standard deviations for discharge coefficients at differential pressures of 27 psi as computed by weighted least-squares from the DAN-4SS data and from the other plate/meter tube configurations. The most useful information should reside in the the 4-inch stainless steel check standard data where the repetitions sample the measurement process over several months time and, therefore, cover a larger range of laboratory conditions than smaller numbers of repetitions on a single meter tube. The latter were frequently, of necessity, done only a day or two apart. Data on the stainless steel meter tube corroborate the data on the plated meter tubes.

Standard deviations are pooled by beta ratio at the bottom of table 55. From the aggregate data it is fairly obvious that process precision is a function of beta ratio and that, as expected, process variability is greatest for very low beta ratio plates. In this case, process is defined for a single repetition where each repetition is the average of three successive test runs at the same flow rate. These standard deviations, based on hundreds of degrees of freedom, represent the best estimate that we have for the NBS calibration process of orifice meters. They reflect the ability of the entire system, consisting of a variety of pumping arrangements, water collection and weighing operations, transducer reactions and flow characteristics to repeat themselves over many month's time.

Standard deviations for nominal differential pressures of 0.40, 1, 3, 10, and 27 are computed from the pooled standard deviations according to eq (51). Limits to random error for the NBS flow facility are computed as three times these standard deviations. For simplicity, we use the same limits to error for all beta ratios greater than or equal to 0.10 based on the largest pooled standard deviation in that range.

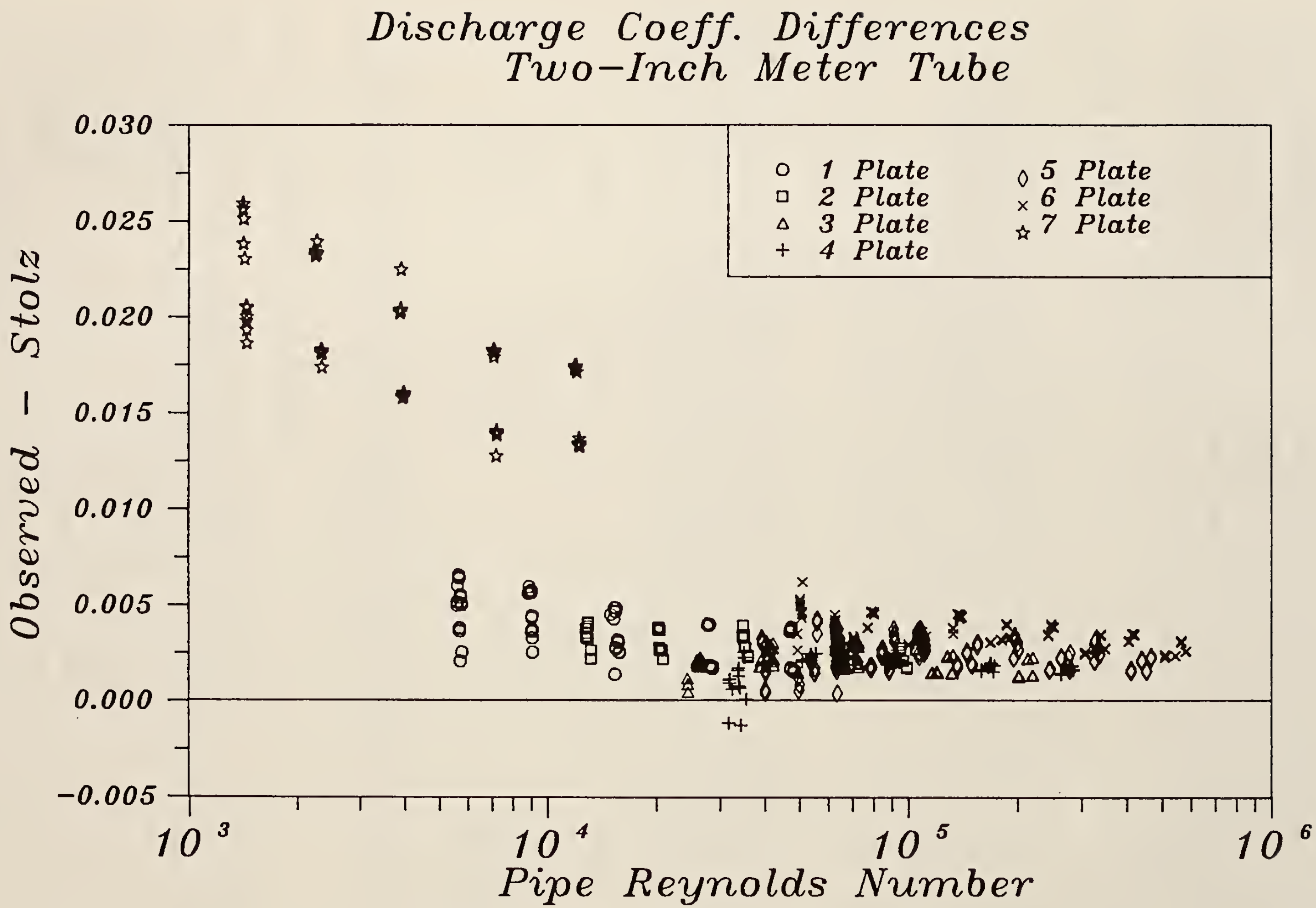


Figure 38A. Plots of Differences Between Observed Discharge Coefficients and Those Computed from the Stolz Correlation

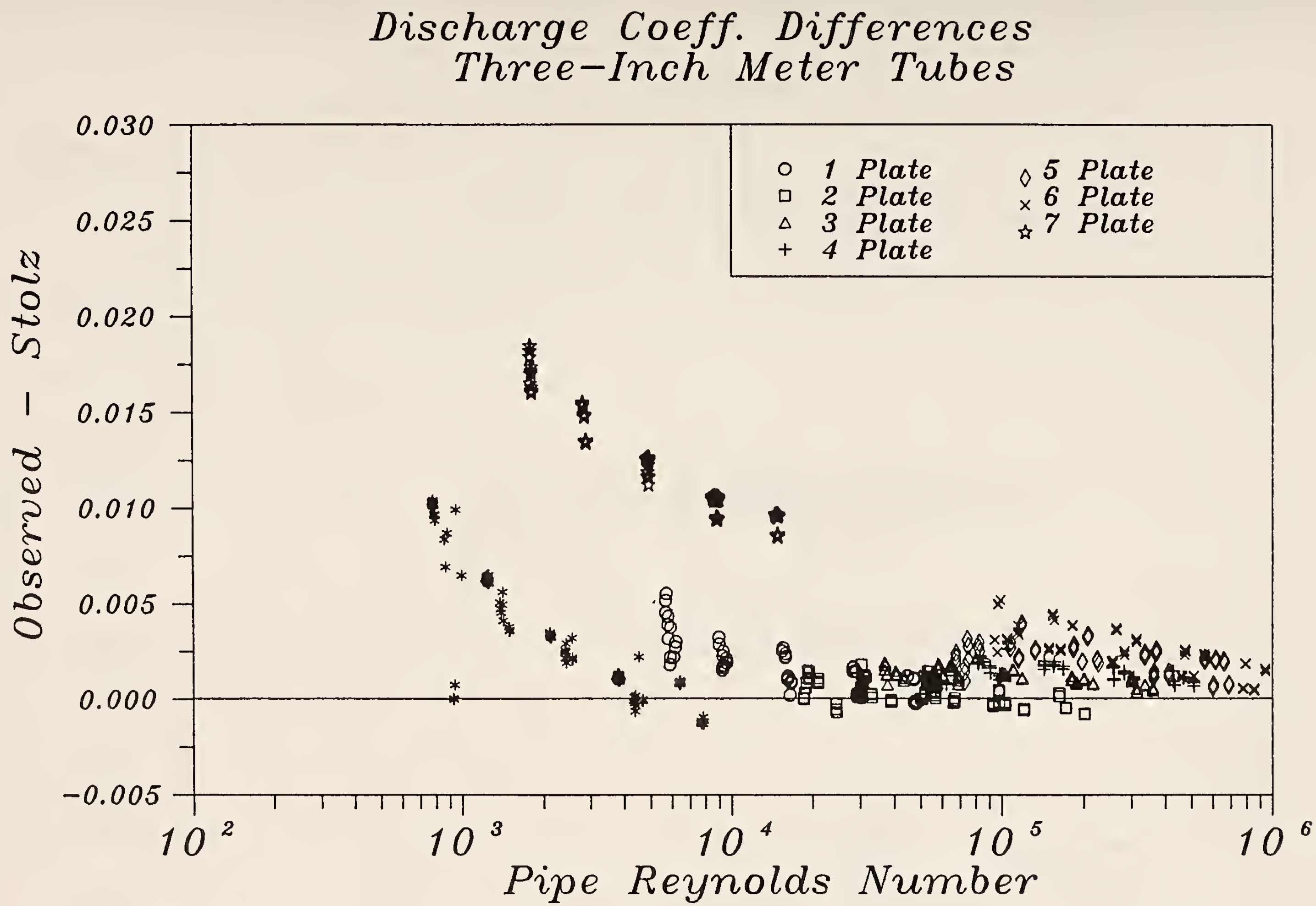


Figure 38B. Plots of Differences Between Observed Discharge Coefficients and Those Computed from the Stolz Correlation

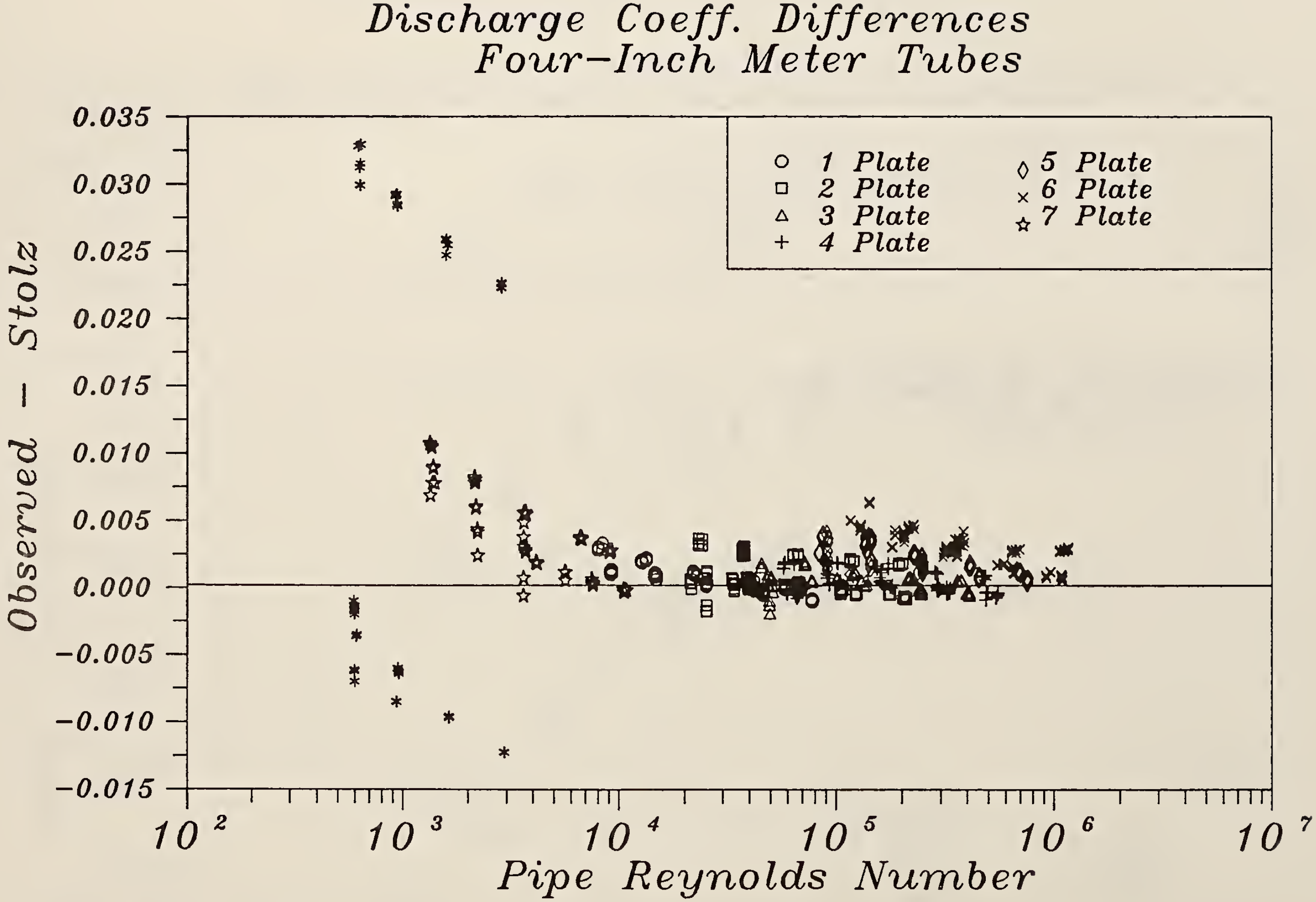


Figure 38C. Plots of Differences Between Observed Discharge Coefficients and Those Computed from the Stolz Correlation

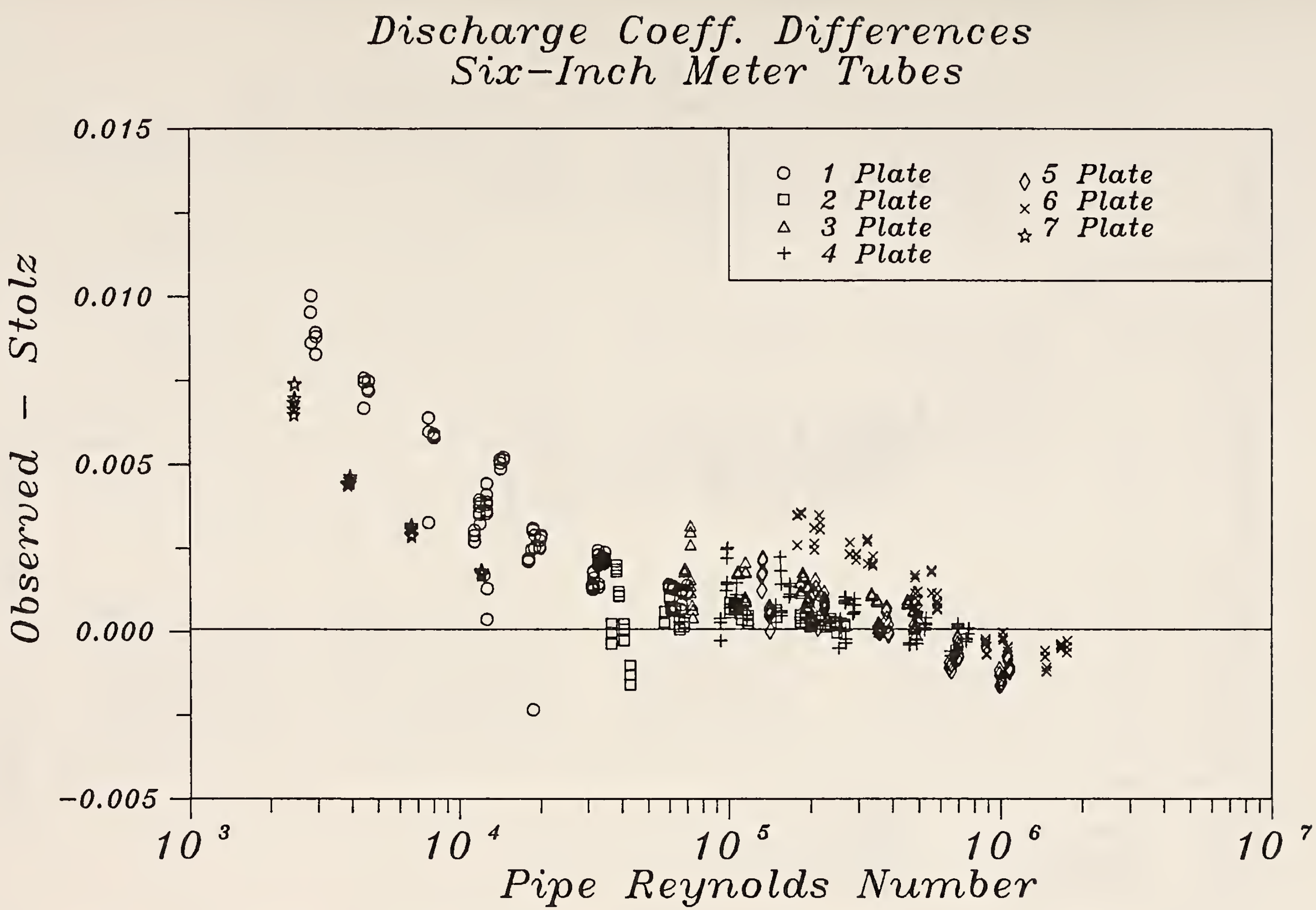


Figure 38D. Plots of Differences Between Observed Discharge Coefficients and Those Computed from the Stolz Correlation

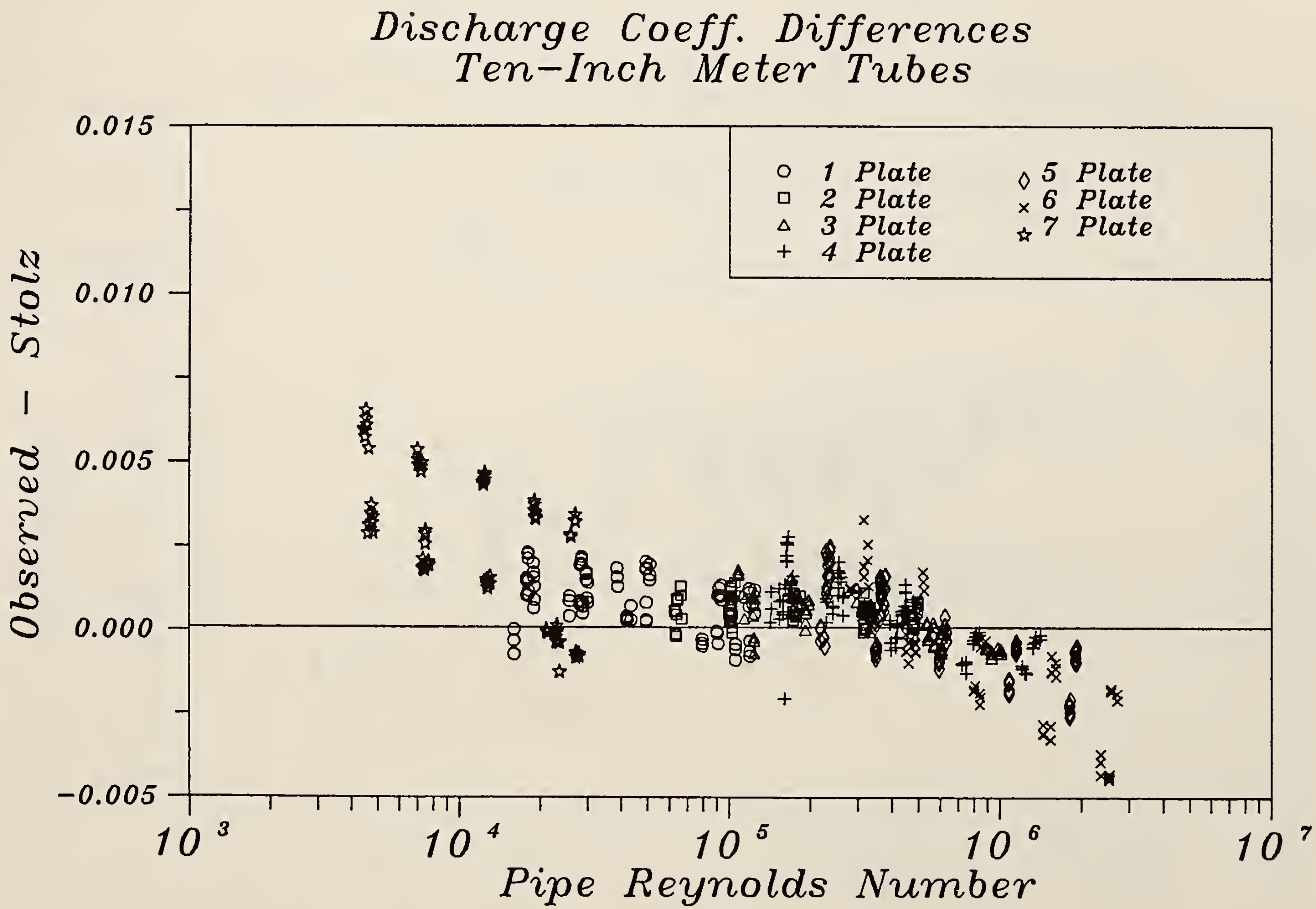


Figure 38E. Plots of Differences Between Observed Discharge Coefficients and Those Computed from the Stolz Correlation

Table 55. Standard Deviations for Average Discharge Coefficients at 27 psi Differential Pressure

Pipe	Plate	Beta Ratio	Pump	Standard Deviation s_t	Degrees of Freedom ν
PE-1	7A	0.12	B	0.0001164	6
	1A	0.24	B	0.0000551	6
	2A	0.36	B	0.0000410	6
	3A	0.48	C	0.0000667	11
	4A	0.54	C	0.0001269	9
	5A	0.66	C	0.0001102	14
	6A	0.72	C	0.0001245	18
PE-2	7B	0.12	C	0.0000797	6
	1B	0.24	B	0.0001115	9
	2B	0.36	B	0.0001170	7
	3B	0.48	C	0.0000516	12
	4B	0.54	C	0.0000799	9
	5B	0.66	C	0.0000306	9
	6B	0.73	C	0.0001072	8
PE-3	8B	0.08	A,B	0.0001176	8
	7B	0.12	A,B	0.0001268	17
	1B	0.20	B,C	0.0000893	7
	2B	0.37	B	0.0000414	3
	3B	0.49	C	0.0000485	8
	4B	0.57	C	0.0000963	10
	5B	0.65	C	0.0000931	8
	6B	0.73	C	0.0000605	9
PE-4	8A	0.08	A,B	0.0000563	11
	7A	0.12	A,B	0.0001023	15
	1A	0.20	B,C	0.0000345	6
	2A	0.37	B,C	0.0000911	4
	3A	0.49	C	0.0000783	9
	4A	0.57	C	0.0000490	7
	5A	0.65	C	0.0000929	9
	6A	0.73	C	0.0000746	6

Table 55. Standard Deviations for Average Discharge Coefficients at 27 psi Differential Pressure -- Continued

Pipe	Plate	Beta Ratio	Pump	Standard Deviation s_t	Degrees of Freedom ν
PE-5	8A	0.06	A	0.0000749	4
	7B	0.09	A,B	0.0003338	9
	2C	0.12	B,C	0.0000484	11
	1B	0.22	B,C	0.0000969	10
	2B	0.37	C	0.0000457	9
	3B	0.49	C	0.0000919	8
	4B	0.56	C	0.0000559	10
	5B	0.65	C	0.0000710	11
	6B	0.74	C	0.0001913	13
PE-6	8A	0.06	A,B	0.0002483	16
	7C	0.09	A,B	0.0001989	14
	2C	0.37	B,C	0.0000712	24
	3C	0.50	C	0.0001195	10
	4C	0.56	C	0.0000984	20
	5C	0.65	C	0.0001030	9
	6C	0.74	C	0.0000949	14
PE-7	8B	0.10	B	0.0001454	5
	1C	0.20	B,C	0.0000546	6
	2B	0.37	B,C	0.0000708	9
	3C	0.49	C	0.0001015	7
	4B	0.57	C	0.0000630	8
	SD	0.65	C	0.0000492	8
	6B	0.73	C	0.0001318	9
PE-8	7A	0.10	B	0.0000997	9
	8A	0.21	B	0.0000346	12
	2A	0.37	C	0.0000573	6
	3A	0.49	C	0.0001015	7
	4A	0.58	C	0.0000948	14
	5C	0.66	C	0.0001114	9
	6A	0.74	C	0.0001004	8

Table 55. Standard Deviations for Average Discharge Coefficients at 27 psi Differential Pressure -- Continued

Pipe	Plate	Beta Ratio	Pump	Standard Deviation s_t	Degrees of Freedom ν
PE-9	7B	0.10	C	0.0001223	8
	1B	0.20	C	0.0000930	9
	2B	0.37	C	0.0000707	8
	3B	0.50	C	0.0000876	9
	4B	0.57	C	0.0000687	9
	5B	0.66	C	0.0000917	8
	6B	0.74	C	0.0000728	9
PE-0	7A	0.10	C	0.0000965	10
	1A	0.20	C	0.0000780	10
	2A	0.37	C	0.0000647	10
	3A	0.50	C	0.0000887	11
	4A	0.57	C	0.0001044	19
	5A	0.66	C	0.0000632	18
	6A	0.75	C	0.0000779	8
DAN	8A	0.06		0.0003853	11
	7C	0.09		0.0002255	26
	1C	0.22		0.0001047	21
	2C	0.37		0.0001058	7
	3C	0.50		0.0000689	35
	4C	0.56		0.0001080	46
	5C	0.65		0.0001166	33
	6C	0.74		0.0001145	32

Beta Ratio	Pooled Standard Deviation	DF
0.06 - 0.09	0.0002387	99
0.10 - 0.12	0.0001063	87
0.20 - 0.24	0.0000863	90
0.36 - 0.38	0.0000758	87
0.48 - 0.50	0.0000788	129
0.54 - 0.58	0.0000958	161
0.64 - 0.66	0.0000938	136
0.72 - 0.75	0.0001212	122
0.10 - 0.75	0.0000956	812

VII. Acknowledgments

Many people have lent their assistance to this project in one way or another. The authors would like to express their gratitude to those who have done so. Specific persons have worked closely with the authors on various aspects of the project, both NBS staff and various individuals associated with the American Petroleum Institute through its Committee on Petroleum Measurement.

In particular the principal investigator wishes to thank Nancy Skinner, Carol Kimmel, and Monica Mock for their excellent work in preparing the various manuscripts involved in finally completing this report. Messrs. J. F. Houser, J. D. Melvin, and K. R. Benson contributed materially to the development or modification of various pieces of equipment used in the measurement systems. The efforts of Mr. G. Scace in operating the water flow measurement facility consistently for one of the three shifts during the 24 hour/day running schedule in 1985 are much appreciated. Many useful discussions with Mr. F. E. Jones contributed to the development of various data reduction algorithms used with the measurement system. Dr. T. Vorburger and Mr. C. Giaugue graciously provided measurements of the the surface topography of rusted meter tube specimens described in Appendix A. Dr. G .E. Mattingly supervised the data collection procedures on orifice meters and velocity profiling measurements which occurred in early 1987. He and Dr. J. J. Ulbrecht wrote Appendix F. Mr. Stefan Leigh and Dr. J. Rosenblatt of the NBS Statistical Engineering Division provided many useful discussions. Mr. J. Hord, Dr. M. M. Hessel, Dr. J. J. Ulbrecht, and Dr. J. W. Lyons were instrumental in various phases of the project's management and coordination with the API. The principal investigator would like to thank Dr. H. G. Semerjian for his encouragement and many suggestions during the latter phases of the work and Mr. B. R. Bateman for his invaluable assistance in archiving the data base and for his suggestions of various computational techniques in completing the data analysis and presentation.

Several individuals outside NBS contributed their time, effort and thought. The membership of the API Orifice Data Base Steering Committee (OSC), with little exception, remained the same throughout the project, and contributed suggestions, observations and opinions to the work. In particular Mr. W. A. Fling, as the API Project Manager, maintained close contact with the work and closely scrutinized the test run results as they were developed. As a result, he consulted with the NBS principal investigator frequently and was instrumental in the solution of several difficulties. Mr. E. L. Upp and Dr. R. Teysanndier of Daniels Industries, Houston, Texas, provided invaluable assistance in the reconditioning of the meter tubes in a timely manner. Mr. D. Goodson, also of Daniels Industries, performed most of the orifice plate edge sharpness measurements. The principal investigator would like to thank Mr. Fling, Mr. Upp and Mr. T. L. Hilburn for many useful technical insights, discussions and suggestions. The members of the OSC maintained a high level of interest throughout the project and were very instrumental in its direction and progress.

VIII. References

[1] Beitler, S. R., "The Flow of Water Through Orifices," The Ohio State University, Engineering Experiment Station Bulletin 89, 73 pp., May 1935.

[2] Ku, H. H., "Notes on the Use of Propagation of Error Formulas," Journal of Research of the National Bureau of Standards - C, Engineering and Instrumentation, Vol. 70C, No. 4, October-December 1966.

[3] Certain commercial equipment and instruments are identified in this paper in order to describe the experimental procedures and results adequately. In no case does such identification imply recommendation or endorsement by the National Bureau of Standards nor does it imply the material or equipment is necessarily the best available for the purpose.

[4] Kinghorn, F. C., MacKay, A., and Harrison, P., "The New United Kingdom Primary Standards for Water Flowrate Measurement." In Flow: Its Measurement and Control in Science and Industry, Vol. 2, p. 761, Instrument Society of America, Research Triangle Park, NC, 1981.

[5] Hayward, A. T. J., Flowmeters, A Basic Guide and Source-Book for Users, John Wiley & Sons, New York, NY, pp. 144-147, 1979.

[6] Jones, F. E., "Estimating Diverter Valve Corrections," Int. J. Heat and Fluid Flow, Vol. 5, No. 4, pp. 247-250, 1984.

[7] Pontius, P. E., Mass and Mass Values, NBS Monograph 133, 1974.

[8] Jones, F. E., "The Air Density Equation and the Transfer of the Mass Unit," J. Res. of NBS, Vol. 83, No.5, pp. 419-428, 1978.

[9] Kell, G. S., "Density, Thermal Expansivity, and Compressibility of Liquid Water from 0 to 150 °C: Correlation and Tables for Atmospheric Pressure and Saturation Reviewed and Expressed on 1968 Temperature Scale," J. Chem. and Eng. Data, Vol. 20, No. 1, 1975.

[10] Heydemann, P. L. M., and Welch, B. E., "Part III. Piston Gages," Experimental Thermodynamics, Vol. II, pp. 147-202, 1975.

[11] American National Standard, "Metric Practice," E380-76, ASTM, 345 East 47th St., New York, NY 10017.

[12] Tate, D. R., Acceleration Due to Gravity at the National Bureau of Standards, NBS Monograph 107, 1968.

[13] Touloukian, Y. S., Kirby, R. K., Taylor, R. E., and Desai, P. D., Thermal Expansion, Metallic Elements and Alloys, Thermophysical Prop. of Matter, Vol. 12, 1975.

[14] Heidelberger, P., and Welch, P. D., "A Spectral Method for Confidence Interval Generation and Run Length Control in Simulations," Comm. of the ACM, Vol. 24, No. 4, pp. 233-245, 1981.

[15] Sprenkle, R. E., and Courtright, N. S., "Straightening Vanes for Flow Measurement," Mechanical Engineering, 80, 71-73, 1958.

[16] "Electroless Nickel Plating," Metals Handbook, Vol. 5, pp. 219-243, 1982.

[17] American Gas Association Report No. 3., Amer. Gas Assoc., Catalog No. XQ0178, Arlington, VA; also American National Standard Institute/American Petroleum Institute 2530.

[18] Kestin, J., Sokolov, M., and Wakeham, W. A., "Viscosity of Liquid Water in the Range -8 °C to 150 °C," J. Phys. Chem. Ref. Data, Vol. 7, No. 3, p. 941, 1978.

[19] Swindells, J. R., Coe, J. R. Jr., and Godfrey, T. B., "Absolute Viscosity of Water at 20°C," J. Res. of NBS, Vol. 48, No. 1, p. 1, 1952.

[20] <u>Fluid Meters</u>, 6th Edition, ASME, New York, 1971.

[21] Miller, R. W., <u>Flow Measurement Engineering Handbook</u>, McGraw-Hill, New York, 1983.

[22] Bean, H. S., and Murdock, J. W., "Effect of Pipe Roughness on Orifice Meter Accuracy," Rept. on AGA Research Proj. NW-20, Amer. Gas. Assoc., Arlington, VA, 1960.

[23] Stolz, J., "A Universal Equation for the Calculation of Discharge Coefficients of Orifice Plates," ISO 5167, FLOMEKO 1978, IMEKO Conference on Flow Measurement of Fluids, Groningen, North-Holland, Amsterdam, 1978.

[24] Britton, C. L., Caldwell, S., Seidl, W., and Snowdon, T., "Research Program to Develop an Archival Data Base of Low Reynolds Number Discharge Coefficients and Related Parameters for Sharp-Edged, Flange-Tapped Orifice Meters," prepared for the American Petroleum Institute, Measurement Coordination Dept., Sept. 1986.

[25] Gorter, J., "Deformation of Orifice Plate; Theory and Practice," FLOMEKO 1978, IMEKO Conference on Flow Measurement of Fluids, Groningen, North-Holland, Amsterdam, 1978.

[26] Draper, N. R., and Smith, H. <u>Applied Regression Analysis, Second Edition</u>, John Wiley & Sons, New York, 1966. See p. 144 for a specific definition of standardized residual.

APPENDIX A
Operational History of the Project

I. Introduction

This appendix gives a rather detailed chronological account of the major events which occurred during this project. It is written as a record of the difficulties encountered and overcome before the successful completion of the data base. Hopefully, future workers may benefit from the insights gained in it. Significant portions of this appendix were taken from the monthly progress reports prepared for the API by the NBS Principal Investigator (J. Whetstone). These have been edited for clarity in the context of this document and for proper language usage. Verbatim excerpts are usually indented for clarity.

A strong advisory role was played by the API Program Manager and the API Orifice Meter Database Steering Committee composed of the following:

	R. Beatty	- Chairman, AMOCO Production Co.
!	D. W. Kemp	- Cities Service Co., Occidental Petroleum Corp.
&	W. A. Fling	- Cities Service Co., Occidental Petroleum Corp.
*	E. L. Upp	- Daniel Industries
*	R. Teyssandier	- Daniel Industries
	H. L. Bean	- El Paso Natural Gas Co., Retired
	T. L. Hilburn	- Phillips Petroleum
	G. Less	- Natural Gas Pipeline Co. of America
	J. K. Walters	- API Staff representation
	R. L. Schreibeis	- API Staff representation

! Ex officio membership on the committee as Chairman, API Committee on Petroleum Measurement

* R. Teyssandier replaced E. L. Upp at approximately the mid-point of the work.

& API Program Manager

Although there was periodic participation by other members of the API's Committees on Petroleum Measurement, Dynamic Measurement and staff, the membership of the Orifice Steering Committee stayed essentially the same throughout the course of the project. Frequent meetings of this committee occurred and, at times, strongly influenced the course of the planning and execution of the project's technical work. On several occasions task groups of the steering committee performed specific tasks. As an example, a facilities task group headed by Mr. Hilburn inspected the measurement facilities at NBS during their development and witnessed the commissioning of the completed system and various additions to it which evolved after the initial commissioning.

As in the main body of the report, reference is made in the remainder of this appendix to the correlations of Buckingham [A1] and Stolz [A2]. These correlations were either completely or substantially based on the discharge coefficient data base of Professor S. R. Beitler developed in the late 1920's and early 1930's [A3] at Ohio State University. This experimental work, which is often referred to as the OSU work or report, provides a comparison base for the work reported here because of its wide use in flow measurement for commercial purposes. The Buckingham correlation is incorporated in AGA Report No. 3 (API 2530) which is a widely used, standard measurement practice in the United States. The Stolz correlation is used in a similar manner in the European Economic Community and is incorporated in the International Standards Organization's R91 document. Because Beitler did not test identical sizes of orifice plates and meter tubes as those involved in this work, the Buckingham and Stolz correlations are used only for convenience of comparison.

II. Development and Commissioning of the Measurement Systems and Initial Results

The project initiation date was early 1982. The initial phase involved the development of the data acquisition, storage, and control systems which were obtained and made functional in the latter portion of 1982. Modifications to the NBS water flow measurement facilities in the form of electronic weigh scales (to minimize the occurrence of data entry errors by the operators and speed data acquisition procedures) and automatic controls for the diverter valves became operational in the early portion of 1983, with orifice flow meter testing beginning in the late spring and early summer of 1983. Total system shakedown testing began in early 1983 using one of the 4-inch meter tubes, FE-6ABC. From June to August 1983 preliminary data were collected using FE-6ABC with orifice plates ranging in nominal beta ratio from 0.2 to 0.75. Data for a 6-inch meter tube were taken during September and November 1983.

A considerable number of test run repetitions over the beta ratio range were performed. The results obtained from these observations in the low Reynolds range of each plate, corresponding to the low differential pressure values, consistently and significantly differed from both the Buckingham and Stolz correlations. However, the discharge coefficient values computed for the higher differential pressure values for each plate showed the expected level of agreement with the correlations.

As a result of this inconsistency between the discharge coefficient values obtained from the test run data and the Stolz and Buckingham correlations at low Reynolds numbers, a thorough analysis of the performance of the entire measurement system was made. This was done to determine whether artifacts of the measurement system were unduly influencing the results, and if so, to eliminate or reduce their effect. Considerable effort was focused on the differential pressure measurement system, particularly the transducers, but these were found to show no systematic effects due to tap connection, physical location, or to any other change. It was noted, however, that the transducers showed a tendency to increase their indication slightly in the initial step of the transducer calibration procedures when a slightly negative differential pressure was applied. Additionally, all of the transducer calibration models required the addition of a constant coefficient to minimize the residual standard deviations of the fit of their response to the calculated differential pressure developed by the two working pressure standards. Investigation of the working pressure standards revealed that the mass values assigned to three of the weights of one of the working pressure standards and to one weight of the second working pressure standard were incorrectly assigned. The weights affected were those comprising the constant load part of the weight stack, which made identification of the problem difficult: Because the weights with incorrectly assigned mass values were always part of the load on the deadweight testers, no indication was produced during the calibrations.

These mass value assignment errors were traced to transposition errors in the recording of the weighing data. Subsequently, mass assignment procedures were repeated on all of the weights used in the calibration procedures for the differential pressure transducers. The results from this second set of data agreed with the previously assigned values within 1 part per million except for the four weights mentioned above. Several additional observations were made on these four items to ensure that the correct mass values were assigned.

Use of the correct working pressure standards mass values resulted in much better agreement with the Buckingham and Stolz correlations in the low differential pressure range of each plate. Regeneration of the data for all orifice plates produced discharge coefficient values which were in much better agreement than had previously been the case. The new values showed similar levels of offset from the Buckingham and Stolz correlations over the full range of differential pressure for each orifice plate. However, this level of agreement was not realized for the largest beta ratio orifice plates, particularly at the highest flow rates. These divergences were relatively small on a day-to-day basis, but, near the upper limit of the range of expected reproducibility.

Although this behavior in the data was unresolved, a decision was made at the urging of the API Orifice Meter Database Steering Committee to proceed with a full test schedule of all orifice meters beginning in late June 1984.

III. Full Database Production Runs - 1984

A schedule of data base generation test runs was agreed upon and begun in the last week of June. This testing was to be done on a relatively tight schedule. Peculiarities in the observations were to be noted. Orifice meters showing unexpected behavior would be investigated for operational/analytical errors, and, rerun after completing the testing schedule. Internal consistency checking of the measurement systems was routine and gave frequent indications of their level of reproducibility.

Data collection activities for the full set of test runs - five flow rates for each plate, five observations per flow rate, fully replicated at least once on another day - for the various meter tubes were completed in early December of 1984. During this series of tests the data were collected on a single meter tube for all orifice plates to be run with it, i.e., seven orifice plates for the 2-, 6- and 10-inch diameter meter tubes, and eight for the 3- and 4-inch diameter tubes. (An eighth series of orifice plates had been added at the steering committee's request to cover very low beta ratios which were coming into use in the industry at that time. These were nominally 0.25 inch orifices for both meter sizes.) The data collection activities for a single meter tube required between 2 and 3 weeks to complete using a daily schedule of testing with five repetitions taken at each flow rate setting. The meter tubes were generally left filled with water when testing procedures were not in progress, in an effort to reduce rusting of the meter tube interiors.

In a review of the results calculated from these data there were significant differences between results obtained for the large beta ratio orifice plates on the first day and on successive replications, for the majority of the meters. Figures A1-A3 show an example of the characteristics of the discharge coefficient values obtained for the full set of plates for the FE-6ABC meter tube. (This meter tube was run more often than others and serves as a check standard for the data base production.) The discharge coefficients computed from the observations for each test run are plotted. The FE-5/6-1A (nominal beta ratio = 0.21) orifice plate and the FE-5/6-2A (nominal beta ratio = 0.375) given in figure A1 shows the expected capabilities of the measurement systems. The results obtained from all observations for each day are shown for one of the transducers. (The Paros Transducer connected to the upper set of taps are plotted here exclusively.) This is done to illustrate the level of performance of the measurement system/orifice meter combination. Replication of discharge coefficient values at similar differential pressure and Reynolds number values on different days are quite good. These replications include removal and insertion of the orifice plate in the meter flanges. Typically the reproducibility of the results within a group of observations at a single flow rate and between days at nominally the same Reynolds number were below 1 part in 600 at the higher differential pressure values. The scatter in the discharge coefficient values increased somewhat at the lower differential pressure values as is expected due to the larger uncertainty at those pressures.

Figure A2 gives the results of test runs performed on the FE-5/6-3A (nominal beta ratio = 0.5) and the FE-5/6-4A (nominal beta ratio = 0.56) orifice plates. Five days of observations are plotted for the 3A plate, while 2 days of observations were taken on the 4A plate. The magnitude of variation in the results are similar and reflect the level expected from the propagation-of-errors analysis. However, for most of the flow rate settings, the scatter between the results taken on different days has become noticeably larger. For the 3A plate this is accentuated by the large number of observation days. The 4A plate has only a single replicate showing a small day-to-day variation in the results.

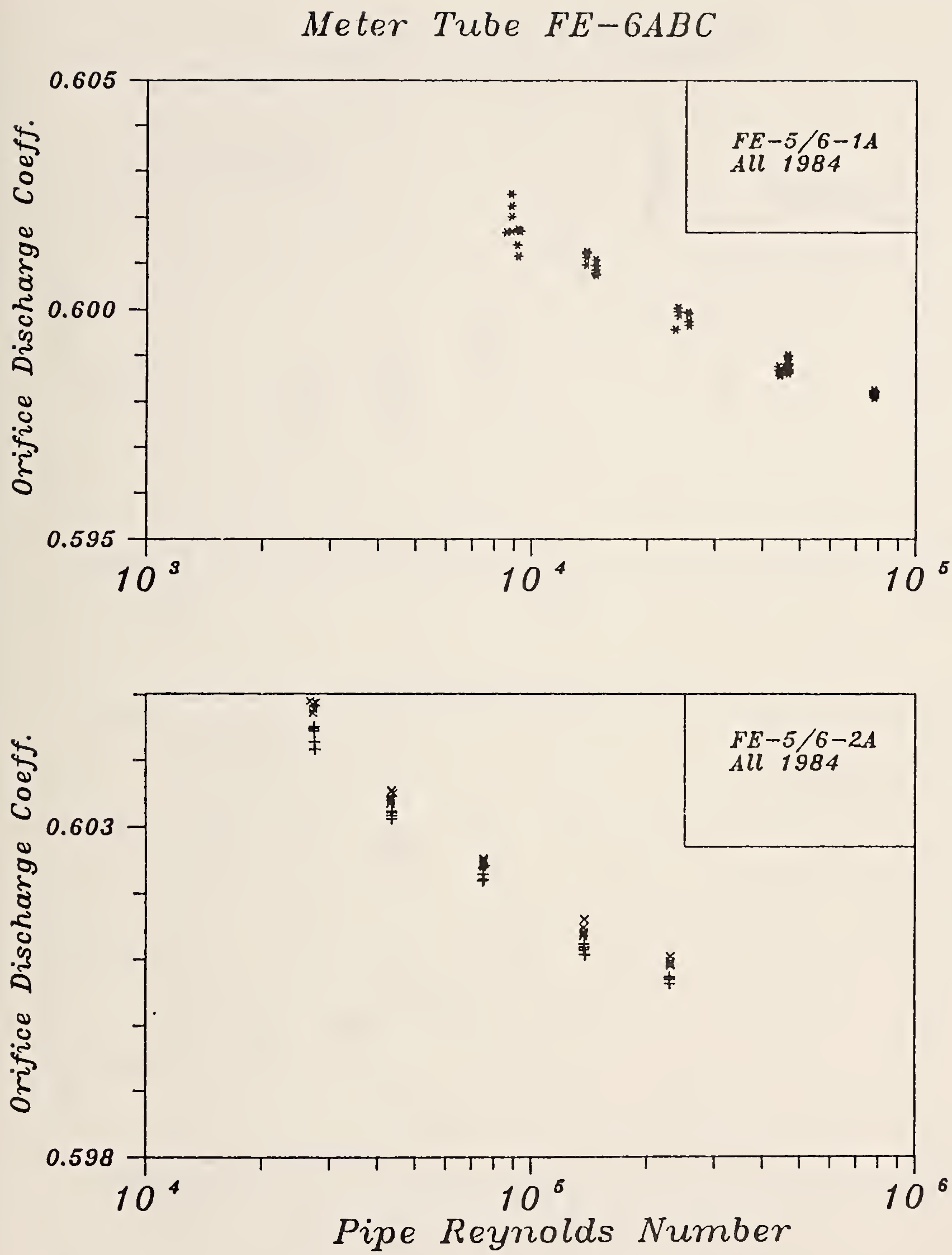


Figure A1. Discharge Coefficient/Reynolds Number Plots, 4-Inch Meter Tube, Beta Ratio 0.2 and 0.375 Orifice Plate, 1984 Observations

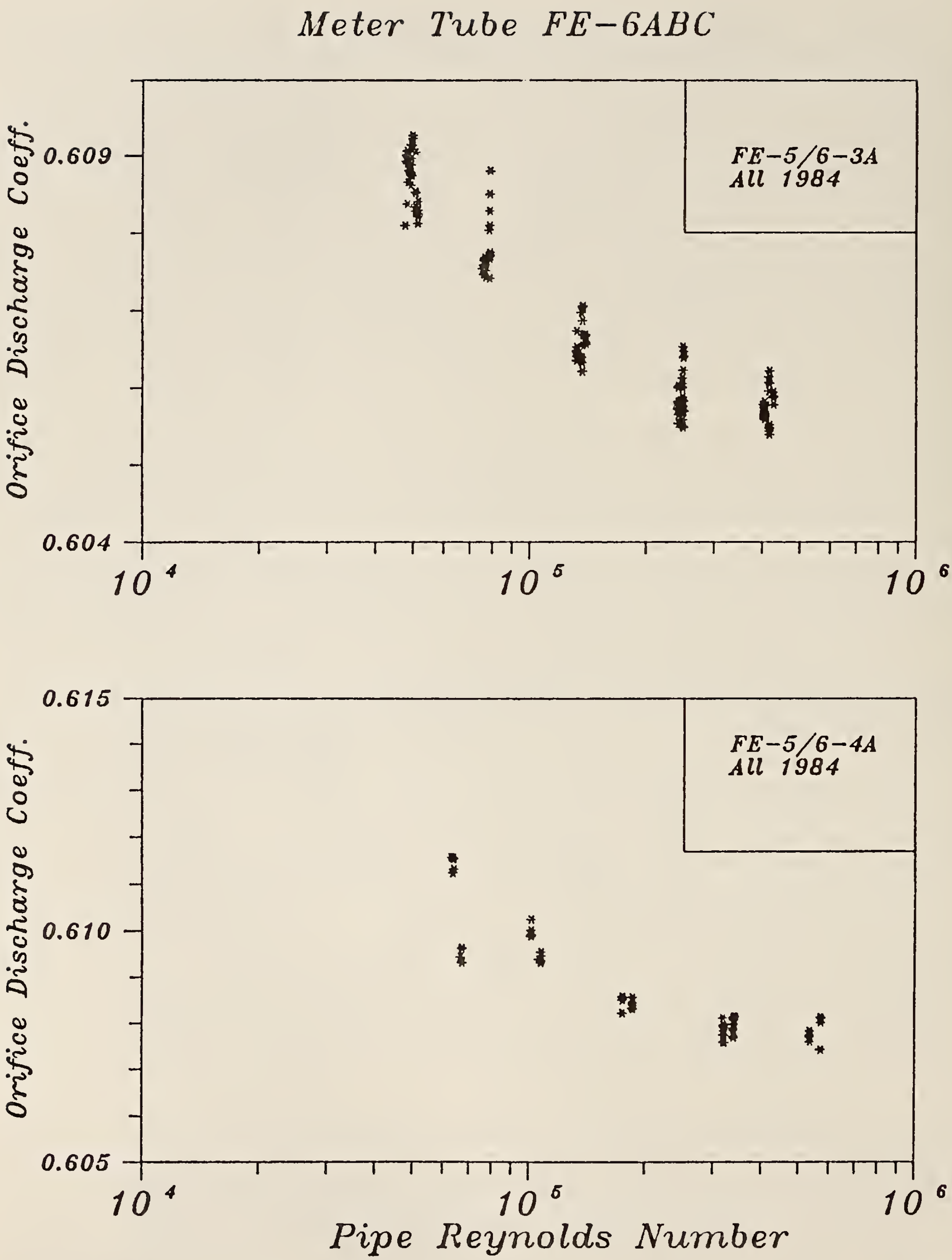
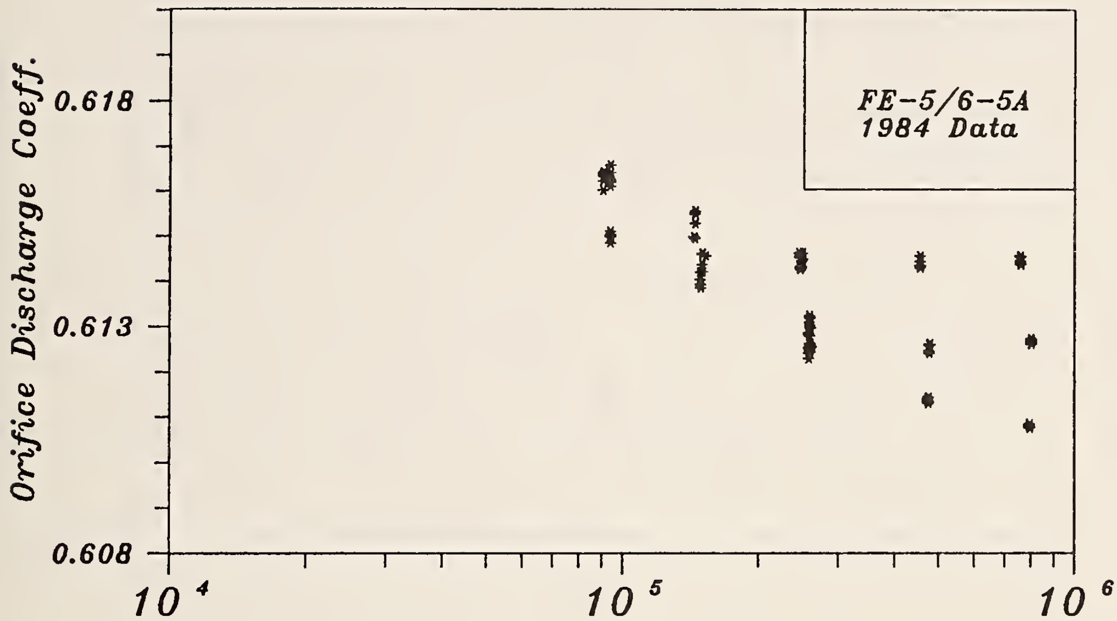


Figure A2. Discharge Coefficient/Reynolds Number Plots, 4-Inch Meter Tube, Beta Ratio 0.5 and 0.56 Orifice Plate, 1984 Observations

Meter Tube FE–6ABC



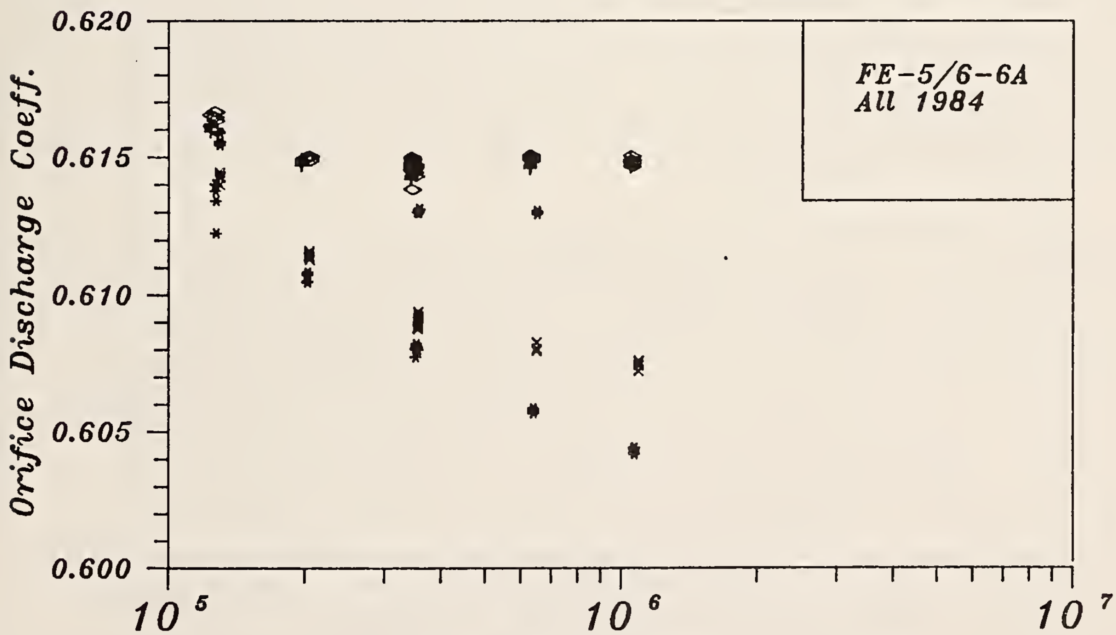


Figure A3. Discharge Coefficient/Reynolds Number Plots, 4-Inch Meter Tube, Beta Ratio 0.62 and 0.75 Orifice Plate, 1984 Observations

Figure A3 shows plots of the results of test runs performed on the FE-5/6-5A (nominal beta ratio = 0.62) and the FE-5/6-6A (nominal beta ratio = 0.75) orifice plates. The initial observations were taken July 25, 1984 with the 6A plate installed. The following day data were taken on the 5A plate. Three additional days of observations were taken between July 25 and August 9, 1984. The variation in the results taken at a single flow setting on one day are most clearly shown in this figure and is greatest at the higher Reynolds number values, where the discharge coefficients calculated from five successive observations do not overlap another day's results but differ from one another 1 to 2 parts in 600. The 6A plate's results shown in the figure were taken from 5 days observations taken from July 25 to August 9, 1984. As with the results from the previous orifice plates the scatter within a group of five observations at a single flow rate is quite small. However, day to day difference is much larger, and increases substantially with increasing Reynolds number. In both cases this effect is sufficiently strong to substantially remove the dependence on Reynolds number of the discharge coefficient after several weeks of daily running of the meter tubes. Due to the lack of reproducibility in the results on these plates, test run groups were taken on the FE-6ABC meter tube for a considerably larger number of days than with the other meter tube.

However, the characteristics of these results were not limited to the FE-6ABC meter tube. Similar characteristics of varying magnitude were observed for other meter tubes in the set. Since the testing schedule was based on single replications for all orifice plates of a set in a single meter tube, most of the orifice meters had data collected on them for only 2 days. Generally most, if not all, of the meter tubes showed similar behavior in their results. Reproducibility of discharge coefficient values obtained on one day was within that expected for the measurement systems for the low beta ratio plates, but deteriorated steadily as the beta ratio increased.

This characteristic was not observed uniformly throughout the data base, but appeared to affect only certain of the meter tubes. Two sets of examples are shown in figures A4 and A5. Figure A4 shows discharge coefficient plots for the 2-inch meter tube, FE-2ABC, orifice plates FE-1/2-2A (nominal beta ratio - 0.375), and FE-1/2-6A (nominal beta ratio - 0.75). Replication of results over 2 day periods for the smaller beta ratio plate is consistent with the measurement-system's estimated uncertainty limits. (Observations on this plate were taken on successive days with the plate remaining between the orifice meter flanges overnight.) However, the replication of the results for the 6A orifice plate shows a between day variation approximately an order of magnitude larger than the variation in five successive observations taken at the highest Reynolds numbers. The increased separation between successive day's observation results with increasing Reynolds number is obvious. The discharge coefficient vs. Reynolds number plots for the two largest beta ratio plates of one of the 10-inch meter tubes, FE-0ABC are shown in figure A5. The discharge coefficients calculated for the observations taken on the FE-9/0-5A orifice plate have a small between-day

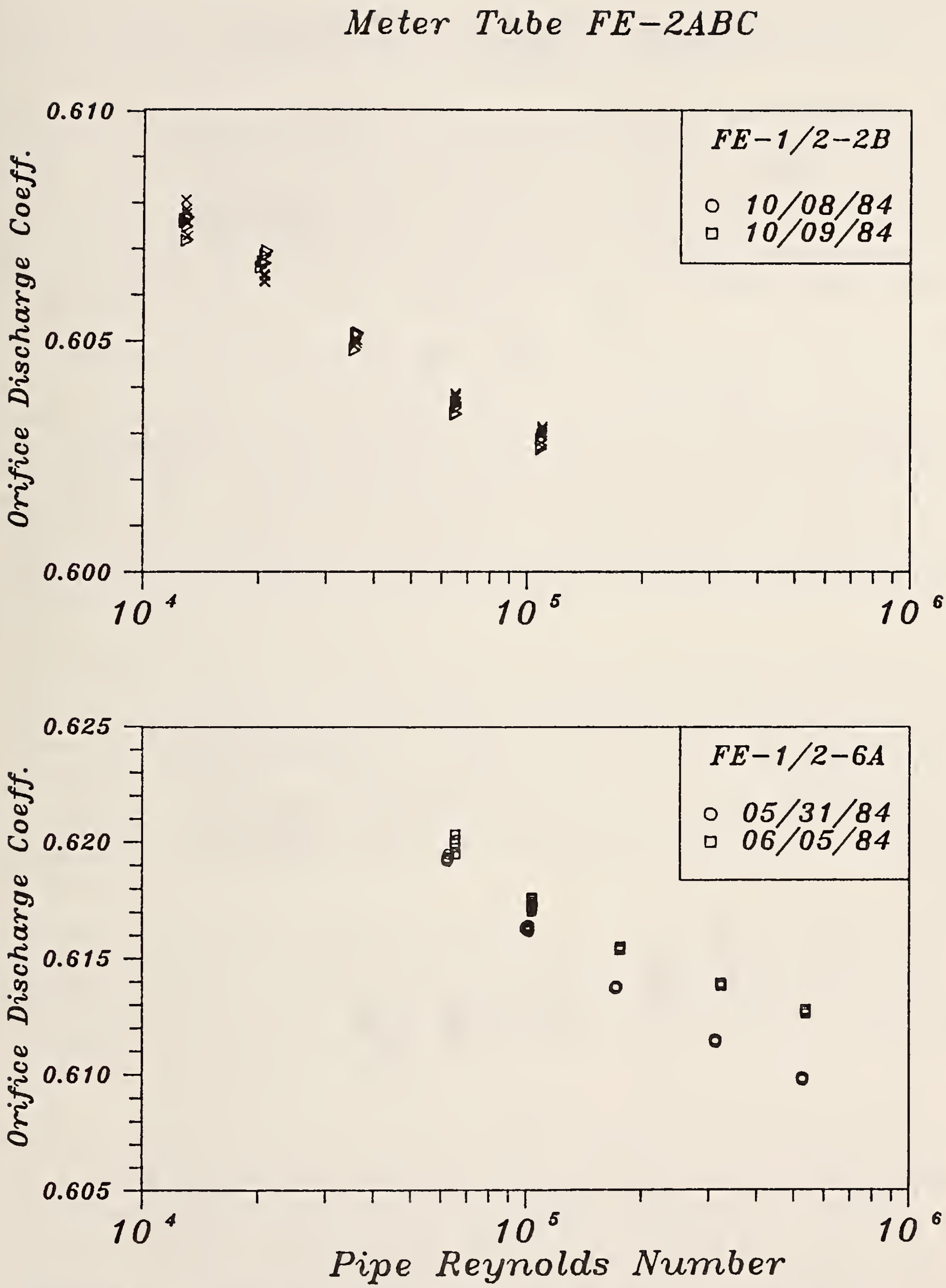


Figure A4. Discharge Coefficient/Reynolds Number Plots, 2-Inch Meter Tube, Beta Ratio 0.375 and 0.75 Orifice Plate, 1984 Observations

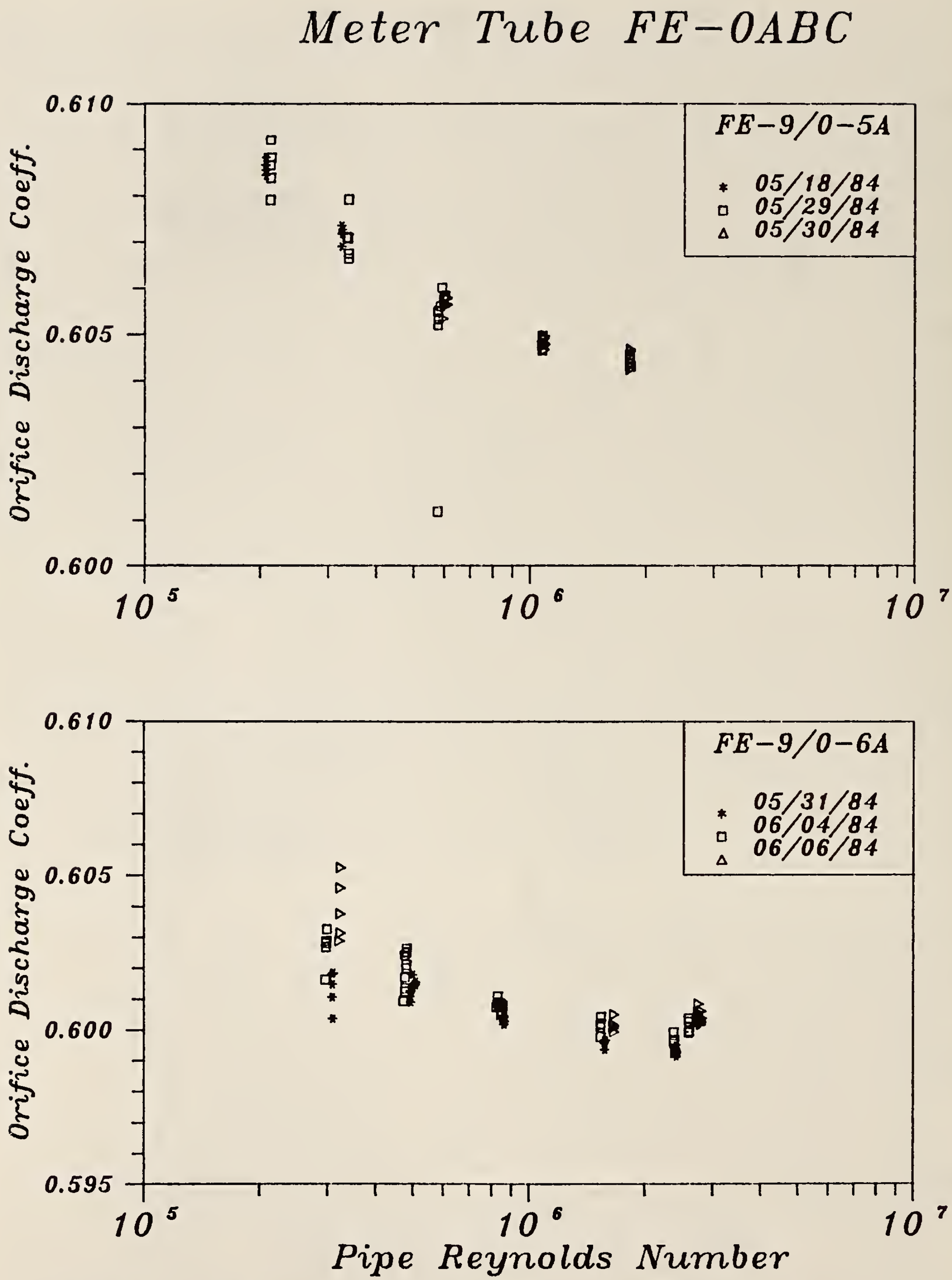


Figure A5. Discharge Coefficient/Reynolds Number Plots, 10-Inch Meter Tube, Beta Ratio 0.62 and 0.75 Orifice Plate, 1984 Observations

variation. The results obtained for the FE-9/0-6A orifice plate have a somewhat larger scatter, but do not exhibit a pronounced day-to-day difference as do the 2-inch meter tube results.

Generally the scatter in the results from the data gathered on the larger beta ratio plates was not absolutely consistent in showing this effect. As a result a considerable level of confusion was encountered since a clearly defined cause and effect relationship was not evident. However, the data base had been substantially completed. The anomalies seen in the results were initially seen as a relatively minor factor which could be eliminated by rerunning those plates having results with unacceptably large day-to-day differences.

IV. Selection of Orifice Meters Requiring Reruns

With the substantial completion of the data base production schedule, the orifice meters to be rerun were to be selected. The selection criteria were based primarily upon the level of internal consistency in the data base, i.e., the level of reproducibility of the results for an orifice meter between observation days. Between-day variation in the results greater than that predicted by the propagation of errors and analysis were considered to be adversely affected by an uncontrolled and undefined source of variability in the system.

As discussed above, a significant number of the large beta ratio plates showed a disturbing degree of non-reproducibility. The degree of variation in the results appeared to decrease with decreasing beta ratio. Unlike the previous occasions in which results were not as expected, the measurement systems were not considered to be at fault. Replication of the results on the small beta ratio plates, coupled with the internal consistency checks in the observation procedures and the small within-group variation, indicated that the measurement systems were performing as expected.

Extensive discussions were held in November and December, 1984 between the NBS Principal Investigator and the Orifice Steering Committee to determine the list of orifice meter tube/plate candidates to be rerun. The dominant concern was the as yet unknown source of the large day-to-day variation in the results on a significant fraction of the total number of orifice plates tested.

With the completion of the testing schedule, all of the meter runs exhibited some visible degree of corrosion. Those which had been involved in the early testing conducted during the initial phase of the project, particularly the FE-5ABC meter tube, showed considerable levels of corrosion throughout each tube section. Although no quantitative surface roughness measurements had been made, it was the feeling of some members of the Orifice Steering Committee and NBS personnel that the roughness level was probably outside the allowable limit of 300 micro-inches given in AGA Report No. 3 and considered as the acceptable limit for commercial practice.

Strong consideration was given to the possibility that increased surface roughness due to corrosion was affecting the results. Several corrosion experts were consulted to determine whether

(1) treatment of the water used in the NBS flow facility could be effective in reducing the level of corrosion in the mild steel meter tubes, or

(2) application of a metallic coating to the meter tubes would inhibit corrosion, i.e., a 0.0005 to 0.001 inch thickness of electroless nickel.

The first course of action was strongly urged by the Orifice Steering Committee which was extremely reluctant to depart from its requirement and concept of the use of "commercial quality" meter tubes for development of the data base. The nickel plating option was suggested by NBS as the most effective and expeditious method. After some investigation and consultation with various corrosion experts, it became clear that the possibilities for water treatment at low concentrations were limited to a small number of chemicals. It was decided to attempt the use of a sodium silicate-based inhibitor for initial testing. If this was not satisfactory then zinc chromate would be considered, although its disposal presented a substantial problem. In treating the water the effect of chemical additives on the density and viscosity of the water was considered to be small since the concentration of the additive chemicals were at the few hundred part per million level or less, and neither were known as strong rheological modifiers in water. A series of tests were planned to investigate rust/corrosion inhibiting effects in an attempt to resolve the discrepancies in the observation data base.

V. Investigations of the Effects of Corrosion Induced Surface Roughness Variations in the Observations.

The FE-5ABC meter tube assembly was shipped to the manufacturer to be refurbished. It was returned to the NBS-Gaithersburg site in late December, 1984. As a result of refurbishment, its diameter had been increased by approximately 0.020 inches. The surface finish of the meter tube in the flange regions appeared to be a newly machined/ground finish and consisted of a bright metallic finish with no visible indications of corrosion. This type of finish extended three to four pipe diameters inside the three meter tube sections. The interior lengths of each tube section were substantially rust free and of a moderate brown color.

A controlled, short set of test runs were planned as an experiment to determine if corrosion was the cause of the previously observed behavior of the discharge coefficient values. These were to use the FE-5ABC meter tube with orifice plates from both 4-inch sets of nominal beta ratios of 0.5, 0.62, and 0.75. Exposure of the meter tube to water was to be minimized to reduce the amount of rust formed in the meter tube assembly. The meter tube sections were to be wiped with ethanol soaked rags and air dried quickly after removal from the test section of the flow facility to remove the remaining water from the tube. The test plan incorporated the 0.5 beta ratio plate as a control plate, since previous results had shown it to be affected less than the larger beta ratio plates. The tests were run January 9, 1985. A synopsis of the results is given below.

V-1. Initial Meter Tube Rust Test Plan Execution and Results

The following report of test results was developed shortly after the test plan was executed.

During the first day, three of the four possible combinations of weighing/diverter systems were used at three differential pressure values (1, 10 and 28 psi) with the 3A plate (0.5 beta), FE-5ABC meter tube. This procedure tested the consistency of the diverter corrections applied for each diverter and was a check of the weighing systems. The collection times were selected to minimize the effect of possible scale errors (5,000 indication units or more were taken). The results are tabulated below.

Diff. Press.	Weighing System Capacity		
(psi)	50,000 lb	10,000 lb	2,000 lb
1		.60699	.60715
10	.6044	.6048	.6049
28	.60515	.60422	

These data were taken with one pump configuration (1000-gpm pump only). Immediately after taking the above data one of the 3000-gpm pumps was used to repeat the 28 psi point. The discharge coefficient value obtained was 0.60532. It appeared that pump disturbances, if present, could be detected within the performance of the system at that time.

During this phase of the tests the density of the water was measured for a sample taken during the tests. The samples from previous fills of the flow facility's sump were measured during late December. All of the measured density values were slightly greater than the corresponding distilled water density by 80 to 150 parts per million (0.015% or less).

Further Analysis of the Data

During the running of the tests, Messrs. Fling, Upp, and Whetstone had extensive discussions of the results (as they were developed) and looked for the existence of correlations between the day-to-day coefficient increase and other system operating parameters. These other parameters included temperature, plate condition (all 4-inch plates on hand were inspected by Messrs. Upp and Fling), and transducer calibration. The following list of possible interfering effects and checks on the performance of various of the measured parameters was compiled.

1. Mass - checked
2. Diverter Time/Crossover - "
3. Weighing System/Crossover - "
4. Plate condition - "
5. Tube condition - clean
6. Transducer Calibration - No variation over time
7. System pressure - See below
8. Temperature - No correlating pattern could be found.
9. Operator quirks - None were found.
10. Computer analysis - No logical errors in the analysis have been found by several different observers.
11. Computer programming - Same comment as no. 10.
12. Pump combinations - None found in these tests or in those carried out by Southwest Research during their investigation of the frequency spectrum seen around the meter taps and in the transducer connection lines.
13. Results evaluation - No effects evident.

Plate condition varied, particularly orifice edge sharpness, but all plates inspected (4-inch sets) by Messrs. Upp and Fling were within acceptable limits. These ranged from as sharp as when made to "not quite as sharp."

Having run the FE-5ABC meter tube for 2 days of testing, the results calculated from the observations showed scatter which was at the level expected from the measurement system performance, i.e., below the 1 part in 600 level at the higher Reynolds number values. Only a very small degree of rusting in the meter tube had occurred and the meter tube was dried and sealed after the tests were completed.

Tests Conducted Using the FE-6ABC Meter Tube

After completing the tests using the FE-5ABC meter tube, the second 4-inch meter tube, FE-6ABC, which had remained in the flow lab since last tested, was put into the line and tests of the FE-5/6-6A plate were begun. The immediate result was that the value of the discharge coefficient was nearly coincident with the last values taken, i.e., the discharge coefficient values at the highest Reynolds number were 1 to 2% above the Buckingham or Stolz values and the initial values obtained for that plate and tube. One of the hypotheses suggested during the course of the discussions of possible causes of the day-to-day effects was cavitation around the orifice itself. Although this did not explain the chronological ordering of the observed effects, a short test was run. Cavitation effects could have been suppressed or reduced by increasing the static pressure at the orifice. The normal operating pressure was 41 psig, measured at the downstream tap. The initial observations of this investigation were made at this pressure for the 6A plate. The pressure was raised to 60 psig and the points were repeated. The coefficient values observed at the higher back pressure closely replicated those observed at the normal operating pressure.

The conclusions drawn from the short tests on the FE-6 meter tube were that the day-to-day effects were much in evidence and could not be suppressed with a rise in the system pressure by 20 psig, which was the practical system maximum. No further changes in the flow system operating parameters could be suggested as the causal agent and the tests were stopped.

Conclusions Drawn from the Test Results

The results of the tests of the FE-5 tube showed that for all large beta ratio plates (6A, 6B, 5A, and 5B), the observed discharge coefficient values were reduced to a level near the originally observed values. The 3A and 3B plates closely reproduced their previous values. The values obtained for nominally identical beta ratio plates were similar and generally agreed with one another within the predicted variation of the experiment.

Further Tests

It was decided to test the FE-6ABC meter tube after it had been cleaned by NBS personnel using a procedure as nearly identical to that used in the refurbishing of FE-5ABC as possible. This procedure entailed the spinning a 3 X 23 inch sander belt on a length of electrical conduit. Belts of 60 to 120 grit were used. The belt is captured in a slot sawed lengthwise in one end of the conduit. (Figure A6 is a photograph of the belts and conduit.) Approximately equal lengths of the belt extend from either side of the slot. The conduit is driven by a hand drill and spun inside the meter tube along its entire length. Wooden spacers were used to ensure that the conduit is near the axis of the tube at all times to eliminate the possibility of gouging the inside surfaces of the tube section. The belt was kept moving along the axis of the tube to reduce the possibility of changing the diameter in one position along the tube. Removal of all rust patches down to the bare metal at either end of the tube was not possible with the equipment at hand. However, all the surface rust was removed and a bright metal finish was evident in a speckled pattern of small sections of the tube interior surface, the remaining corrosion being too hard and strongly attached to remove. The rust removal procedures enlarged the diameters by .002 to .005 inches over the rusted diameter measurements and polished the inner surfaces until they were smooth to the touch.

The FE-6ABC meter tube was installed in the water flow loop for tests of several of the orifice plates. This series of short tests was designed to determine whether removal of substantial portions of rust from the meter tube would reduce the value of the discharge coefficients. The large beta ratio plates were tested first since these showed the

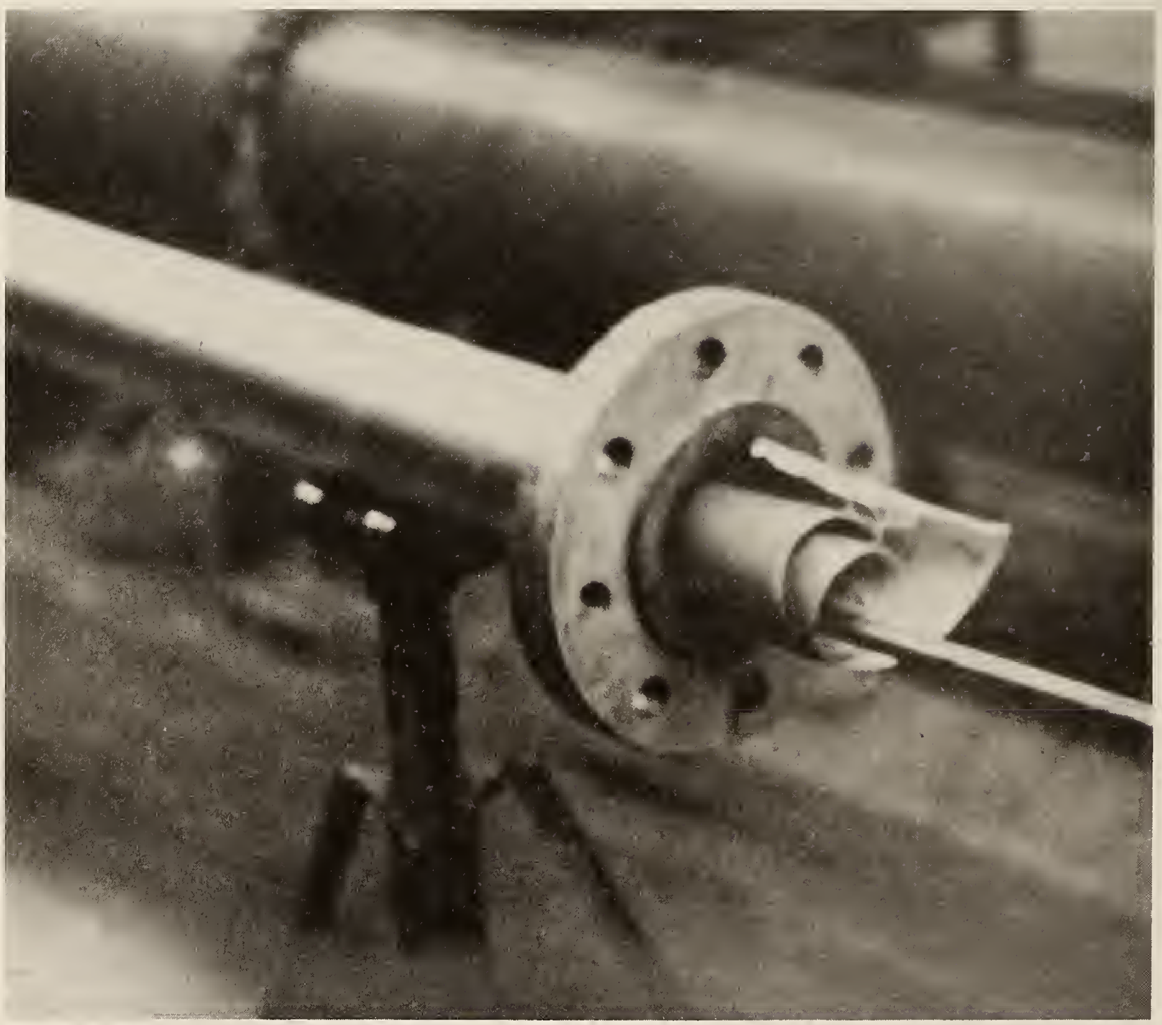


Figure A6. Sanding Belt and Conduit Used In Rust Removal.

greatest effects. The results were dramatically changed from those obtained in the most recent tests with the discharge coefficient values being reduced significantly relative to the corroded tube values for all plates tested. With these results in hand it was decided by the Orifice Steering Committee to have all tubes reconditioned. Although it was generally agreed that a mild steel tube must not be allowed to rust to the point of affecting the test results, the method of corrosion inhibition had not yet been decided. Consequently an extensive set of tests was performed between February and mid-June of 1985 in an attempt to develop a procedure which would inhibit rusting of the meter tube interior surfaces without physical modification of the meter tubes, and without substantial change to the manner and conditions under which the data were collected.

VI. The Search for Chemical Means of Corrosion Inhibition

The search for a means of chemically treating the flow facility water to inhibit corrosion ultimately failed. Two chemicals were considered for use, sodium silicate and zinc chromate. The sodium silicate was used in concentrations up to approximately 100 parts per million and exhibited a level of corrosion inhibition which was not acceptable, i.e., it did not completely stop rust formation. Additional tests with oil-treated meter tube surfaces were performed and proved futile. Finally, the Orifice Steering Committee agreed to electroless nickel plate one of the meter tubes with a nominal thickness of 0.001 inch and to perform test runs on it. This section is given as a brief record of the sequence of events during this period of the project in the hope that future workers will profit from it.

VI-1. Tests of FE-5ABC - No Corrosion Inhibitors

In late January and early February a short series of tests were performed to determine the operating time allowable before the effects of corrosion on the meter tube surfaces were detectable. The FE-5ABC meter tube, which was still very near its refurbished state, was used. The results reported to the Orifice Steering Committee by NBS are given below with minor editorial changes.

> Testing of the FE-5ABC meter tube and selected plates was begun January 31 with the testing of the 2A orifice plate. Before the meter run was placed in the line for testing it was inspected visually. The report of the inspectors (Sam Woo and J. Whetstone) is the following.
>
> 31 January 1985
>
> Section 5B of meter FE-5ABC has been sealed with desiccant and oil since 16 January 1985. Before its return to the system flow loop, it was visually inspected to note its condition. Prior to inspection, the desiccant and oil were rinsed out using (ethyl) alcohol. Upon inspection, the meter section was found to be in relatively clean shape. There was some rust that had formed in the circular cut grooves on the refurbished section of the meter tubes and it seemed to

all be located on one side (as if the meter had sat in one position and collected water). Though the meter section had been rinsed with alcohol, there was still a slight oil residue. Further upstream, in the midsection of the meter section, the pipe was still dark colored. The 2A plates were run on Thursday, January 31. The meter run was left filled with water overnight and the upstream meter tube (FE-5B) was raised (from the test section rack) and inspected for corrosion the following morning. The report of the inspector is the following.

> Meter FE-5ABC was run 1/31/85 and left full of water overnight. After draining the meter the morning of 2/1/85, the 5B section was lifted from the line and inspected. As the inner surface dried, a light film of rust became visible on the refurbished surface which could be rubbed off with a finger, but the fine grooves formed by the refurbishing could still be felt with a fingernail. The refurbished area extends 9 inches into the 5B-D end of the section and 6 inches into the 5B-U end of section 5B.

Dr. Whetstone inspected the tube also. The following is a portion of his report entered in the notebook files on the subject.

> Following the original tests in January surfaces of the meter tubes were somewhat discolored with a light coating of rust. This coating covered only a small fraction (25% or so) of the bright metal regions near the flanges. Also a darker color was appearing. These darker colored regions are spreading as the testing has been continued now.

The 3B and 4A plates were run February 1 and the meter run was left filled with water over the weekend. Again the B section was inspected, as were the other sections at their open flanges. The inspection occurred after the running of the 3B plate in the morning. A substantial increase in the level of rust in the meter tubes was generally evident. Surface rust could be removed easily with a paper towel or rag, but beneath this layer a harder level of corrosion had developed. Dr. Whetstone decided that an attempt should be made to remove the rust using 120 grit sanding belts in the manner described in the January report. This procedure succeeded in removing the large majority of the rust and restoring the regions near the ends of the B and C meter tube sections (sections adjacent to the orifice plate) to a bright metal finish similar to that after refurbishing. There were some very small areas of rust in the surface grooves that were not removed. The surfaces felt smooth and the circumferential surface grooves could be felt easily with a fingernail.

The meter was re-installed in the test loop and the 5B, 6A, and 6B plates were run on Feb. 4 and 5. The 6A plate was run on the morning of Feb. 6. Then the meter tube was again taken down and inspected. The inspection report is the following.

Sections 5B and 5C were taken down and cleaned after this morning's pass on plate 6A. The meter sections showed substantial corrosion as rust could be seen growing from the grooves in the refurbished sections of pipe. The sections were cleaned using the hand drill and 120 grit sand paper. The majority of rust was removed but a thin coating remained on the pipe. This coating could be rubbed away using a rag. It appears that the rust is beginning to discolor the surface of the metal. After the meter tube is cleaned, the surface does not completely shine as brightly metallic as it did originally. Instead there are some dark patches that appear on the pipe.

The meter tube was remounted and the 4A and 5B plates were tested on February 7. Testing of the meter tube was suspended at this point due to deterioration of the meter tube surfaces. (In the above discussion the surfaces referred to are those at the flanges of each tube where the refurbishing had produced a bright metallic surface two to three diameters into the meter tube.)

Test Results

The results of this series of tests will be given by plate chronologically and qualitatively.

Plate 2A - Jan. 31, 1985 - The discharge coefficient values consistently fell below the previous data, taken in late March and early April 1984, except at low Reynolds numbers. The new data is from 3 to 15 parts in 6,000 higher than Stolz/Buckingham.

Plate 4A - Feb. 1, 1985 - The discharge coefficient values are similar to that of 2A and uniformly below the previous data, taken late March to early April, by 2 to 3 parts in 600.

Feb. 7, 1985 - The data shows the between day variation seen previously. The magnitude of the variation is approximately 1.5 parts in 600 at the highest Reynolds number and 0.3 parts in 600 at the lowest Reynolds number. The variations increase uniformly with Reynolds number.

Plate 3B - Feb. 1, 1985 - The discharge coefficient values match the previous data within the variation seen in a set of five observations. The previous discharge coefficient values have some significant between-day scatter at the lowest Reynolds number.

Plate 5B - Feb. 2, 1985 - The discharge coefficient values fall within the previous data, which has a variation of approximately 2.5 parts in 600. At higher Reynolds numbers these values progressively drop to the lowest values of the previous results.

Feb. 7, 1985 - The discharge coefficient values exhibit the classic between-day variations seen previously, with the low Reynolds number values agreeing well with the Feb. 2 values with the difference between the 2 day's values becoming progressively greater. The highest Reynolds number values are near the top of the band of the data taken in February, March, and April 1984

Plate 6B - Feb. 5, 1985 - The discharge coefficient values lie below the previous values (March, May and June 1984) at low Reynolds numbers and within the lower portion of the previous data band at the high Reynolds numbers.

Feb. 6, 1985 - The discharge coefficient values replicate the Feb. 5 results and lie approximately 3 to 5 parts in 6,000 below them.

Plate 6A - Feb. 5, 1985 - The results are similar to that of 6B but are somewhat closer to the bottom of the data band of the early 1984 6B data.

Feb. 6, 1985 - The discharge coefficient values replicate the Feb. 5 results but lie above them by as much as 1 part in 600.

The FE-5ABC meter tube was taken from the test loop and dried out. It was not sealed since considerable rust had accumulated throughout the tube. A bright red layer of surface rust is evident on all interior surfaces of the meter tubes.

VI-2. Test Results with N-Sodium Silicate Treated Water

In late February 1985 a quantity of N-sodium silicate had been obtained and the water was dosed with a concentration of 25 to 30 parts per million. This was the concentration level recommended by a corrosion expert furnished by the API. Tests were performed using a stainless steel 3-inch meter tube furnished by the Gas Research Institute through its research contract with the NBS Boulder Laboratories. Base line data had been obtained with the meter tube before treating the water. The discharge coefficients observed on February 27 using the 0.75 beta ratio orifice plate agreed with the base line data taken the previous week.

The FE-5ABC meter tube was placed in the line and and test runs were made on the 0.75 beta ratio plate, 6B. The meter tube had been reconditioned using the sanding belt method. The first test run data with the sodium silicate treated water was taken on March 1. Test runs were made using the 5B plate (beta - 0.66) on March 4 and 5.

The second day's data on the 6B plate was taken on March 6. The results showed a day-to-day effect of approximately 1% in the discharge coefficient. This set of observations was repeated March 7 after leaving the meter tube filled overnight. The day-to-day effect was still evident with the discharge coefficient values increasing approximately 1 to 2 parts in 600 at the highest Reynolds numbers. The meter was removed from the flow line and visually inspected. A fine powdery coating of rust was on the surface of the meter tubes. Distributed along the pipe wall were grains of rust which could not be brushed off with a finger as the fine rust dust could. These grains were approximately twice the size of a grain of table salt. Some could be dislodged with a fingernail, others with light pressure from a knife blade. Photographs were taken of the interior of the meter tube at the upstream flange. These clearly showed the definite patterns developed on the interior surfaces of the meter tubes. There were very definite patterns of rust grains. The grains were disposed in roughly circular and helical patterns around the pipe circumference with areas between the corroded areas which had almost no rust grains in them and appeared to be very near the surface condition before the tests were begun. Two of the more illustrative of these photographs are given in figures A7 and A8.

During this time a product bulletin for the inhibitor arrived from its manufacturer which recommended concentration levels of 100 to 300 parts per million with a pH range of 7.0 to 9.1. The concentration in the flume water was increased from 25 to 88 parts per million, which used the entire drum of N sodium silicate solution on hand. Also, the pH was adjusted to approximately 8.1, which matched the value for the untreated flume water samples. FE-5ABC was conditioned again using the sanding belts and data was taken over the full range of flow rates on March 8. The discharge coefficient values were very near those obtained earlier with the refurbished surface. The meter tube was left filled with flume water over the weekend and the second set of observations were made over the full flow rate range on March 11. The difference in discharge coefficient values between the 2 days at the highest Reynolds number was 4.5 parts in 600 (approx. 0.6%).

The meter tube was removed from the test section for visual inspection. Corrosion had once again appeared on the meter tube surface. The pattern of corroded areas was similar to the previous one. The general appearance of the surface was different from the 25 ppm inhibitor case in that the corroded areas had a pronounced yellow hue. Also the amount of corrosion appeared to have diminished somewhat, but not dramatically. With these results the use of N-sodium silicate for corrosion inhibition was no longer considered to be a viable alternative, and the water was removed from the facility reservoir. The reservoir was refilled with water from the municipal water mains.

The use of zinc chromate was then considered but rejected on the grounds of difficulty of disposal. The treatment necessary to dispose of 60,000 gallons of water treated with zinc chromate was of such a magnitude that NBS was not willing to treat the water.

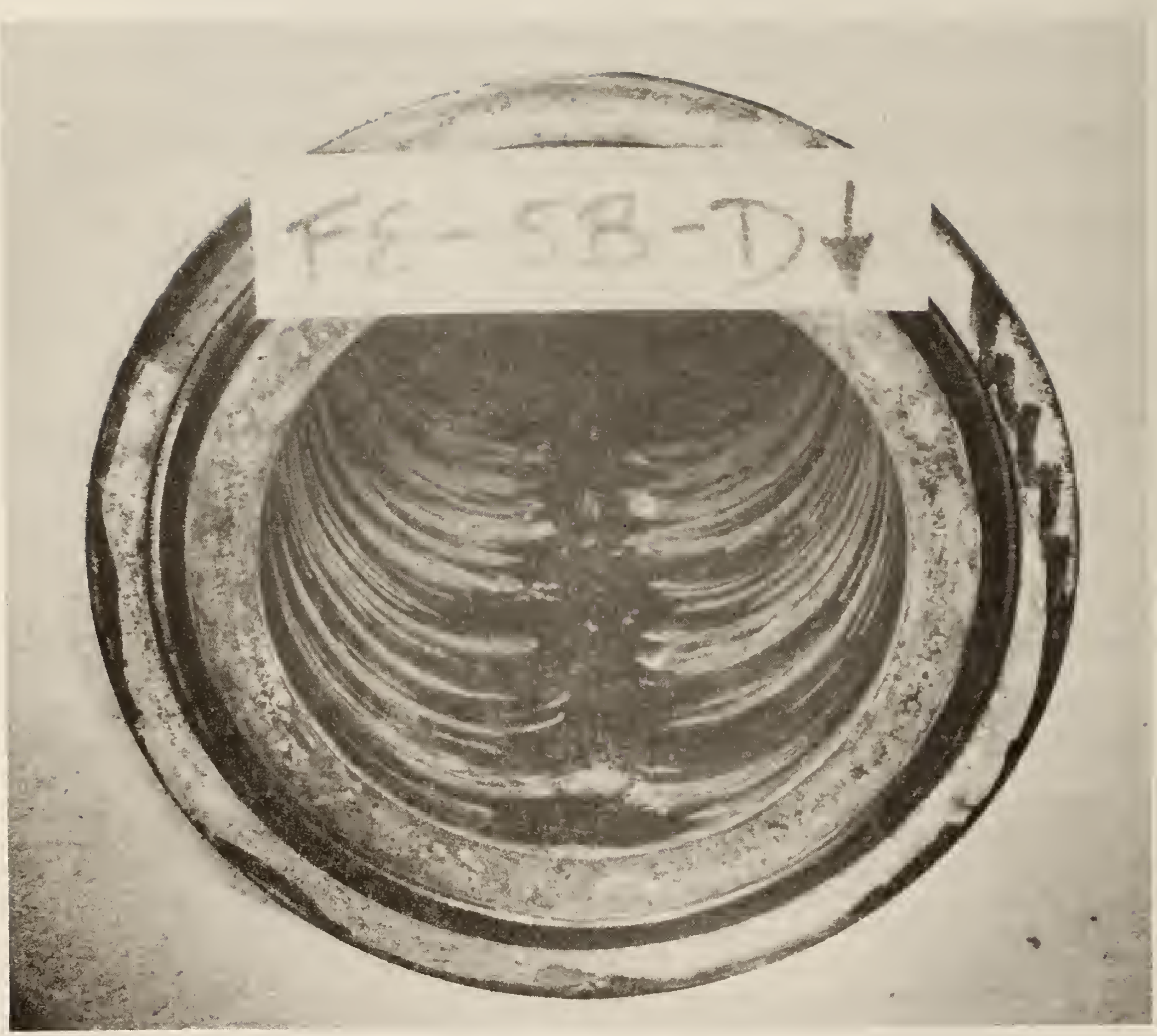


Figure A7. Corrosion Patterns in the FE-5B Meter Tube Section After Testing with N-Sodium Silicate Treated Water.

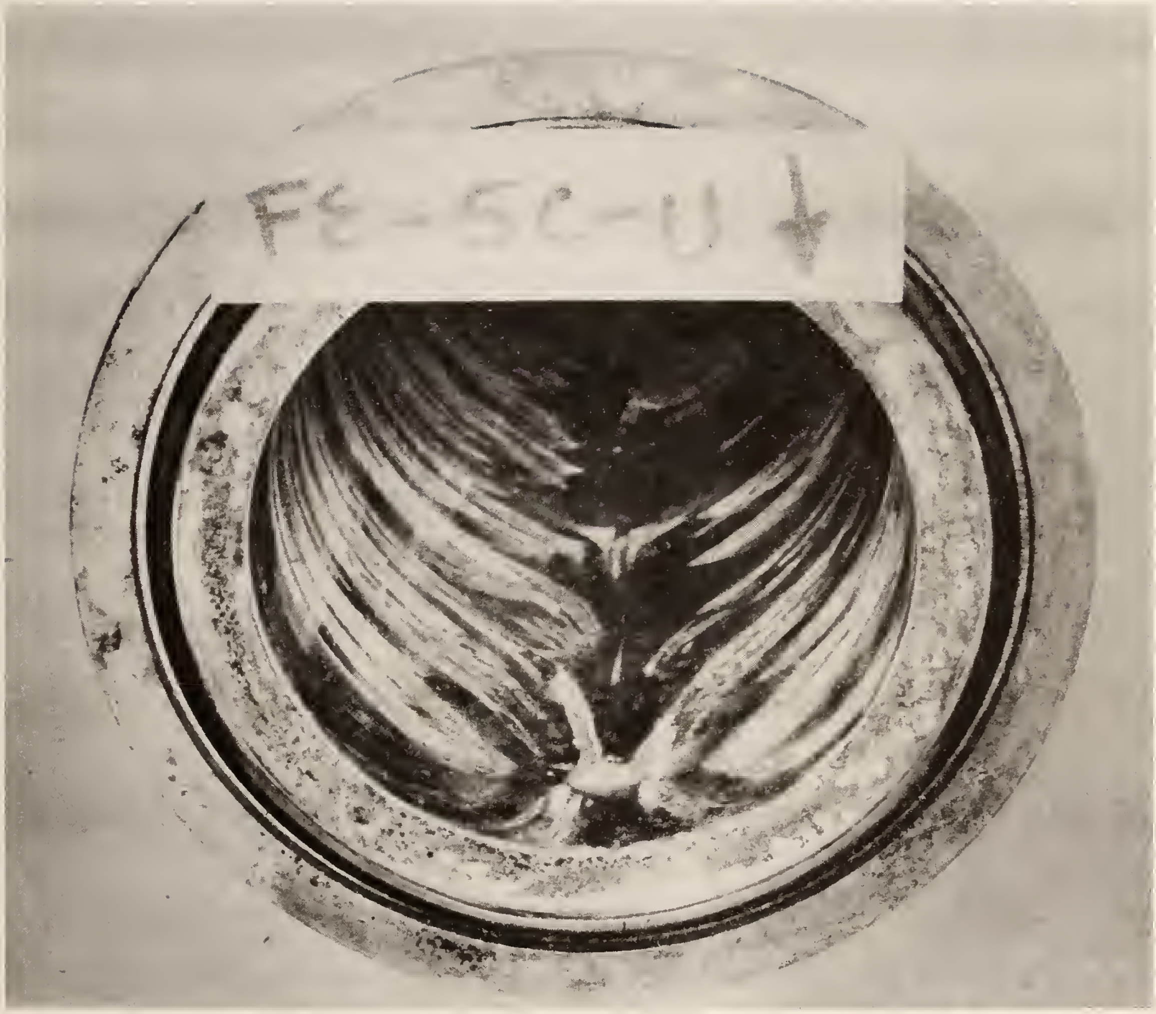


Figure A8. Corrosion Patterns in the FE-5C Meter Tube Section After Testing with N-Sodium Silicate Treated Water.

VI-3. Oil Treatment and Testing of the Meter Tubes Leading to Electroless Plating of the FE-6ABC Meter Tube

In early April 1985 the API's Orifice Meter Database Steering Committee recommended what it termed a "pull and wipe" strategy consisting of the following steps:

1. The meter tube would be initially wiped with a light weight oil through its entire length before a test run.

2. It would periodically be pulled from the test rack, inspected, and any rust removed using the sanding belt method,

3. The interior surfaces wiped with oil again, and reinstalled in the test rack for further tests.

A test of this procedure was scheduled to begin on the morning of April 8, 1985 with designated members of the Orifice Steering Committee in attendance. The FE-5ABC meter tube was used. An edited version of the report of that work is given below.

Extended Test Run - April 8 - 10, 1985

This test was designed to simulate the operating conditions proposed for rerunning of the orifice meter data base. The proposed schedule involves running of the flow system on a 24-hour-a-day basis. Therefore, this test involved running of the system continuously for a period approximately equivalent to the amount of time estimated to complete the data collection for one meter tube (all plates - one set). The estimated time is 56 hours barring any difficulties.

April 8

The meter tube was prepared using the sanding belt technique. The surfaces of the meter tube are a shiny dark color after passing the spinning belts along the meter tube surface. This preparation was used along the entire length of the meter tube and produced a smooth surface to the touch. The meter tube was wiped with an oily rag containing 10W 40 lubricating oil. The rag was passed through the tube sections twice. This resulted in the appearance of a shiny surface along the entire length of the meter tube. The tube's inner surfaces appeared to be coated uniformly with oil.

The meter tube was placed in the test rack and the beta 0.75 plate was installed in the orifice flange. Data collection was begun at 11:00 a.m. April 8, 1985. Observations were made over the range of differential pressures (0.4 to 28 psi). A beta 0.375 plate was installed (approx. 30 minutes was necessary to do this) and data at the highest differential pressures were taken. The system was allowed to run unattended all night long. The measurement system was shut off for the night while the flow system ran throughout the night.

April 9

At about 8:00 a.m. the flow system was shut down and the meter tube was removed from the test rack for inspection. The inspection report of Mr. Sam Woo is given below.

FE-5C - "Upon initial inspection, the wet pipe showed little or no corrosion. The surface still had an oily residue along all surfaces of the pipe (5 - 10% of the pipe surfaces have a light coat of rust. All in all, it showed a minimal amount of corrosion.). The surface still had an oily residue (could be smudged with fingerprints). The rust could be wiped/rubbed out on the interior of the pipe but not along the flange edge. There was more rust along the bottom of the pipe than on top. The rust has a very fine consistency."

FE-5B - "The upstream meter section doesn't look nearly as bad as the downstream section. The characteristics of the corrosion are similar to the downstream section but there is less rust."

The meter was reinstalled in the test rack with no treatment of the tube and the water flow started by 10:30 a.m.. The beta 0.75 orifice plate was installed and the observation points of the previous day were repeated. Both sets of results agreed within the uncertainty of the measurement system. That is, the mean values of each set of five observations at a flow rate taken over the 22-hour period reproduced one another within 3 to 5 parts in 6,000.

The beta 0.5 orifice was placed in the meter and data were obtained over the range of differential pressures.

The flow system was allowed to run unattended overnight.

April 10

Beginning at 11:52 a.m. data were taken on the beta 0.75 orifice plate after it had been installed. Again the data were taken over the range of differential pressures. The discharge coefficients calculated from this data showed the characteristic (day-to-day) increase with Reynolds number. The difference between the discharge coefficients at the highest Reynolds number points (28 psi diff. press.) was .0014 or 0.23 percent.

The 0.5 beta ratio plate was installed and run at 17:00. These values agreed with those taken the previous day (oil film assumed to be still intact) within 0.1 percent or better which is about the reproducibility expected of the measurement system. Both sets of values agreed with those taken in early January 1985 when the meter tube interior surfaces were newly refurbished and in a bright metallic condition. The system was shut down and the plate removed at 17:30. Total running time - approx. 56 hours.

April 11

The meter tube was inspected. Corrosion patches were evident on the tube's interior surfaces. These were not the powdery rust observed at the 22-hour inspection, although such rust dust was generally present over the surfaces of the tubes. A harder and physically larger type of corrosion was observed which consisted of either single nodules or patches of nodules. These were rather hard, although single nodules or small groups of nodules could be broken off the surface either totally or partially intact with finger pressure only. It was found that by fitting a 35-mm camera with the proper lenses a magnified photograph of the surface could be taken. This was done in several places on both the C and B sections of the tube. The photographs shown in figures A9 and A10 are representative of that series of photographs. Both were taken of areas near the flange face of the meter tube section. In figure A9 a tap hole (1/2-inch diameter) is in the center with a 0.5 millimeter (0.020 inches) length of pencil lead placed on the surface between the tap hole and the flange face to give an impression of the scale of the rust nodules. Figure A10 shows an area to the side of the tap hole which has a somewhat greater coverage of rust nodules occurring both singly and in multiple nodule patches.

An attempt at a quantitative measurement of the size of the nodules was attempted. A telemicroscope was used to focus on a single nodule formed near the top tap hole of the downstream meter section (meter section C). (This nodule is shown as the bright speck located at the upper left of the pencil lead in fig. A10.) The telemicroscope was mounted on a traversing stage having a resolution of 0.00001 inches. The microscope stage was moved until a crosshair was tangent to one side of the nodule. The traversing stage reading was recorded and the stage moved until the crosshair was tangent with the opposite side of the nodule. This was repeated several times. The results of this measurement indicate that the diameter of the nodule was of the order of 0.001 inches. Therefore, its height above the surface would be of the same size assuming a roughly spherical shape for the nodule.

In viewing patches of nodules with the telemicroscope the general appearance of the patches was that of an aggregation of nodules connected with smaller nodules forming a continuous layer. It would be expected that the height of these patches above the surface was the same as that of a single nodule. The patches covered from 20 to 50 percent of the surface.

Following this testing schedule it was decided that the "pull and wipe" strategy recommended by the Orifice Meter Database Steering Committee would be followed in subsequent tests. Running periods of 18 to 20 hours between pulling and wiping of the meter tube would be used.

Figure A9. Photograph of Corrosion Nodules Around the Tap Hole of FE-5B After Tests Using Oiled Surfaces for Corrosion Inhibition

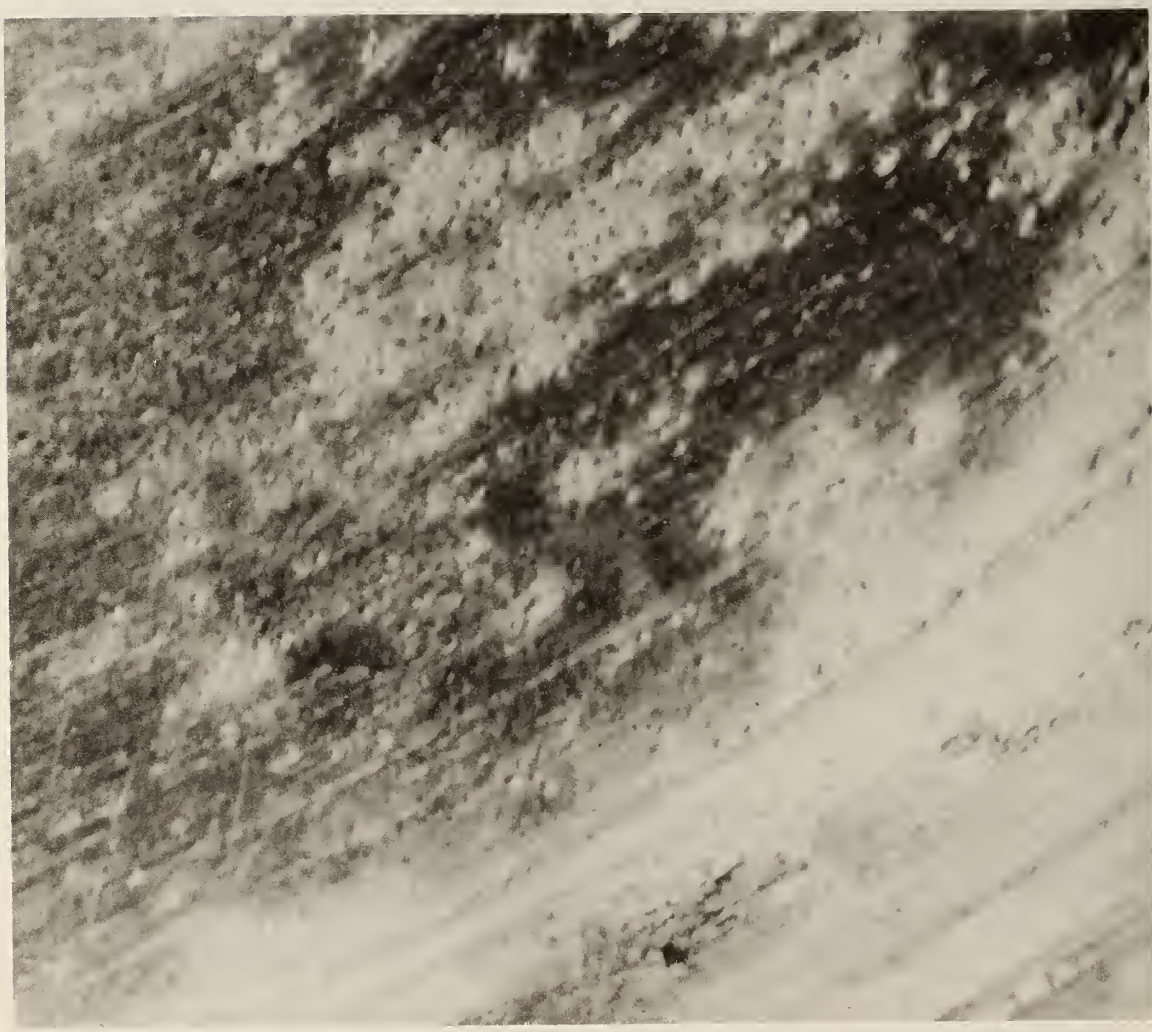


Figure A10. Photograph of Corrosion Patches to the Side of the Tap Hole of FE-5B After Tests Using Oiled Surfaces for Corrosion Inhibition

VI-3A. Tests of the Effect of Oiled Surfaces Using the GRI 3-Inch Meter Tube

NBS proposed a set of tests to determine whether the hydrophobic nature of any oil used for wiping would affect the results of the tests. These tests were performed with the GRI 3-inch stainless meter tube so that removal of the oil from the surfaces would not result in corrosion induced discharge coefficient value increases. In this way it was intended to limit the experiment to changes induced by the presence of oil alone. Extensive testing was performed using several different types of oils. Sets of test runs were made with the stainless steel meter tube oiled and not oiled. These were done between May 23 through May 29, 1985.

Three complete replicates of the data set were run consisting of all five flow rates for both the 2A and 6A plates with the meter tube surfaces alternately oiled and not oiled. This data has provided the basis for an estimate of the reproducibility of the measurement system (2A plate data) and an estimate of the magnitude of the effect that oiling the meter tube surfaces may have on the discharge coefficient values for the 6A plate. A rigorous statistical analysis was performed by the NBS Center for Applied Mathematics, Statistical Engineering Division. The major conclusions of this analysis are given below.

1. Effects of oil on the discharge coefficient

   An increase in the discharge coefficient is seen at the higher Reynolds number for the 6A plate (0.75 beta ratio) with an increase of approximately 0.004 discernible at 28 psi. For the 2A plate (0.375 beta ratio) a decrease of 0.006 in the discharge coefficient is seen at the two lowest flow rates (0.4 and 1.0 psi differential pressure) with the remainder of the flow rates showing no discernible effect.

2. No temperature dependent effects were found over the range of 26 to 38 °C.

3. A criterion for the identification of outliers in the data has been developed. This criteria will be used in an attempt to maintain real-time statistical control of the measurement process in the future.

4. The results of the measurements on the 6A plate show a temporal drift of several parts in 600 across the Reynolds number range. This drift is systematic at the higher flow rates. The 2A plate does not show this drift. The data to be collected on the 4-inch, stainless steel meter tube will be used to determine the magnitude of drift in the measurement system during the remainder of the orifice meter tests.

5. Initial estimate of measurement system reproducibility

This initial estimate is based on 8 days of measurements taken on the 2A plate. These data extend over a period of approximately 5 months. Three times the total standard deviation for these data is 0.00064 in the discharge coefficient. This is a relative uncertainty of approximately 1 part in 1,000.

From these limited tests it appeared that the presence of oil on the surface of the 3-inch stainless meter tube could be detected in the discharge coefficients.

VI-3B. Oiled Test of FE-5ABC Meter Tube

Since the GRI stainless steel meter tube was considerably smoother than the typical mild steel tubes, a test was run to investigate the residence time of the oil for a mild steel meter tube. The 4-inch meter tube, FE-5ABC, was set up for a 24-hour test. The FE-5ABC mild steel meter tube was oiled using a commercial 30-weight oil. A swab consisting of rags wrapped in a soft cloth was used to coat the interior of the meter tube. A similar swab was passed through the meter tube sections to remove the excess oil. This removal was quite thorough, causing some concern over the lifetime of the oil coating. The meter tube was mounted with the 6B orifice plate (0.75 beta ratio) between the orifice flanges and the base case data was taken beginning at 14:10 on May 16, 1985 (three observations at each of the five usual flow rates). Following this the water flow was maintained through the night.

The next day data collection began at 10:24 at a differential pressure of 10 psi. Data collection procedures were completed at 16:20 with a 28-psi data point. The 10- and 28-psi results are summarized below.

Date	Run No.	Time	Diff. Press. (psid)	Discharge Coefficients Ruska	Upper	Lower
05/16/85	1 - 3	13:48	10	.60396	.60397	.60397
05/17/85	19 - 20	10:24	10	.60407	.60418	.60419
05/16/85	16 - 18	15:36	28	.60219	.60222	.60223
05/17/85	34 - 36	12:29	28	.60292	.60307	.60307
05/17/85	52 - 54	16:05	28	.60290	.60293	.60293

As a check of these results a second test was performed beginning Monday, May 20, and completed Tuesday, May 21. The meter tube was prepared using the sanding belt method and the 30 weight non detergent motor oil was applied using a rotating rag method. After this application a dry rag was passed through the tube sections to remove excess oil and the meter tube was mounted in the test rack with the 6B orifice plate in place for testing. The tests were begun with the taking of the initial data and the water flow was maintained at a significant pipe Reynolds value throughout the night. The replicate data was taken the following morning, the meter tube dismounted from the test rack, air dried with compressed air and inspected. The discharge coefficient results of this test are given below.

Date	Run No.	Time	Diff. Press. (psid)	Discharge Coefficients Ruska	Upper	Lower
05/20/85	55 - 57	11:09	10	.60341	.60345	.60346
05/21/85	73 - 75	09:26	10	.60400	.60390	.60390
05/20/85	58 - 60	11:24	28	.60183	.60185	.60185
05/21/85	76 - 78	09:46	28	.60269	.60268	.60270

Visual and tactile inspections of the meter tube surfaces were made following each dismounting of the FE-5ABC meter tube. These inspections yielded similar observations. In both cases the meter tube did not have substantial, newly corroded areas. The surface was mainly smooth to the touch with isolated nodules of rust easily distinguished by touch from the surrounding metal surface. It was noted that due to the large number of tests which had been run on the meter tube since it had been refurbished back to a bright metal surface, the tube surface color had turned a dark brown color with several pits in the surface. The abrasive treatment of the surface with the rotating sanding belts had smoothed the surface to the point that it had a sheen to it immediately after the treatment. A light dusting of very fine rust grains came off on the fingers. A light scrubbing action across the surface with a finger did not remove the larger rust nodules.

In both of these cases the results of the tests showed a small systematic shift upward in the value of the discharge coefficient after about 24 hours of continuous running. However, the magnitude of the shift was within the expected performance of the measurement system.

VI-3C. Initiation of Testing of the Mild Steel Meter Tubes

Even though the results of tests on the GRI stainless steel meter tube and on the mild steel meter tube were somewhat conflicting, the need to proceed with the generation of a viable data base was great and plans were made to proceed with that testing. Testing of both 3-inch mild steel meter tubes and the 4-inch stainless meter tube were scheduled to begin the week of June 3. The mild steel tubes had been refurbished as mentioned earlier and had not been run in the flow facility at all. A 4-inch stainless meter tube had been obtained to act as a check standard during this final attempt to develop the data base. The tests were scheduled to run on a three shift per day basis with the following objectives:

1. Determine the amount of time necessary to complete testing of a set of seven plates (Beta ratio 0.1 to 0.75) with a single set-up of the meter tube. This was expected to be 24 to 30 hours of continuous operation based on previous, shorter-term tests.

2. Develop data on two of the mild steel meter tubes (complete two passes on FE-6ABC).

3. Develop the base-line data (two replicates) for the 4-inch stainless meter tube. This depends upon the arrival of the meter tube. If the tube does not arrive in time to complete two replicates, the second replicate of FE-4ABC will be done.

4. Use a replicate test of the largest beta ratio plate to determine whether oiling of the meter tube's interior surfaces effectively inhibits corrosion to an extent that the test results were not affected. The largest beta ratio orifice plate was selected for this test since past results have shown that the effect of pipe corrosion was most pronounced in the results on the large beta ratio plates.

Operating Schedule -- Week 1 - three shifts/day

Day	Meter Tube	Size	Plate Sequence
1	FE-4	3-inch	6,4,5,2,3,7,1,6
2	FE-6	4-inch	6,5,1,4,2,3,7,6
3	SS-4	4-inch	6,4,5,2,3,7,1,6
4	FE-6	4-inch	6,4,5,2,3,7,1,6
5	SS-4	4-inch	6,5,1,4,2,3,7,6

In preparation for continuous testing, the flow facility sump water was substantially replaced on June 2 to obtain the lowest water temperature possible at the beginning of the test period. The tests on the GRI stainless steel, 3-inch meter run, in the oiled/not oiled tests, had raised the water temperature to above 35 °C. It was expected that as the tests progressed through the week, the water temperature would reach rather high temperatures due to the almost continual pumping. The water change was completed early in the evening of June 2.

The first shift of the week was begun at 22:00 hours, June 2 with the inspection (diameter measurements and visual inspection) and mounting of the FE-4ABC meter tube. This required several hours, including the coating of the inner surfaces of the tube with 30-weight non detergent lubricating oil, API Grade SB. The meter tube was first wetted with water at approximately 03:30 on June 3, and the initial data on the 6A orifice plate was begun at 05:30. The intervening time, 03:30 to

05:30, was necessary to clear the air from the flow lines. The first day's schedule for the week was followed and the replicate data for the 6A plate was taken at approximately 05:30 on June 4. The meter tube was immediately taken down and dried by blowing compressed air through the meter tube sections until the inner surfaces were dry.

Results of the First Day's Testing

1. The results of the data taken at the last of the test runs on the 6A plate were divergent by 2 to 3 parts in 600 at the highest Reynolds number values relative to the initial values. This divergence was a clear indication that the oil coating had not prevented corrosion from occurring in the meter tube.

2. A visual inspection of the meter tube surfaces was made. The tube's inner surfaces were covered uniformly with a red rusty coating which had two distinct topologies. The first was observed in the upstream meter tube section, FE-4A, and the upstream portion of the second section, FE-4B. The rust was formed roughly into streaks extending longitudinally along the tube wall. These were separated by areas which had a smaller degree of corrosion, but were still lightly covered with a red dusting of rust. In these areas the original tool marks in the tube wall could be observed visually. Near the orifice plate flanges the streaks gave way to the second topology, a speckled pattern of rust. The speckles were separated by areas similar in appearance to those separating the streaks in the upstream tubes. The downstream meter tube, FE-4C, showed a transition from the speckled pattern to the streaked pattern about midway down its length. The position of the weld between the flange and the meter tubing was clearly marked as a continuous ring around the tube's inner circumference.

3. Pictures were taken of the corrosion patterns near the orifice meter flanges. Figure A11 is one of the photographs taken of the FE-4B meter tube. Figure A12 shows the area around the tap hole on downstream tube FE-4C.

4. Surface roughness measurements were made using a stylus-type surface roughness measurement instrument. A measurement was made in the location of the previous measurements for the tube, i.e., near the tap hole on the upstream meter tube, FE-4B. Successive readings were 190, 170, and 150 microinches. These were taken with two traverses of the stylus comprising each reading. The downward force on the stylus is estimated equivalent to 1 to 2 grams. The stylus was probably crushing the rust progressively as it made successive traversals over the surface. With the use of an instrument of this type, the apparently fragile structure of the rust was seriously affected by the roughness measurement itself and did not accurately reflect the surface profile of the rusty meter tube.

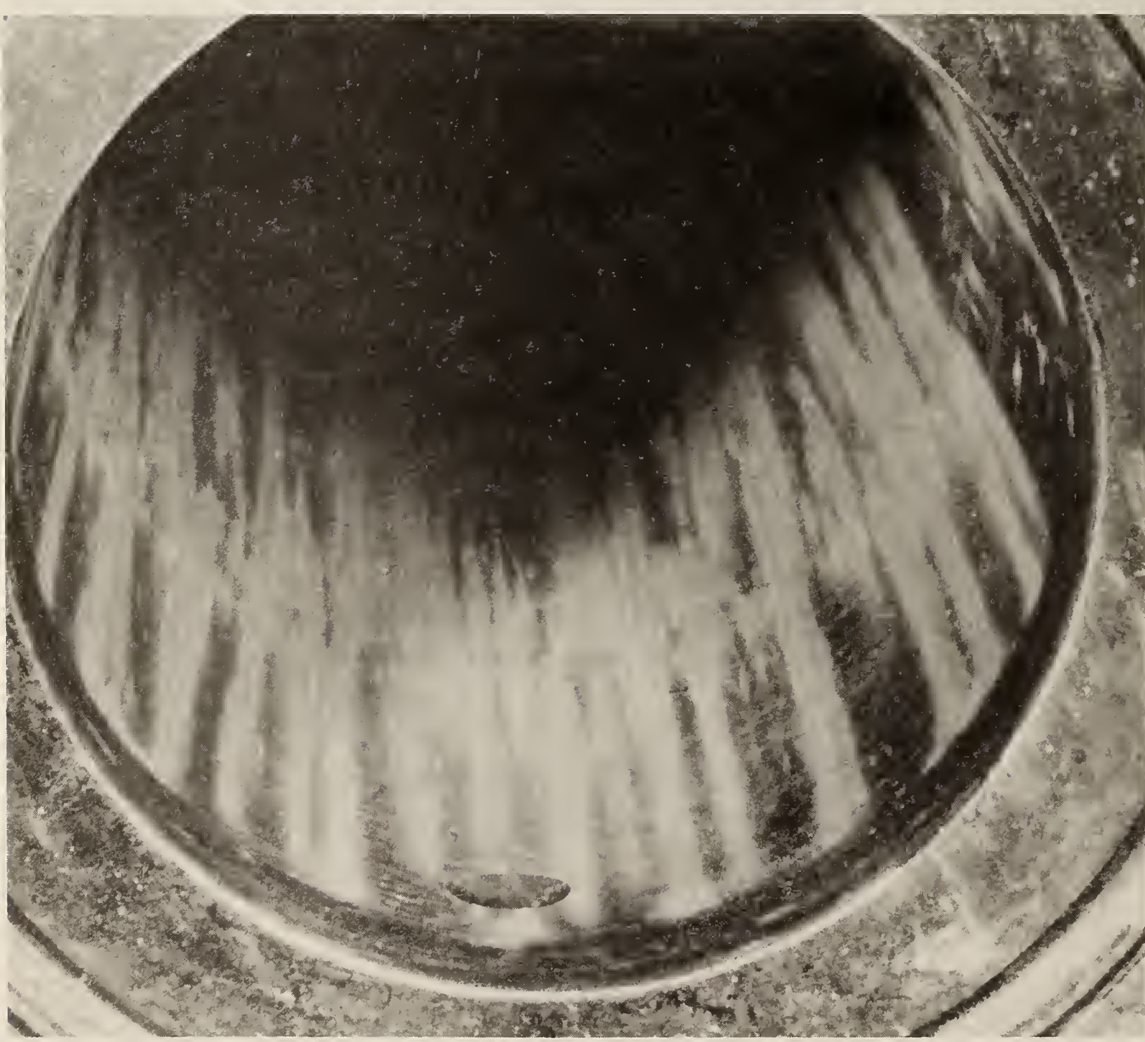


Figure A11. Photograph of Speckled Corrosion Pattern on FE-4B.

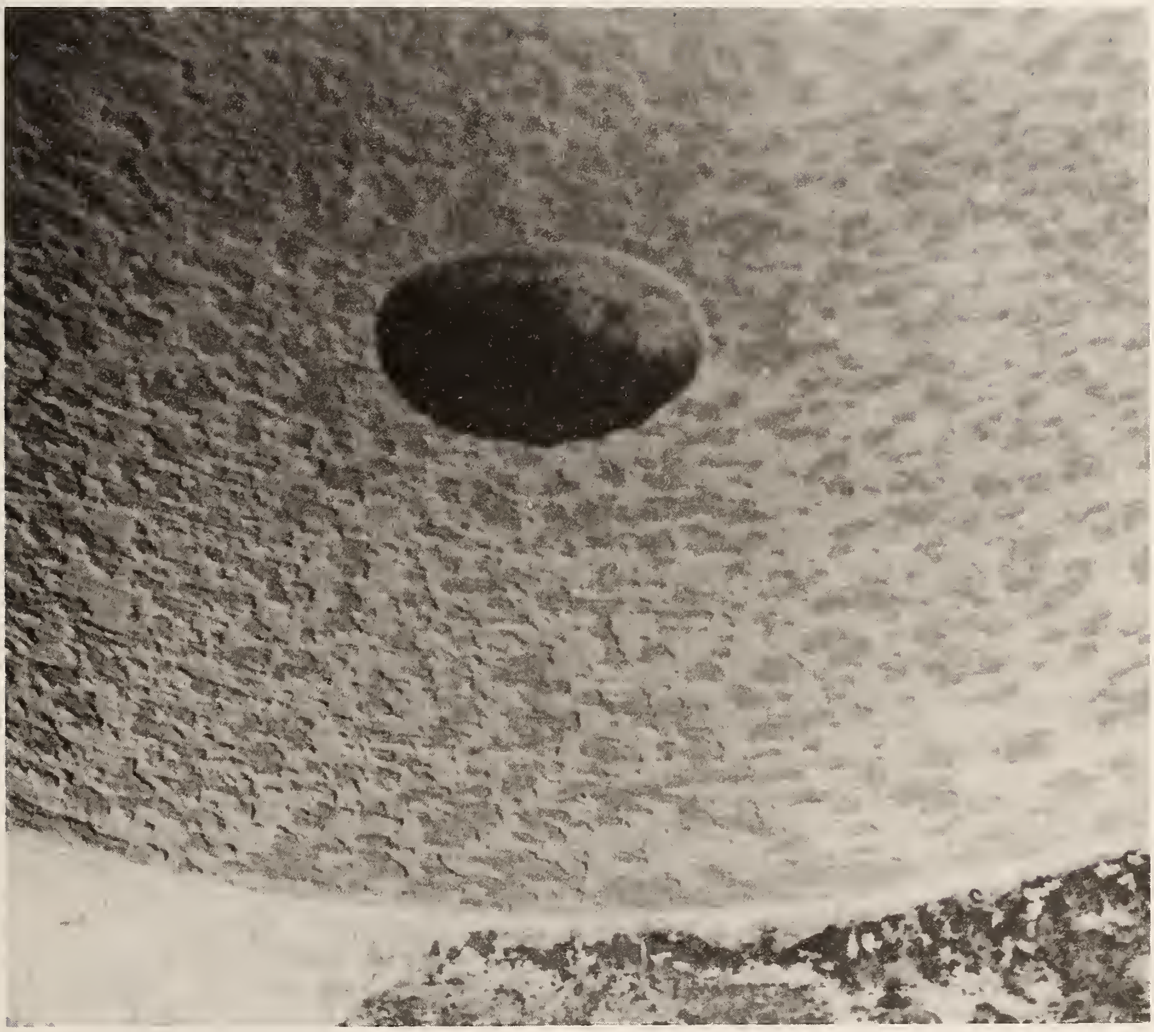


Figure A12. Photograph of Speckled Corrosion Pattern on FE-4C.

The testing schedule was suspended due to these results. Designated members of the Orifice Steering Committee were present in the flow laboratory. Both observed the condition of the meter tubes and concurred that further testing would not be advisable. Clearly the most recent corrosion inhibiting oil had failed to deter corrosion formation and the effects induced by it. A meeting of the Orifice Meter Database Steering Committee was planned.

Topographical Traces of Selected Regions on FE-4B

Characterization of the topography of the surface of the meter tubes was attempted through the use of a recording topographical instrument used at NBS for state-of-the-art surface roughness and step height measurements. This is a stylus instrument having a resolution in the submicrometer range (1 micrometer = 39.37 microinches). In this way an estimate of the height of the rust patches observed in the upstream (FE-4B) meter tube section could be made. Figure A13 shows two of these traces. Each trace was taken at a different position in the meter tube near the upstream orifice flange face. Both were taken over a traverse of approximately 750 micrometers (0.030 inches) along the axis of the meter tube. The horizontal scale of each trace is the traverse direction. The reversal of the traverse is clearly shown by the traverse direction trace given at the top of plot. Unlike the instrument used for the measurement described under item 4 above, this instrument had an extremely small down force and did not appear to disturb the major features of the surface topography. In the top plot the surface shows abrupt changes in height in the 40- to 50-micrometer range (0.0016 to 0.0020 inches).

Both traces show an inclined background height. This was caused by small differences in parallelism between the motion axis of the instrument and the surface of the meter tube.

The topography observed at the second position (bottom trace) shows less dramatic changes in surface height. This trace was taken at a point selected to pass through a rust-free area of the meter tube and pass over one of the rust patches. The position of the rusty patch is shown in the plot. The initial step at the edge of the rust patch appears to be approximately 40 micrometers in amplitude with approximately the same level of height variation inside the patch as that observed outside the patch. The topography outside the patch shows intermittent large height changes of 10- to 20-micrometer amplitude. These may be the tool marks made during the refurbishing of the meter tube. Although these are considerably larger than the 170- to 190-microinch rms average surface roughness value observed with the instrument of item 4 above, it should be stressed that the normally quoted surface roughness values are average values over the length of the trace. Within the trace, step heights considerably larger than the rms value will occur and are offset in the average value by much smaller background values. This behavior is seen in the areas between the peaks where the local topography is much smaller than the step amplitudes.

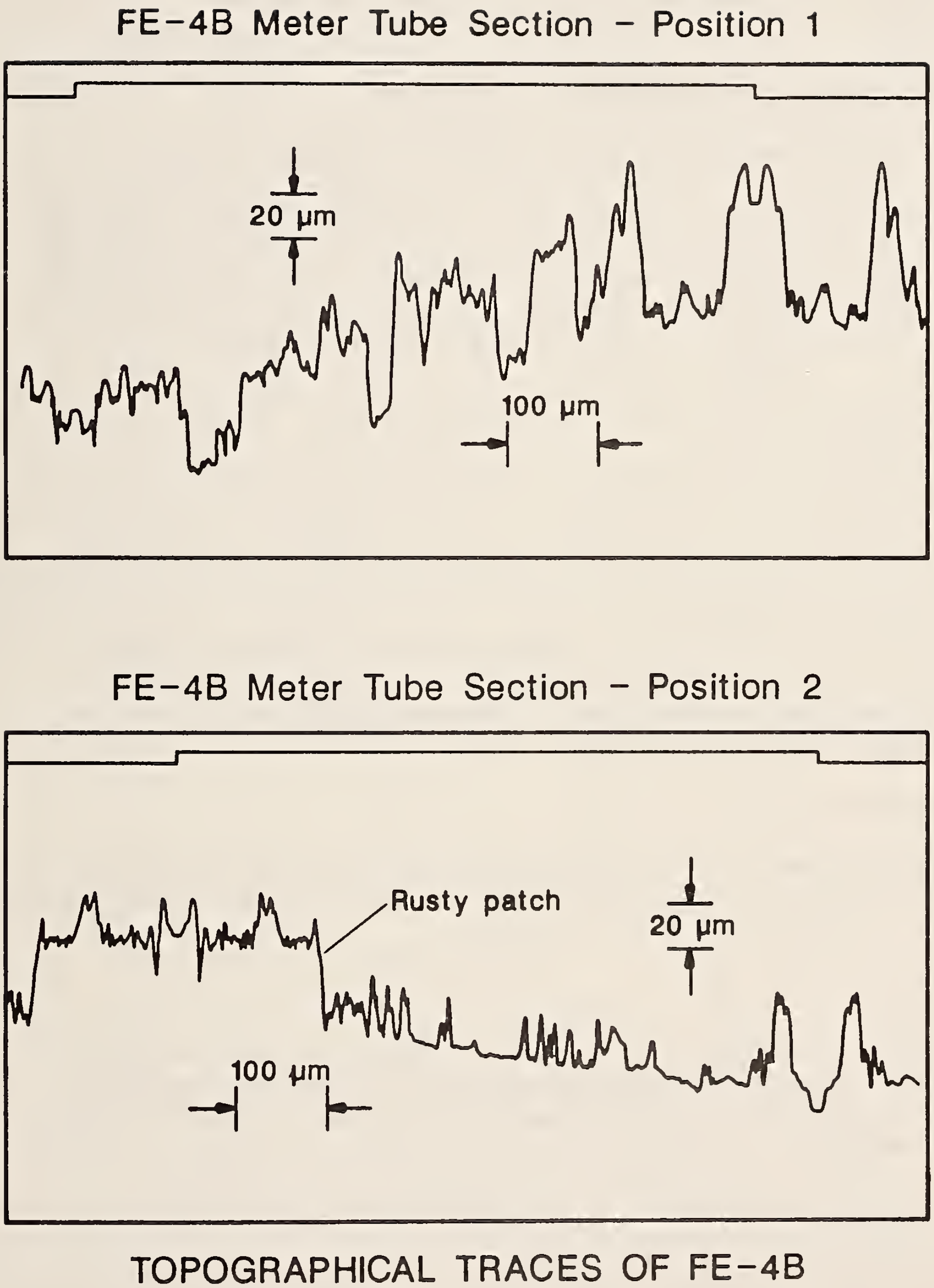


Figure A13. Topographic Traces of the Speckled Corrosion Pattern in FE-4B

These topographical measurements quantified the height of the rust patches in the meter tubes and gave some indication of the topology of those portions of the meter tube which were essentially unaffected by corrosion. These measurements showed clearly that even small amounts of rust roughened the surface to a degree greater than the 300-microinch level allowed for a commercial grade meter tube by AGA Report No. 3.

Further Action by the Orifice Steering Committee

The API Orifice Meter Database Project Steering Committee met on June 5, 1985. The result of the meeting was a request by the committee for NBS to use another oil for corrosion inhibition. This oil was normally used for storing meter tubes after manufacture. It was obtained and arrived at NBS in the late morning of June 7. The testing of the FE-4ABC (3-inch) meter tube was scheduled for June 10. A summary of the report of the tests run using this oil is given below.

Summary of Data Collected on Meter Tube FE-4, Orifice Plate 6A
June 10, 1985

Tube Preparation

Recondition the meter tube surfaces using the rotating sanding belt method.

Oil the meter tube surfaces with (the corrosion inhibiting oil) using the paint roller method used before. (Application was done liberally since the corrosion inhibiting oil appeared to have a viscosity near that of kerosene.)

Experiment Objective

Determine the amount of time required for the discharge coefficient to increase due to corrosion of the meter tube surfaces after having been coated with Rust Veto No. 377 [3].

Data Collection Procedures

Mount the meter assembly and run continuously with data collected approximately every hour at the differential pressure (Reynolds number) most sensitive to the effect, i.e., 28 psi, with the Beta 0.75 orifice plate.

Run No.	Time	Differential Press. (psi)	Discharge Coefficients Ruska	Upper	Lower
37 - 39	11:03	28	.60633	.60635	.60690
49 - 51	12:12	28	.60633	.60632	.60690
58 - 60	13:14	28	.60628	.60631	.60687
61 - 63	14:26	28	.60643	.60649	.60691
70 - 72	15:25	28	.60650	.60652	.60690

Run No.	Time	Differential Press. (psi)	Discharge Coefficients Ruska	Upper	Lower
73 - 75	16:07	28	.60645	.60648	.60692
79 - 81	17:18	28	.60640	.60645	.60690
82 - 84	18:33	28	.60645	.60651	.60698
85 - 87	19:19	28	.60654	.60659	.60699
88 - 90	20:25	28	.60645	.60653	.60703
91 - 92	21:22	28	.60663	.60669	.60712

21:30 to 22:45 - Meter Tube Taken Down for Inspection - The tube was air dried with compressed air as soon as possible after removing it from the test rack. Very little rust could be seen. The tube surfaces were 85 to 95% bright metal. The effects of the previous rusting were evident visually in the small pitting of the tube wall. Small flecks of rust could be observed in an approximately random pattern uniformly along the wall. These flecks were not prominent. No rust patches of any size could be seen.

Run No.	Time	Differential Press. (psi)	Discharge Coefficients Ruska	Upper	Lower
93 - 95	23:05	28	.60653	.60659	.60705

The differential pressure was reduced to 0.4 psi or below and the system was allowed to run for approximately 6 or 7 hours.

6/11/85 - Continuation of observations

98 - 100	06:07	28	.60786	.60787	.60858

Meter Taken Down for Inspection - The coverage of rust had increased. Although the general appearance was of a larger coverage of the rust than the previous inspection, the amount of bright metal surface was definitely the majority of the meter tube surface. Pictures of all tubes in the vicinity of the flanges were taken. The tube was air dried using compressed air as soon as possible after removing from the test rack. The meter tube was replaced in the test rack and the following results were obtained to insure that the previous values were not a fluke.

101 - 103	10:24	28	.60794	.60795	.60855

The meter tube was dismounted from the test rack and inspected. The tube surfaces were essentially unchanged from the previous observation.

Since the majority of this test had been run with the pipe Reynolds number at the maximum value for this beta ratio, and the stability of the discharge coefficient values did not degrade until the Reynolds number was reduced, a second test was begun. The Reynolds number was to be set to a low value for the beta 0.75 plate, but in the region where a substantial number of tests would be needed for the smaller beta ratio plates. This flow rate was to be maintained except for the period of data collection at 28 psi. The meter tube was again treated with the sanding belts to remove the rust, thereby returning the meter tube surface to a nearly 100% bright metallic color, the diameter was measured, the rust inhibiting oil was applied to all meter tube inner surfaces, and the test was started. The following table lists the results.

Run No.	Time	Differential Press. (psi)	Discharge Coefficients Ruska	Upper	Lower
107 - 109	12:46	28	.60608	.60609	.60644
110 - 112	13:36	28	.60612	.60615	.60654
113 - 115	14:45	28	.60607	.60614	.60651
116 - 118	15:40	28	.60613	.60615	.60656
119 - 121	16:39	28	.60623	.60625	.60667
122 - 124	20:02	28	.60679	.60706	.60728
125 - 127	23:07[a]	28	.60821	.60843	.60855
128 - 130	00:29[a]	28	.60811	.60829	.60845

[a] Reynolds Number maintained near 28 psi shortly before run no. 125 through the end of this test.

The NBS principal investigator visually inspected the meter tube. The following are his observations.

The interior surfaces of the meter tube had a very different appearance compared with that observed in this meter tube following the runs of June 3 and 4. In this case the meter tube contained two very distinct regions with disparate corrosion topographies. As with the previous rusting topography (June 3 & 4), the two distinctive regions were characterized by streaked and speckled patterns. The streaked pattern was the most pronounced, covering all of the two upstream sections, FE-4A and B. The speckled region extended several diameters from the face of the orifice flange of the C tube section with streaks forming in its downstream half. The predominant feature was the streaked region. The streaks are quite prominent because the areas separating them are brightly metallic with essentially no rust on them, much as they appeared before starting the test. The streaks themselves are comprised of a continuous patch of closely spaced rust nodules in a contiguous line parallel to the axis of the tube. The width of the streaks is approximately 1/8 to 3/16 of an inch. There are 24 of them distributed around the circumference of FE-4B viewed from the upstream orifice plate flange. All of the streaks terminate at a distance of 5/8 of an inch from the upstream orifice plate flange face. The variation in this distance is very small, 1/16 of an inch or less. A well defined, continuous ring of corrosion is seen at the position of the weld between the tube and the flange. I would emphasize that the areas between these streaks are essentially free of corrosion and bright metallic in color. There are a few isolated rust nodules in these areas, but their coverage is a quite small percentage of the bright areas.

The appearance of FE-4C, at the downstream orifice plate flange, is quite different. There are patches of rust, comprised of the same type of nodules making up the streaks, randomly placed along and around the tube for the first 3 to 5 diameters of the tube. There are three prominent patches between the flange face and the tap holes with other smaller patches or single nodules and flecks of rust on the basic bright metallic surface. I would estimate roughly that the corrosion coverage is 2 to 5% of the total interior surface area of this region of FE-4C.

The streaks seen in the middle tube section, FE-4B, are continued through FE-4A along its entire length and appear to continue across the surface of the beta 1.0 sealing plate between the A and B sections.

The results of these tests were communicated to the API Program Manager as the testing progressed. A meeting of the Orifice Meter Database Steering Committee and NBS personnel was held at 9:00 a.m., June 14. The results discussed above were presented to the committee by the NBS Principal Investigator. NBS proposed that the meter tube surface roughness level be stabilized by electroless nickel plating the meter tubes; a plating thickness of 0.001 inch was recommended.

VI. Nickel plating of FE-6: The End of Corrosion-Induced Effects on the Database

As part of the NBS proposal to the API Orifice Meter Database Steering Committee it was agreed that should the orifice project steering committee agree with the NBS proposal to electroless nickel plate the 4-inch meter tube, FE-6ABC, control tests of the meter tube, subsequently termed bare tube tests, would be run on the largest beta ratio plate prior to plating. These tests would be run in the shortest amount of time possible to minimize the potential for corrosion of the tube surfaces. The reason for taking this data was to provide data with which to determine whether plating of the meter tube caused any detectable difference in the resulting discharge coefficient values.

On June 17,1985 the final approval for plating of the FE-6ABC meter tube was given. The bare tube tests were completed the morning and early afternoon of June 18 and the meter tube taken to be plated the following day. The meter tube was plated with a nominal thickness of 0.001 inches of nickel and returned to the NBS site Friday, June 21.

The FE-6ABC meter tube was inspected after the bare tube test. No sign of corrosion was noted on the inner surfaces after the 3-hour test was completed. At that time the tube surface was a bright metallic color on which there were isolated pits having a dark color. These were very shallow and thought to be remaining from the original pitting of the meter tube. The entire meter tube was electroless nickel plated. The appearance of the inside surfaces were very similar to the appearance before plating, i.e., the tool marks made during the honing process were visually unchanged. The color of all tube surfaces was a silver matte finish. The internal diameter measurements were repeated. These showed a very small decrease in the mean value of the diameter.

Surface topography traces were made on PE-6B before it was run. One of these is shown in figure A14. Although there are steps of approximately 300-microinch height observed in the surface structure, probably the tool marks developed during refurbishment, the structure is more uniform in character and has a generally smaller amplitude than the traces of the rusted tube shown in figures A12 and A13. The photograph in figure A15 shows the interior surface near one of the tap holes. The surface is evenly finished with the tool marks clearly visible.

The PE-6ABC meter tube was mounted in the water flow facility test rack and tests of the 6C plate were begun June 24. The preliminary results of these tests showed no discernible change from the bare meter tube results. A second plate was also run that day. The meter tube was opened for inspection at the end of the day. After approximately 8 hours of running the meter tube showed some minor discoloration of the surface where rusting had occurred through a few pin holes in the plating, and a small section in the downstream meter tube section, PE-6C, which was discolored, as if the plating was breached in a one-half by 5- or 6-inch long strip. No change in the surface finish was evident to the touch. These results were reported to the Orifice Steering Committee in a conference call June 27. NBS proposed that one meter tube of each size be plated. Additionally, the scope of the bare meter

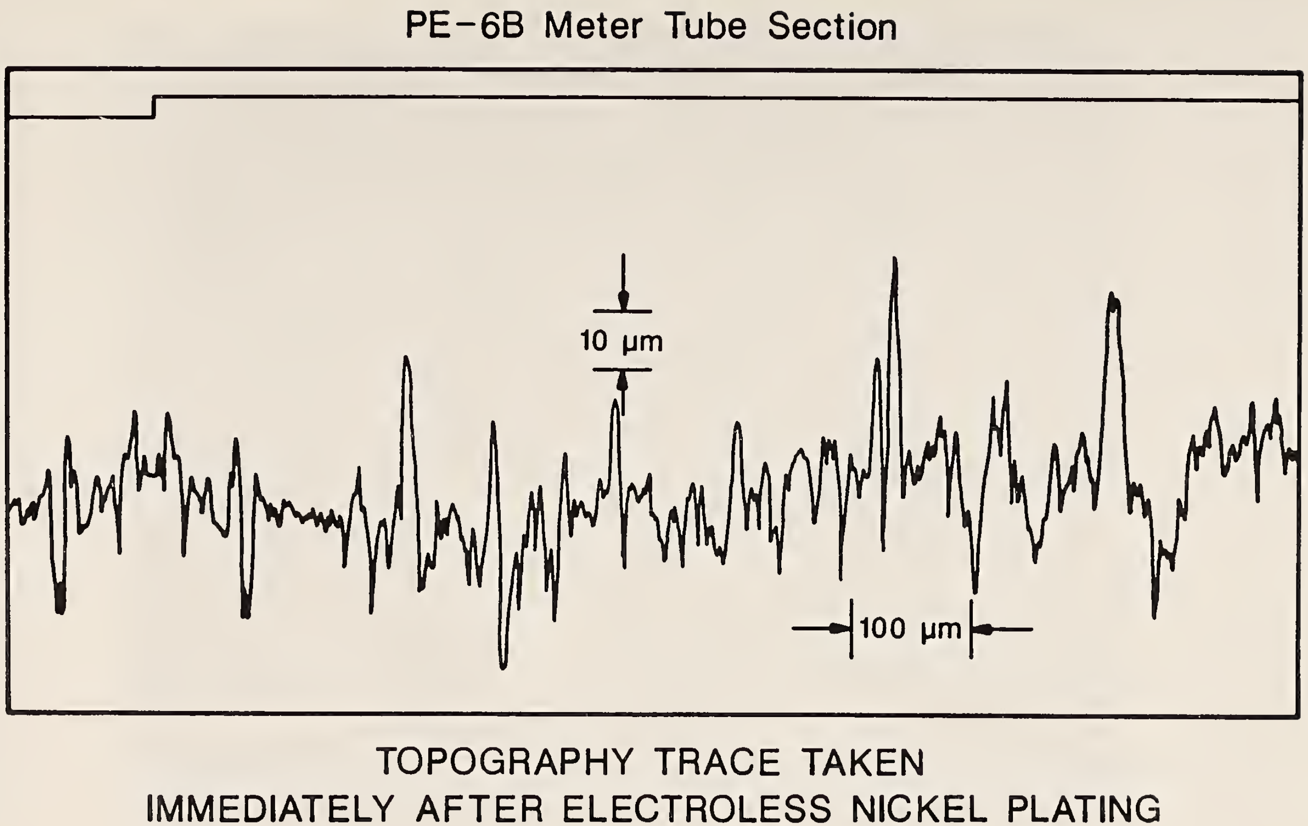


Figure A14. Topographic Traces Taken Immediately After Electroless Nickel Plating of PE-6B

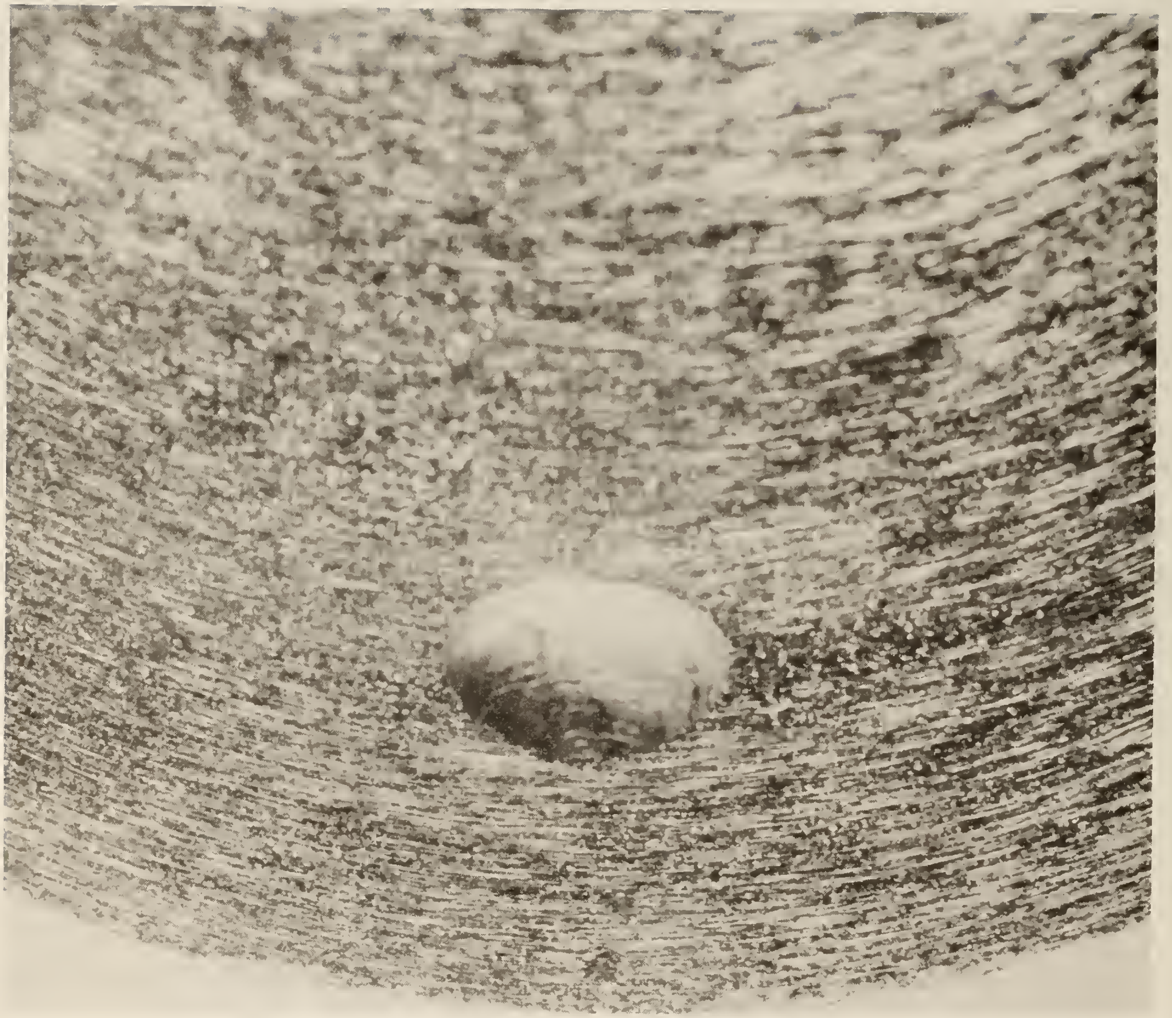


Figure A15. Photograph of the Tap Hole of PE-6B.

tube testing was proposed to be enlarged to 6 hours to include an orifice plate of nominal beta ratio 0.375 in order to cover the envelope of observed, corrosion induced effects.

Testing of all of the C series plates (beta ratio 0.1 to 0.75) in PE-6ABC was completed July 1. Additional tests of the 6C plate (beta ratio 0.75) were included to test for the effects of changes in the surface roughness from corrosion. During these tests the meter tube was opened frequently for visual inspections. The results of these inspections were that the appearance of the inner meter tube surface did not change from the initial rust staining at the pin holes which occurred during the first day of running. Additionally, the light dusting of rust which had always appeared on the orifice plate surfaces after previous tests with the mild steel meter tubes, was absent. The data for all plates replicated itself very well with the exception of one pass on one plate. A third pass on the beta 0.75 plate resulted in the third pass replicating the initial pass very well.

VIII. Completion of the Database and the Project

The remainder of the meter tubes were plated with a 0.001 nominal thickness of electroless nickel much as FE-6ABC was. The two plate, bare tube test schedule was run on each. The bare tube tests were denoted with the FE designation. The designation of the meter tubes was changed to PE-6ABC, etc. to denote the addition of the nickel plating. Completion of the data collection phase occurred in December 1985. Upon the advice of the NBS Statistical Engineering Division observations on two plates of the PE-1ABC meter tube were repeated in January 1986. The analysis of the data base by NBS occurred over the remainder of 1986. The API requested the rerunning of certain of the small beta ratio plates. This occurred in early 1987.

IX. References

[A1] American Gas Association Report No. 3., Amer. Gas Assoc., Catalog No. XQ0178, Arlington, VA, also American National Standard Institute/American Petroleum Institute 2530.

[A2] Stolz, J., "A Universal Equation for the Calculation of Discharge Coefficients of Orifice Plates," FLOMEKO 1978, IMEKO Conference on Flow Measurement of Fluids, Groningen, North-Holland, Amsterdam, 1978; also found in ISO 5167.

[A3] Beitler, S. R., "The Flow of Water Through Orifices," The Ohio State University, Engineering Experiment Station Bulletin 89, 73 pgs., May 1935.

APPENDIX B
Water Density Measurements

Measurements of the density of samples of the water flowing in the NBS flow facility were made using a vibrating tube technique [B1]. This is a comparative technique requiring two liquids of known density over the range of temperatures used. The equation governing the operation of the comparator is the following:

$$\rho_1 - \rho_2 = K\,(T_1^2 - T_2^2)$$

where ρ_1 = Density of liquid 1
ρ_2 = " " " 2
T_1 = Period of Oscillation for liquid 1
T_2 = Period of Oscillation for liquid 2

Calibration of the comparator must be done for each measurement temperature. This temperature is maintained very near a constant value set by a thermostatic jacket surrounding the measurement cell. Temperature measurements of the cell are made by placing a suitable thermometer in a re-entrant tube of the cell. A thick film platinum resistance thermometer (PRT), which had been previously calibrated against a standard platinum resistance thermometer, was used for this purpose. The uncertainty in the temperature measurement using the thick film PRT is estimated to be approximately 0.12 degrees Celsius.

The calibration liquids used were distilled water and a sample of xylene having previously assigned density values over this temperature range [B2]. Computation of the density of distilled water was made using the correlation of Kell [B3]. For both liquids the density is computed from the temperature of the measurement, T, as determined from the thick film platinum resistance thermometer. The mathematical relations used are the following:

Xylene Density $\rho_x = 884.671 - 0.86147\,T$

Distilled Water Density

$$\rho_w = \sum_{n=0}^{5} \frac{A_n\,T^n}{1 + CT}$$

where
$A_o = 999.83952$
$A_1 = 16.945176$
$A_2 = -7.9870401 \times 10^{-3}$
$A_3 = -46.170461 \times 10^{-6}$
$A_4 = 105.56302 \times 10^{-9}$
$A_5 = -208.54253 \times 10^{-12}$
$C = 16.879850 \times 10^{-3}$

The density of both is given in units of kg/m^3. Temperature values are in degrees Celsius.

The measurement sequence consisted of observation of the comparator response, or period value, beginning with the distilled water and xylene. These observations allowed the value of the instrument constant, K, to be determined. Subsequently, the samples of unknown density were loaded into the comparator cell and several successive observations of the period values for each were made after stabilization of the PRT resistance value. The period was judged to be valid if successive period values repeated one another within two to four counts of the device. (One count of the device corresponds to approximately 0.001 kg/m^3 or approximately 1 part per million for these water samples.) Table B1 gives the mean values of the observations for the calibration liquids and the water samples and the results of the measurements. The column labeled Diff. is the difference between the density of the reservoir sample and that of distilled water at the temperature at which the reservior sample is measured. The average value is given at the bottom of the table. This value represents the average offset between the density of distilled water and the water obtained periodically from the local city water supply used to fill the reservior. This difference is attributable to the dissolved mineral content of the water. Its effect is considered not to be temperature dependent. In computing the density of the water used in this test this value will be used.

Table B1. Measured Density Values for Water Samples

Sample Type	Period Value (sec)	PRT Resistance (ohms)	Temperature (Deg. C)	Density (kg/m^3)	Diff. (kg/m^3)
Dist. Water	38.67970	1086.06	22.191	997.728	
Xylene	37.37086	1086.04	22.186	865.555	
8/02/85	38.68136	1086.03	22.184	997.898	0.182
7/18/85	38.68145	1086.03	22.184	997.910	0.170
6/25/85	38.68142	1086.00	22.176	997.908	0.178
8/02/85	38.68142	1086.05	22.189	997.905	0.177
1/09/85	38.68109	1086.05	22.189	997.871	0.143
10/20/83	38.68174	1086.04	22.186	997.938	0.209
7/24/85	38.68140	1086.05	22.186	997.903	0.175
12/27/84	38.68212	1086.05	22.186	997.977	0.250
4/05/86	38.68224	1086.06	22.191	997.989	0.262

Computed Instrument Constant = 1.3278645 Average Diff. 0.194

The uncertainty in these density measurements is composed of three components, the precision of the comparator, the uncertainty of the standard liquids, and the uncertainty in the temperature measurement. The precision of the comparator appears to be approximately 1 to 2 counts in the period value. This corresponds to approximately 0.001 to 0.002 kg/m^3. The uncertainty in the density of distilled water as computed from the Kell formula is estimated by Kell to be approximately 0.010 kg/m^3. A similar value is the case for the xylene. The largest contributor to the uncertainty in this series of density measurements is due to the platinum resistance thermometer used. This was a 1000 ohm device which had been calibrated previous to its use. A fit of its resistance as a function of temperature in degrees Celsius was made resulting in the following relation:

$$\text{Temperature} = -260.548 + 0.260355 \times \text{Resistance}$$

The residual standard deviation of this fit is 0.040 degrees. This value is tripled to obtain the 99% confidence level, and the uncertainty in the temperature measurement is taken to be 0.120 degrees Celsius. The effect of this uncertainty in the temperature on the density values of the standard liquids is approximately 0.034 kg/m^3 for the distilled water and 0.106 kg/m^3 for the xylene. These are treated as systematic errors in the measurement and are considerably larger than the comparative uncertainty. These uncertainties must be applied to the absolute values of the density assigned to each sample. However, the difference values between the reservoir samples and distilled water are primarily influenced by the uncertainty in the distilled water density value computed from the temperature measurements and by the comparative precision. These are combined additively to give approximately 0.045 kg/m^3 in the difference value.

References:

[B1] Kratky, O., Leopold, H., and Stabinger, H., Angew. Phys. 27, (1969).

[B2] Whetstone, J. R., et al., National Bureau of Standards Internal Report 78-1533, 1978.

[B3] Kell, G. S., "Density, Thermal Expansivity, and Compressibility of Liquid Water from 0 to 150°C: Correlations and Tables for Atmospheric Pressure and Saturation Reviewed and Expressed on 1968 Temperature Scale," J. Chem. and Eng. Data, Vol. 20, No.1 (1975).

APPENDIX C

Differential Pressure Transducer Coefficient Values

Table C1. Response Model Coefficients for the Ruska Transducer Serial Number 30827 Connected to the Upper Orifice Meter Taps

Date	Zero ΔP Response (volts.)	C_1 (psid)	C_2 (psid/volt)	Residual Std. Dev. (psid)
06/10/85	0.0054	0.00086	2.88919	0.00044
06/14/85	0.0048	0.00055	2.88933	0.00094
06/17/85	0.0051	0.00128	2.88929	0.00043
06/18/85	0.0051	0.00178	2.88922	0.00082
06/24/85	0.0053	0.00100	2.88912	0.00088
06/25/85	0.0051	0.00060	2.88913	0.00070
06/26/85	0.0052	0.00017	2.88917	0.00067
07/01/85	0.0020	0.00078	2.88927	0.00076
07/02/85	0.0020	0.00078	2.88927	0.00076
07/03/85	0.0038	0.00038	2.88919	0.00046
07/05/85	0.0045	0.00102	2.88909	0.00049
07/08/85	0.0050	0.00100	2.88912	0.00069
07/09/85	0.0046	0.00077	2.88914	0.00052
07/12/85	0.0050	0.00129	2.88911	0.00040
07/15/85	0.0049	0.00116	2.88922	0.00108
07/16/85	0.0053	0.00204	2.88913	0.00102
07/17/85	0.0041	0.00102	2.88921	0.00055
07/18/85	0.0044	0.00100	2.88927	0.00082
07/24/85	0.0040	0.00081	2.88920	0.00051
07/25/85	0.0045	0.00040	2.88928	0.00114
07/26/85	0.0041	0.00047	2.88921	0.00101
07/29/85	0.0046	-0.00049	2.88930	0.00080
07/30/85	0.0046	-0.00009	2.88920	0.00120
07/31/85	0.0045	-0.00060	2.88935	0.00090
08/01/85	0.0045	0.00022	2.88927	0.00064
08/02/85	0.0042	-0.00042	2.88927	0.00123
08/05/85	0.0041	-0.00000	2.88916	0.00103
08/06/85	0.0042	0.00065	2.88912	0.00053
08/07/85	0.0043	-0.00097	2.88930	0.00073
08/08/85	0.0043	-0.00030	2.88923	0.00061
08/09/85	0.0042	-0.00014	2.88927	0.00115
08/12/85	0.0021	0.00172	2.88906	0.00064
08/13/85	0.0048	0.00081	2.88904	0.00082
08/14/85	0.0079	0.00160	2.88925	0.00108
08/19/85	0.0049	0.00069	2.88902	0.00078
08/23/85	0.0023	-0.00064	2.88908	0.00062
08/26/85	0.0016	0.00003	2.88897	0.00087
08/27/85	0.0004	-0.01179	2.88952	0.01665
08/28/85	0.0051	-0.00080	2.88948	0.00201
08/29/85	0.0008	-0.00236	2.88907	0.00086
08/30/85	0.0017	-0.00004	2.88906	0.00067
09/03/85	0.0003	-0.00253	2.88921	0.00064

Table C1. Response Model Coefficients for the Ruska Transducer Serial Number 30827 Connected to the Upper Orifice Meter Taps -- Continued

Date	Zero ΔP Response (volts.)	C_1 (psid)	C_2 (psid/volt)	Residual Std. Dev. (psid)
09/04/85	0.0001	-0.00188	2.88910	0.00048
09/05/85	0.0002	-0.00065	2.88896	0.00058
09/06/85	-0.0001	0.00036	2.88906	0.00055
09/09/85	-0.0011	0.00000	2.88919	0.00081
09/10/85	-0.0009	0.00107	2.88911	0.00053
09/11/85	-0.0010	0.00159	2.88904	0.00069
09/13/85	-0.0011	0.00012	2.88906	0.00058
09/17/85	-0.0012	-0.00031	2.88901	0.00070
09/18/85	-0.0012	-0.00047	2.88909	0.00061
09/19/85	-0.0014	0.00008	2.88899	0.00061
09/20/85	-0.0013	0.00003	2.88915	0.00037
09/24/85	-0.0013	0.00102	2.88917	0.00070
09/25/85	0.0043	0.00657	2.88995	0.00604
09/26/85	0.0044	0.00076	2.88892	0.00073
09/27/85	0.0050	0.00118	2.88905	0.00084
09/30/85	0.0050	-0.00012	2.88896	0.00094
10/09/85	0.0039	0.00104	2.88904	0.00037
10/09/85	0.0039	0.00104	2.88904	0.00037
10/11/85	0.0042	0.00169	2.88909	0.00173
10/15/85	0.0044	0.00150	2.88900	0.00041
10/16/85	0.0045	0.00149	2.88903	0.00090
10/17/85	0.0044	0.00025	2.88904	0.00038
10/22/85	0.0043	-0.00000	2.88894	0.00111
10/23/85	0.0042	0.00068	2.88895	0.00035
10/24/85	0.0043	0.00096	2.88902	0.00060
11/06/85	0.0267	0.01326	2.89737	0.00497
11/07/85	0.0049	0.00098	2.88895	0.00077
11/08/85	0.0046	0.00071	2.88895	0.00066
11/12/85	0.0042	0.00070	2.88898	0.00067
11/13/85	0.0041	0.00075	2.88897	0.00080
11/14/85	0.0040	0.00168	2.88897	0.00048
11/15/85	0.0040	0.00173	2.88892	0.00070
11/18/85	0.0037	0.00054	2.88902	0.00047
11/19/85	0.0036	0.00061	2.88905	0.00078
11/20/85	0.0035	0.00177	2.88894	0.00065
11/21/85	0.0032	-0.00035	2.88898	0.00088
11/22/85	0.0000	0.00000	0.00000	0.00000
12/04/85	0.0045	-0.00004	2.88899	0.00025
12/05/85	0.0042	-0.00077	2.88895	0.00057
12/06/85	0.0045	-0.00055	2.88899	0.00050
12/09/85	0.0044	-0.00034	2.88898	0.00061
12/10/85	0.0043	-0.00126	2.88887	0.00070
12/30/85	0.0035	-0.00063	2.88897	0.00074
01/07/86	0.0039	-0.03044	2.90353	0.09070

Table C2. Response Model Coefficients for the Paros Transducer Serial Number 13150 Connected to the Upper Orifice Meter Taps

Date	Zero ΔP Response (microsec.)	A (psid)	B (psid)	C (psid)	Residual Std. Dev. (psid)
06/03/85	25.59684	-0.00095	448.7446	-121.940	0.00088
06/10/85	25.59669	0.00023	448.6931	-121.516	0.00070
06/14/85	25.59776	0.00067	449.0188	-117.534	0.00067
06/17/85	25.59778	0.00135	449.0262	-117.877	0.00059
06/18/85	25.59776	0.00220	449.0067	-117.964	0.00079
06/24/85	25.59767	0.00033	449.0287	-118.668	0.00097
06/25/85	25.59751	-0.00162	448.9875	-118.331	0.00133
06/26/85	25.59751	-0.00129	448.9802	-118.100	0.00109
07/01/85	25.59732	0.00006	449.0227	-118.628	0.00093
07/02/85	25.59732	0.00006	449.0227	-118.628	0.00093
07/03/85	25.59736	0.00044	448.9887	-118.112	0.00066
07/05/85	25.59743	0.00173	448.9725	-117.925	0.00074
07/08/85	25.59743	0.00116	448.9723	-117.665	0.00086
07/09/85	25.59735	0.00053	448.9830	-117.984	0.00059
07/12/85	25.59736	0.00132	448.9643	-117.838	0.00055
07/15/85	25.59735	0.00100	449.0201	-118.573	0.00108
07/16/85	25.59740	0.00173	449.0620	-119.310	0.00080
07/17/85	25.59747	0.00200	449.0032	-118.117	0.00069
07/18/85	25.59750	0.00152	449.0750	-119.233	0.00086
07/24/85	25.59738	0.00053	448.9635	-118.045	0.00066
07/25/85	25.59749	0.00097	448.9855	-117.735	0.00119
07/26/85	25.59723	-0.00109	449.0392	-119.145	0.00089
07/29/85	25.59736	-0.00036	449.0013	-118.679	0.00071
07/30/85	25.59736	-0.00061	449.0097	-118.693	0.00138
07/31/85	25.59727	-0.00205	449.0534	-119.158	0.00099
08/01/85	25.59734	-0.00072	448.9954	-118.232	0.00082
08/02/85	25.59736	-0.00148	449.0253	-119.061	0.00156
08/05/85	25.59739	-0.00052	449.0149	-119.688	0.00130
08/06/85	25.59739	0.00010	448.9466	-118.374	0.00063
08/07/85	25.59745	-0.00070	448.9735	-118.211	0.00060
08/08/85	25.59743	-0.00066	449.0058	-119.004	0.00069
08/09/85	25.59744	-0.00012	448.9768	-118.810	0.00117
08/12/85	25.59737	0.00082	448.8544	-117.971	0.00113
08/13/85	25.59755	0.00187	448.9474	-119.279	0.00090
08/14/85	25.59744	0.00103	448.9851	-119.816	0.00084
08/16/85	25.59741	0.00050	448.9158	-119.388	0.00094
08/19/85	25.59739	0.00058	448.8405	-118.598	0.00095
08/23/85	25.59752	-0.00047	448.8501	-117.922	0.00084
08/26/85	25.59756	0.00031	448.7809	-117.840	0.00078
08/27/85	25.59750	0.00030	448.8625	-119.810	0.00105
08/28/85	25.59762	0.00031	448.8756	-119.827	0.00101
08/29/85	25.59757	-0.00035	448.8288	-119.248	0.00072
08/30/85	25.59760	-0.00024	448.8561	-119.712	0.00043

Table C2. Response Model Coefficients for the Paros Transducer Serial Number 13150 Connected to the Upper Orifice Meter Taps -- Continued

Date	Zero ΔP Response (microsec.)	A (psid)	B (psid)	C (psid)	Residual Std. Dev. (psid)
09/03/85	25.59752	-0.00246	448.8151	-119.298	0.00074
09/04/85	25.59756	-0.00172	448.8282	-119.835	0.00042
09/05/85	25.59767	-0.00065	448.8135	-120.192	0.00054
09/06/85	25.59763	-0.00006	448.8053	-120.093	0.00044
09/09/85	25.59762	-0.00051	448.7766	-119.773	0.00087
09/10/85	25.59768	0.00077	448.7926	-119.796	0.00071
09/11/85	25.59767	0.00114	448.8131	-120.228	0.00037
09/13/85	25.59760	-0.00035	448.7672	-119.659	0.00076
09/16/85	25.59761	-0.00090	448.7689	-119.546	0.00105
09/17/85	25.59768	-0.00042	448.8028	-120.300	0.00083
09/18/85	25.59764	-0.00025	448.7461	-119.045	0.00088
09/19/85	25.59767	0.00026	448.7910	-120.064	0.00066
09/20/85	25.59763	-0.00020	448.7845	-119.359	0.00062
09/24/85	25.59761	0.00040	448.8559	-120.301	0.00062
09/25/85	25.59768	0.00089	448.8476	-120.333	0.00054
09/26/85	25.59764	0.00075	448.7944	-119.599	0.00054
09/27/85	25.59767	0.00095	448.8900	-120.563	0.00062
09/30/85	25.59755	-0.00064	448.8541	-121.114	0.00080
10/09/85	25.59755	0.00110	448.7829	-119.424	0.00066
10/09/85	25.59755	0.00110	448.7829	-119.424	0.00066
10/11/85	25.59757	0.00159	448.8263	-120.277	0.00068
10/15/85	25.59756	0.00172	448.7854	-119.751	0.00046
10/16/85	25.59760	0.00108	448.8554	-120.631	0.00043
10/17/85	25.59767	0.00043	448.8204	-119.813	0.00035
10/22/85	25.59751	-0.00013	448.8612	-121.473	0.00094
10/23/85	25.59754	0.00066	448.7871	-119.854	0.00060
10/24/85	25.59756	0.00125	448.8096	-120.034	0.00092
11/06/85	25.59762	0.00164	448.8437	-120.744	0.00051
11/07/85	25.59763	0.00087	448.8750	-120.862	0.00050
11/08/85	25.59764	0.00090	448.8481	-120.240	0.00048
11/12/85	25.59765	0.00148	448.8444	-120.182	0.00075
11/13/85	25.59761	0.00067	448.8881	-120.641	0.00064
11/14/85	25.59759	0.00169	448.8601	-120.331	0.00040
11/15/85	25.59758	0.00136	448.8471	-120.217	0.00061
11/18/85	25.59755	0.00068	448.8324	-120.123	0.00053
11/19/85	25.59761	0.00033	448.9084	-121.059	0.00045
11/20/85	25.59749	0.00129	448.8292	-120.024	0.00055
11/21/85	25.59757	-0.00102	448.9148	-121.369	0.00088
11/22/85	25.59762	0.00069	448.8521	-120.079	0.00033

Table C2. Response Model Coefficients for the Paros Transducer Serial Number 13150 Connected to the Upper Orifice Meter Taps -- Continued

Date	Zero ΔP Response (microsec.)	A (psid)	B (psid)	C (psid)	Residual Std. Dev. (psid)
12/04/85	25.59748	0.00108	449.0544	-119.458	0.00042
12/05/85	25.59746	-0.00009	449.1114	-119.668	0.00028
12/06/85	25.59742	-0.00014	449.1095	-119.257	0.00046
12/09/85	25.59737	0.00039	449.1084	-119.196	0.00056
12/10/85	25.59737	-0.00077	449.1702	-120.004	0.00066
12/30/85	25.59710	-0.00036	449.0776	-119.195	0.00030
01/07/86	25.59724	-0.00041	449.1444	-119.541	0.00053

Table C3. Response Model Coefficients for the Paros Transducer Serial Number 12200 Connected to the Lower Orifice Meter Taps

Date	Zero ΔP Response (microsec.)	A (psid)	B (psid)	C (psid)	Residual Std. Dev. (psid)
06/03/85	25.21105	-0.00007	512.7597	-150.197	0.00071
06/10/85	25.21102	0.00036	512.7783	-150.764	0.00037
06/14/85	25.21104	0.00073	512.8116	-150.284	0.00065
06/17/85	25.21108	0.00138	512.8181	-150.614	0.00032
06/18/85	25.21108	0.00230	512.7912	-150.561	0.00063
06/24/85	25.21105	0.00061	512.8100	-151.419	0.00061
06/25/85	25.21098	-0.00067	512.7602	-150.664	0.00086
06/26/85	25.21093	-0.00078	512.7477	-150.557	0.00069
07/01/85	25.21107	0.00007	512.8270	-151.406	0.00055
07/02/85	25.21107	0.00007	512.8270	-151.406	0.00055
07/03/85	25.21113	0.00075	512.7840	-150.682	0.00035
07/05/85	25.21120	0.00216	512.7562	-150.473	0.00041
07/08/85	25.21118	0.00127	512.7567	-150.108	0.00049
07/09/85	25.21113	0.00094	512.7656	-150.538	0.00038
07/12/85	25.21118	0.00139	512.7499	-150.263	0.00030
07/15/85	25.21122	0.00157	512.8071	-151.193	0.00061
07/16/85	25.21124	0.00176	512.8758	-152.371	0.00062
07/17/85	25.21131	0.00219	512.8037	-150.695	0.00042
07/18/85	25.21135	0.00160	512.8867	-151.882	0.00043
07/24/85	25.21140	0.00106	512.7867	-150.526	0.00038
07/25/85	25.21133	0.00067	512.8087	-150.090	0.00098
07/26/85	25.21120	-0.00072	512.8676	-151.966	0.00058
07/29/85	25.20285	0.00024	512.8383	-150.772	0.00054
07/30/85	25.20285	-0.00032	512.8519	-150.730	0.00119
07/31/85	25.20279	-0.00162	512.9070	-151.546	0.00087
08/01/85	25.20283	-0.00048	512.8560	-150.468	0.00072
08/02/85	25.20290	-0.00096	512.8989	-151.262	0.00135
08/05/85	25.20299	-0.00024	512.8953	-152.291	0.00107
08/06/85	25.20294	0.00026	512.8221	-150.584	0.00039
08/07/85	25.20299	-0.00061	512.8538	-150.309	0.00069
08/08/85	25.20301	-0.00052	512.8804	-151.164	0.00049
08/09/85	25.20305	0.00007	512.8651	-150.962	0.00112
08/12/85	25.20306	0.00129	512.7378	-149.960	0.00083
08/13/85	25.20319	0.00180	512.8442	-151.363	0.00077
08/14/85	25.20312	0.00116	512.8990	-152.317	0.00069
08/16/85	25.20322	0.00093	512.8139	-151.520	0.00070
08/19/85	25.20335	0.00125	512.7312	-150.401	0.00088
08/23/85	25.20344	-0.00191	512.8495	-150.927	0.00032
08/26/85	25.20347	0.00047	512.7024	-149.415	0.00094
08/27/85	25.20344	0.00051	512.8297	-151.876	0.00081
08/28/85	25.20352	0.00079	512.8485	-151.627	0.00081
08/29/85	25.20351	0.00002	512.8010	-151.029	0.00056

Table C3. Response Model Coefficients for the Paros Transducer Serial Number 12200 Connected to the Lower Orifice Meter Taps -- Continued

Date	Zero ΔP Response (microsec.)	A (psid)	B (psid)	C (psid)	Residual Std. Dev. (psid)
08/30/85	25.20355	-0.00015	512.8241	-151.568	0.00035
09/03/85	25.20361	-0.00230	512.7818	-151.257	0.00067
09/04/85	25.20361	-0.00174	512.8185	-152.000	0.00045
09/05/85	25.20371	-0.00072	512.8261	-152.196	0.00036
09/06/85	25.20372	0.00005	512.8242	-152.239	0.00035
09/09/85	25.20382	-0.00036	512.7705	-151.619	0.00062
09/10/85	25.20387	0.00103	512.7967	-151.776	0.00042
09/11/85	25.20393	0.00134	512.8228	-152.455	0.00031
09/13/85	25.20405	-0.00008	512.7668	-151.691	0.00055
09/16/85	25.20425	-0.00050	512.7913	-151.908	0.00099
09/17/85	25.20431	-0.00006	512.8236	-152.883	0.00072
09/18/85	25.20433	0.00033	512.7798	-151.633	0.00072
09/19/85	25.20434	0.00082	512.8005	-152.549	0.00058
09/20/85	25.20432	0.00012	512.7816	-151.558	0.00047
09/24/85	25.20440	0.00059	512.8194	-152.747	0.00048
09/25/85	25.20443	0.00067	512.8135	-152.570	0.00038
09/26/85	25.20444	0.00070	512.7285	-151.446	0.00055
09/27/85	25.20449	0.00088	512.8356	-152.894	0.00051
09/30/85	25.20453	-0.00054	512.7771	-153.466	0.00062
10/09/85	25.20458	0.00103	512.6816	-151.518	0.00036
10/09/85	25.20458	0.00103	512.6816	-151.518	0.00036
10/11/85	25.20462	0.00170	512.7511	-152.551	0.00047
10/15/85	25.20483	0.00227	512.6942	-151.985	0.00058
10/16/85	25.20477	0.00109	512.7811	-153.065	0.00034
10/17/85	25.20489	0.00060	512.7797	-152.481	0.00026
10/22/85	25.20484	0.00012	512.7474	-154.017	0.00061
10/23/85	25.20487	0.00091	512.6684	-151.857	0.00038
10/24/85	25.20495	0.00177	512.7128	-152.411	0.00059
11/06/85	25.20524	0.00211	512.7809	-153.970	0.00049
11/07/85	25.20515	0.00119	512.8041	-153.937	0.00033
11/08/85	25.20515	0.00132	512.7560	-153.085	0.00047
11/12/85	25.20607	0.00161	512.7314	-152.825	0.00061
11/13/85	25.20602	0.00099	512.7867	-153.422	0.00065
11/14/85	25.20602	0.00182	512.7578	-153.201	0.00024
11/15/85	25.20595	0.00115	512.7405	-152.932	0.00049
11/18/85	25.20620	0.00114	512.7127	-152.904	0.00040
11/19/85	25.20618	0.00073	512.7904	-154.012	0.00036
11/20/85	25.20605	0.00150	512.6896	-152.638	0.00051
11/21/85	25.20618	-0.00106	512.8356	-154.946	0.00069
11/22/85	25.20626	0.00076	512.7245	-152.869	0.00031

Table C3. Response Model Coefficients for the Paros Transducer Serial Number 12200 Connected to the Lower Orifice Meter Taps -- Continued

Date	Zero ΔP Response (microsec.)	A (psid)	B (psid)	C (psid)	Residual Std. Dev. (psid)
12/04/85	25.20767	0.00148	512.7023	-152.694	0.00041
12/05/85	25.20770	-0.00024	512.7867	-153.616	0.00040
12/06/85	25.20772	-0.00002	512.7631	-153.056	0.00050
12/09/85	25.20787	0.00067	512.7306	-153.478	0.00070
12/10/85	25.20785	-0.00075	512.8034	-154.508	0.00050
12/30/85	25.20758	-0.00015	512.6372	-152.997	0.00053
01/07/86	25.20791	-0.00040	512.7819	-154.350	0.00049

APPENDIX D
Archival Data Base Format
Intermediate Reynolds Number Project

Format for raw data, for the Intermediate Reynolds Number Data Base Project

1. Differential pressure transducer coefficient data blocks.

The coefficient data necessary to convert the recorded pressure transducer readings to pressure units for the water data are recorded in a series of 3 record pairs. The format for each record pair is given here:

Record # or description	Columns	Format	Comments
record I			
transducer ID	1 - 11	XXXXXXXXXXX	
	12	blank	
date	13 - 20	MM/DD/YY	
	21	blank	
observation time	22 - 29	HH:MM:SS	
	30	blank	
fit date	31 - 38	MM/DD/YY	
	39 - 40	blank	
transducer zero	41 - 48	+N.NNNNN	units of μsec for Paros-type transducers (upper and lower) or volts for the Ruska transducer
	49 - 80	blank	
record II			
constant coefficient	1 - 17	+N.NNNNNNNNNNE+NN	
	18 - 20	blank	
linear coefficient	21 - 37	+N.NNNNNNNNNNE+NN	
	38 - 40	blank	
quadratic coefficient	41 - 57	+N.NNNNNNNNNNE+NN	
	58 - 60	blank	
fit residual standard deviation	61 - 77	+N.NNNNNNNNNNE+NN	
	78 - 80	blank	

2. Test run header data blocks.

The header data for the water data collection are recorded in five-record blocks. The header includes the number of pressure records which follow the header records. The format of the header records is given here:

Record # or description	Columns	Format	Comments
record I			
run number	1 - 4	NNNN	
system ID	5 - 6	NN	
date	7 - 14	MM/DD/YY	
	15	blank	
time	16 - 23	HH:MM:SS	
tube	24 - 30	XXXXXXX	
	31 - 38	blank	
plate	39 - 47	XXXXXXXXX	
	48 - 53	blank	
upper transducer ID	54 - 64	XXXXXXXXXXX	
	65 - 66	blank	
lower transducer ID	67 - 77	XXXXXXXXXXX	
	78 - 80	blank	
record II			
tare weight (lbm)	1 - 11	NNNNNN.NNNN	
gross weight (lbm)	12 - 22	NNNNNN.NNNN	
no flow correction factor (upper, μsec)	23 - 32	NNN.NNNNNN	
no flow correction factor (lower, μsec)	33 - 42	NNN.NNNNNN	
no flow correction factor (Ruska, volts)	43 - 52	NNN.NNNNNN	
diverter time (sec)	53 - 62	NNNNN.NNNN	
flow temp (deg. C)	63 - 68	NNN.NN	
tank temp (deg. C)	69 - 74	NNN.NN	
air temp (deg. C)	75 - 80	NNN.NN	

Record # or description	Columns	Format	Comments
record III			
system	1	X	
	2 - 4	blank	
upper transducer zero (μsec)	5 - 14	NNN.NNNNNN	
lower transducer zero (μsec)	15 - 24	NNN.NNNNNN	
Ruska transducer zero (volts)	25 - 34	NNN.NNNNNN	
Paros offset (μsec)	35 - 39	NNN.N	
barometer (cm Hg)	40 - 45	NNN.NN	
relative humidity (%)	46 - 51	NNN.NN	
	52 - 54	blank	
turbine count	55 - 61	NNNNNNN	
	62	blank	
tube diameter (in.)	63 - 69	NN.NNNN	
	70	blank	
plate diameter (in.)	71 - 77	NN.NNNN	
	78 - 80		
record IV			
check string	1 - 80	XXXX...XXXX	Many test runs had no check string stored. In these cases, the string "NO Check String Recorded" appears in record IV and record V does not appear.
record V			
check string (contd.)	1 - 80	XXXX...XXXX	

3. Test run differential pressure transducer observation data blocks.

The differential pressure transducer observation data for the Intermediate Reynolds Number data base are recorded in three blocks, one for each differential pressure transducer. Each block consists of a single identification record followed by a variable number of data records. Each complete data record contains eight observed values, and the last data record contains from one to eight observed values. The header record contains the actual total number of observations to follow, and the number of records is computed from this value. The format of the record block is given here:

Record # or description	Columns	Format	Comments
record I			
run number	1 - 4	NNNN	
	5	blank	
transducer	6	X	R=Ruska, U=upper, L=lower
	7	blank	
date	8 - 15	MM/DD/YY	
	16	blank	
plate	17 - 25	NNNNNNNNN	
	26	blank	
number of observations	27 - 29	NNN	
record II - record N			
	1 - 2	blank	
pressure reading i	3 - 11	NNN.NNNNN	units of μsec for Paros-type transducers (upper and lower) or volts for the Ruska transducer
pressure reading i + 1	12 - 20	NNN.NNNNN	
pressure reading i + 2	21 - 29	NNN.NNNNN	
pressure reading i + 3	30 - 38	NNN.NNNNN	
pressure reading i + 4	39 - 47	NNN.NNNNN	
pressure reading i + 5	48 - 56	NNN.NNNNN	
pressure reading i + 6	57 - 65	NNN.NNNNN	
pressure reading i + 7	66 - 74	NNN.NNNNN	
	75 - 80	blank	

Format for the Auxiliary File of the Intermediate Reynolds Number Project

For the Intermediate Reynolds Number data base, the auxiliary file contains the zero differential pressure observations and the daily transducer calibration data.

1. Differential pressure transducer zero observation data blocks.

The zero differential pressure observation file contains information taken daily consisting of 25 observed values each for the no-flow transducer observations and the zero differential pressure observations. The data are recorded in four record blocks for each transducer. The format of these records is given here:

Record # or description	Columns	Format	Comments
record I			
observation type	1 - 6	XXXXXX	
	7	blank	
transducer ID	8 - 18	XXXXXXXXXXX	
	19	blank	
date	20 - 27	MM/DD/YY	
	28	blank	
time	29 - 36	HH:MM:SS	
	37	blank	
reading 1	38 - 45	+N.NNNNN	units of μsec for Paros-type transducers (upper and lower) or volts for the Ruska transducer
	46 - 80	blank	
record II			
reading 2	1 - 8	+N.NNNNN	
	9	blank	
reading 3	10 - 17	+N.NNNNN	
	18	blank	
reading 4	19 - 26	+N.NNNNN	
	27	blank	
reading 5	28 - 35	+N.NNNNN	
	36	blank	
reading 6	37 - 44	+N.NNNNN	
	45	blank	
reading 7	46 - 53	+N.NNNNN	
	54	blank	
reading 8	55 - 62	+N.NNNNN	
	63	blank	
reading 9	64 - 71	+N.NNNNN	
	72 - 80	blank	

Record # or description	Columns	Format	Comments
record III			
reading 10	1 - 8	+N.NNNNN	
	9	blank	
reading 11	10 - 17	+N.NNNNN	
	18	blank	
reading 12	19 - 26	+N.NNNNN	
	27	blank	
reading 13	28 - 35	+N.NNNNN	
	36	blank	
reading 14	37 - 44	+N.NNNNN	
	45	blank	
reading 15	46 - 53	+N.NNNNN	
	54	blank	
reading 16	55 - 62	+N.NNNNN	
	63	blank	
reading 17	64 - 71	+N.NNNNN	
	72 - 80	blank	
record IV			
reading 18	1 - 8	+N.NNNNN	
	9	blank	
reading 19	10 - 17	+N.NNNNN	
	18	blank	
reading 20	19 - 26	+N.NNNNN	
	27	blank	
reading 21	28 - 35	+N.NNNNN	
	36	blank	
reading 22	37 - 44	+N.NNNNN	
	45	blank	
reading 23	46 - 53	+N.NNNNN	
	54	blank	
reading 24	55 - 62	+N.NNNNN	
	63	blank	
reading 25	64 - 71	+N.NNNNN	
	72 - 80	blank	

2. Differential pressure transducer calibration data blocks.

The transducer calibration data files for the Intermediate Reynolds Number data base are recorded as a series of five record groups. Each group contains the data for a single observation in the calibration procedures for all three transducers. The format of the records is given here:

record I

calibration observation number	1 - 2	NN	
	3	blank	
date	4 - 11	MM/DD/YY	
	12	blank	
time	13 - 20	HH:MM:SS	
reference dead weight tester serial number	21 - 25	XXXXX	
	26	blank	
test dead weight tester serial number	27 - 31	XXXXX	
	32	blank	
test weight stack	33 - 72	XXXX...XXXX	... indicates characters left out
test pressure (psig)	73 - 80	+NN.NNNN	

record II

reference weight stack	1 - 12	XXXXXXXXXXXX
reference pressure (psig)	13 - 20	+NN.NNNN
	21	blank
weight carrier	22 - 29	XXXXXXXX
	30	blank
barometric pressure (cm of Hg)	31 - 36	+NN.NN
	37	blank
air temperature (deg. F)	38 - 42	NN.NN
	43	blank
relative humidity (%)	44 - 48	NNN.N
	49	blank
Paros offset (μsec)	50 - 54	NNN.N
	55 - 80	blank

Record # or description	Columns	Format	Comments
record III			
transducer 1 ID	1 - 11	XXXXXXXXXXX	
	12	blank	
transducer 1 zero	13 - 21	+NN.NNNNN	μsec for Paros (upper or lower), volts for Ruska
	22	blank	
transducer 1 response	23 - 31	+NN.NNNNN	
	32 - 80	blank	
record IV			
transducer 2 ID	1 - 11	XXXXXXXXXXX	
	12	blank	
transducer 2 zero	13 - 21	+NN.NNNNN	
	22	blank	
transducer 2 response	23 - 31	+NN.NNNNN	
	32 - 80	blank	
record V			
transducer 3 ID	1 - 11	XXXXXXXXXXX	
	12	blank	
transducer 3 zero	13 - 21	+NN.NNNNN	
	22	blank	
transducer 3 response	23 - 31	+NN.NNNNN	
	32 - 80	blank	

APPENDIX E
Measurements of Orifice Plate Edge Sharpness

Measurements of the sharpness of the orifice edge of most of the plates used in this series of tests were made using the lead foil technique. This method was initially described by Herning [E1] and has been improved by later investigators [E2, E3, E4]. This method uses a fixture holding the orifice plate in place relative to an arm carrying a 0.005 inch thick lead foil in a holder. The holder and foil are pressed against the orifice edge thereby recording the shape edge in the foil. Typical indentation depths are 0.3 mm. The lead foil is then inspected with an optical comparator having a magnification of 250. This allows the radius of the edge and the indentation depth to be estimated. The radius of the indentation in the foil was measured using an optical microscope having a magnification of 304. The image of the foil was projected onto a ground glass screen and the radius of this image was measured with a normal radius gauge.

Table E1 lists the results of the edge sharpness measurements for those plates measured. Not all of the plates involved in the testing were measured. The authors would like to express their appreciation to Dr. R. Teysanndier, Mr. E. L. Upp, and Mr. D. Goodson of Daniels Industries, Inc., Houston, Texas for their cooperation in making most of these measurements. One of the authors (WGC) made the initial measurement at Daniels (Sept. 1983). The majority of the measurements were made shortly before beginning the data collection for the final data base on the nickel meter tubes. The acceptance tolerance, 0.0004 x orifice diameter, as defined by the International Standards Organization Standard 5167, is listed for each plate.

Additionally, observations were made on each plate using a light scattering method in accordance with the ANSI/API 2530, [E5] which states,

> "(e) The inlet edge of the orifice shall be square and sharp, free from either burrs or rounding, so that when viewed without magnification a beam of light is not reflected visibly by the edge."

Comparison of the initial and final sharpness observations show a scatter in the differences which seem to be normally distributed about a zero difference value. It is assumed that this difference gives a measure of the precision of the measurements process than a degradation of the edge sharpness of the orifice plates.

Orifice plates having orifice diameters of 0.5 inches or less were considered to be too small to measure accurately. These are marked with asterisks in table E2.

Table E1. Initial Orifice Plate Edge Sharpness Measurement Results

Plate	Obser. Date	Nom. Meter Dia.	Nom. Orifce Dia. (In.)	Plate Thickness (In.)	Measured Edge Radius (In.)	ISO-5167 Tol. Radius (In.)
FE-1/2-1A	06/17/85	2-INCH	0.500	0.125	0.000154	0.000200
FE-1/2-1B	06/17/85	2-INCH	0.500	0.125	0.000167	0.000200
FE-1/2-2A	06/17/85	2-INCH	0.750	0.125	0.000193	0.000300
FE-1/2-2B	06/17/85	2-INCH	0.750	0.125	0.000115	0.000300
FE-1/2-3A	06/17/85	2-INCH	1.000	0.125	0.000141	0.000400
FE-1/2-3B	06/17/85	2-INCH	1.000	0.125	0.000089	0.000400
FE-1/2-4A	06/17/85	2-INCH	1.125	0.125	0.000115	0.000450
FE-1/2-4B	06/17/85	2-INCH	1.125	0.125	0.000115	0.000450
FE-1/2-5A	06/17/85	2-INCH	1.375	0.125	0.000102	0.000550
FE-1/2-5B	06/17/85	2-INCH	1.375	0.125	0.000102	0.000550
FE-1/2-6A	06/17/85	2-INCH	1.500	0.125	0.000090	0.000600
FE-1/2-6B	06/17/85	2-INCH	1.500	0.125	0.000128	0.000600
FE-1/2-7A	06/17/85	2-INCH	0.250	0.125	0.000167	0.000100
FE-1/2-7B	06/17/85	2-INCH	0.250	0.125	0.000141	0.000100
FE-5/6-1A	06/19/85	4-INCH	0.875	0.125	0.000103	0.000350
FE-5/6-1B	09/20/83	4-INCH	0.875	0.125	0.000090	0.000350
FE-5/6-1C	04/15/85	4-INCH	0.875	0.125	0.000090	0.000350
FE-5/6-2A	06/19/85	4-INCH	1.500	0.125	0.000103	0.000600
FE-5/6-2B	09/20/83	4-INCH	1.500	0.125	0.000180	0.000600
FE-5/6-2C	04/15/85	4-INCH	1.500	0.125	0.000218	0.000600
FE-5/6-3A	06/19/85	4-INCH	2.000	0.125	0.000103	0.000800
FE-5/6-3B	09/20/83	4-INCH	2.000	0.125	0.000103	0.000800
FE-5/6-3C	04/15/85	4-INCH	2.000	0.125	0.000180	0.000800
FE-5/6-4A	06/19/85	4-INCH	2.250	0.125	0.000128	0.000900
FE-5/6-4B	09/20/83	4-INCH	2.250	0.125	0.000128	0.000900
FE-5/6-4C	04/15/85	4-INCH	2.250	0.125	0.000150	0.000900
FE-5/6-5A	06/19/85	4-INCH	2.625	0.125	0.000231	0.001050
FE-5/6-5B	09/20/83	4-INCH	2.625	0.125	0.000310	0.001050
FE-5/6-5C	04/15/85	4-INCH	2.625	0.125	0.000190	0.001050
FE-5/6-6A	06/19/85	4-INCH	3.000	0.125	0.000154	0.001200
FE-5/6-6A	09/20/83	4-INCH	4.500	0.125	0.000130	0.001200
FE-5/6-6B	09/20/83	4-INCH	4.500	0.125	0.000218	0.001200
FE-5/6-6C	04/15/85	4-INCH	3.000	0.125	0.000257	0.001200
FE-5/6-7A	06/19/85	4-INCH	0.375	0.125	0.000090	0.000150
FE-5/6-7C	04/15/85	4-INCH	0.375	0.125	0.000077	0.000150
FE-5/6-8A	06/19/85	4-INCH	0.250	0.125	0.000141	0.000100
FE-7/8-2A	09/20/83	6-INCH	2.250	0.125	0.000051	0.000900
FE-7/8-3A	09/20/83	6-INCH	3.000	0.125	0.000120	0.001200
FE-7/8-4A	09/20/83	6-INCH	3.500	0.125	0.000140	0.001400
FE-7/8-5A	09/20/83	6-INCH	4.000	0.125	0.000100	0.001600
FE-7/8-6A	09/20/83	6-INCH	4.500	0.125	0.000130	0.001800

Table E1. Initial Orifice Plate Edge Sharpness Measurement Results -- Continued

Plate	Obser. Date	Nom. Meter Dia.	Nom. Orifce Dia. (In.)	Plate Thickness (In.)	Measured Edge Radius (In.)	ISO-5167 Tol. Radius (In.)
FE-9/0-1A	06/19/85	10-INCH	2.000	0.250	0.000154	0.000800
FE-9/0-1B	06/19/85	10-INCH	2.000	0.250	0.000141	0.000800
FE-9/0-2A	06/19/85	10-INCH	3.750	0.250	0.000257	0.001500
FE-9/0-2B	06/19/85	10-INCH	3.750	0.250	0.000128	0.001500
FE-9/0-3A	06/19/85	10-INCH	5.000	0.250	0.000116	0.002000
FE-9/0-3B	06/19/85	10-INCH	5.000	0.250	0.000154	0.002000
FE-9/0-4A	06/19/85	10-INCH	5.750	0.250	0.000128	0.002300
FE-9/0-4B	06/19/85	10-INCH	5.750	0.250	0.000141	0.002300
FE-9/0-5A	06/19/85	10-INCH	6.625	0.250	0.000192	0.002650
FE-9/0-5B	06/19/85	10-INCH	6.625	0.250	0.000179	0.002650
FE-9/0-6A	06/19/85	10-INCH	7.500	0.250	0.000179	0.003000
FE-9/0-6B	06/19/85	10-INCH	7.500	0.250	0.000167	0.003000
FE-9/0-7A	06/19/85	10-INCH	1.000	0.250	0.000090	0.000400
FE-9/0-7B	06/19/85	10-INCH	1.000	0.250	0.000156	0.000400

Table E2. Final Orifice Plate Edge Sharpness Measurement Results

Plate	Obser. Date	Nom. Meter Dia. (In.)	Nom. Orifce Dia. (In.)	Plate Thickness (In.)	Measured Edge Radius (In.)	ISO-5167 Tol. Radius (In.)
FE-1/2-1A	09/25/87	2	0.500	0.125	0.000064	0.000200
FE-1/2-2A	09/25/87	2	0.750	0.125	0.000128	0.000300
FE-1/2-3A	09/25/87	2	1.000	0.125	0.000128	0.000400
FE-1/2-4A	09/25/87	2	1.125	0.125	0.000090	0.000450
FE-1/2-5A	09/25/87	2	1.375	0.125	0.000154	0.000550
FE-1/2-6A	09/25/87	2	1.500	0.125	0.000128	0.000600
FE-1/2-7A	09/25/87	2	0.250	0.125	**	0.000100
FE-1/2-1B	09/28/87	2	0.500	0.125	0.000154	0.000200
FE-1/2-2B	09/28/87	2	0.750	0.125	0.000154	0.000300
FE-1/2-3B	09/28/87	2	1.000	0.125	0.000103	0.000400
FE-1/2-4B	09/28/87	2	1.125	0.125	0.000115	0.000450
FE-1/2-5B	09/28/87	2	1.375	0.125	0.000103	0.000550
FE-1/2-6B	09/25/87	2	1.500	0.125	0.000128	0.000600
FE-1/2-7B	09/25/87	2	0.250	0.125	**	0.000100
FE-3/4-1A	09/11/87	3	0.625	0.125	0.000077	0.000250
FE-3/4-2A	09/11/87	3	1.125	0.125	0.000141	0.000450
FE-3/4-3A	09/11/87	3	1.500	0.125	0.000128	0.000600
FE-3/4-4A	09/11/87	3	1.750	0.125	0.000102	0.000700
FE-3/4-5A	09/11/87	3	2.000	0.125	0.000205	0.000800
FE-3/4-6A	09/11/87	3	2.250	0.125	0.000115	0.000900
FE-3/4-7A	09/11/87	3	0.375	0.125	0.000154	0.000150
FE-3/4-8A	09/11/87	3	0.250	0.125	**	0.000100
FE-3/4-1B	09/11/87	3	0.625	0.125	0.000141	0.000250
FE-3/4-2B	09/11/87	3	1.125	0.125	0.000077	0.000450
FE-3/4-3B	09/11/87	3	1.500	0.125	0.000089	0.000600
FE-3/4-4B	09/11/87	3	1.750	0.125	0.000128	0.000700
FE-3/4-5B	09/11/87	3	2.000	0.125	0.000115	0.000800
FE-3/4-6B	09/11/87	3	2.250	0.125	0.000141	0.000900
FE-3/4-7B	09/11/87	3	0.375	0.125	0.000128	0.000150
FE-3/4-8B	09/11/87	3	0.250	0.125	**	0.000100

! - two bad spots noted on the edge at the 1 and 5 o'clock positions viewing the inlet face of the plate.

Table E2. Final Orifice Plate Edge Sharpness Measurement Results -- Continued

Plate	Obser. Date	Nom. Meter Dia. (In.)	Nom. Orifce Dia. (In.)	Plate Thickness (In.)	Measured Edge Radius (In.)	ISO-5167 Tol. Radius (In.)
FE-5/6-1A	09/18/87	4	0.875	0.125	0.000141	0.000350
FE-5/6-2A	09/18/87	4	1.500	0.125	0.000115	0.000600
FE-5/6-3A	09/18/87	4	2.000	0.125	0.000115	0.000800
FE-5/6-4A	09/18/87	4	2.250	0.125	0.000154	0.000900
FE-5/6-5A	09/18/87	4	2.625	0.125	0.000205	0.001050
FE-5/6-6A	09/18/87	4	3.000	0.125	0.000089	0.001200
FE-5/6-7A	09/18/87	4	0.375	0.125	0.000115*	0.000150
FE-5/6-8A	09/18/87	4	0.250	0.125	**	0.000100
FE-5/6-1B	09/18/87	4	0.875	0.125	0.000077	0.000350
FE-5/6-2B	09/18/87	4	1.500	0.125	0.000218	0.000600
FE-5/6-3B	09/18/87	4	2.000	0.125	0.000193	0.000800
FE-5/6-4B	09/18/87	4	2.250	0.125	0.000167	0.000900
FE-5/6-5B	09/18/87	4	2.625	0.125	0.000231	0.001050
FE-5/6-6B	09/18/87	4	3.000	0.125	0.000103	0.001200
FE-5/6-7B	09/11/87	4	0.375	0.125	0.000064*	0.000150
FE-5/6-8B	09/11/87	4	0.250	0.125	**	0.000100
FE-5/6-1C	09/17/87	4	0.875	0.125	0.000077	0.000350
FE-5/6-2C	09/17/87	4	1.500	0.125	0.000179	0.000600
FE-5/6-3C	09/17/87	4	2.000	0.125	0.000103	0.000800
FE-5/6-4C	09/17/87	4	2.250	0.125	0.000179	0.000900
FE-5/6-5C	09/17/87	4	2.625	0.125	0.000154	0.001050
FE-5/6-6C	09/17/87	4	3.000	0.125	0.000179	0.001200
FE-5/6-7C	09/18/87	4	0.375	0.125	0.000090*	0.000150
FE-7/8-1A	09/29/87	6	1.250	0.125	0.000103	0.000500
FE-7/8-2A	10/19/87	6	2.250	0.125	0.000103	0.000900
FE-7/8-3A	10/19/87	6	3.000	0.125	0.000154	0.001200
FE-7/8-4A	10/19/87	6	3.500	0.125	0.000141	0.001400
FE-7/8-5A	10/19/87	6	4.000	0.125	0.000103	0.001600
FE-7/8-6A	10/19/87	6	4.500	0.125	0.000154	0.001800
FE-7/8-7A	09/11/87	6	0.625	0.125	0.000103	0.000250
FE-7/8-8A	10/19/87	6	1.250	0.125	0.000141	0.000500

Table E2. Final Orifice Plate Edge Sharpness Measurement Results -- Continued

Plate	Obser. Date	Nom. Meter Dia. (In.)	Nom. Orifce Dia. (In.)	Plate Thickness (In.)	Measured Edge Radius (In.)	ISO-5167 Tol. Radius (In.)
FE-7/8-1B	09/29/87	6	1.250	0.125	0.000090	0.000500
FE-7/8-2B	09/11/87	6	2.250	0.125	0.000167	0.000900
FE-7/8-3B	09/11/87	6	3.000	0.125	0.000103	0.001200
FE-7/8-4B	09/11/87	6	3.500	0.125	0.000116	0.001400
FE-7/8-5B	09/11/87	6	4.000	0.125	0.000103	0.001600
FE-7/8-6B	09/11/87	6	4.500	0.125	0.000128	0.001800
FE-7/8-7B	09/11/87	6	0.625	0.125	0.000141	0.000250
FE-7/8-8B	09/11/87	6	0.625	0.125	0.000141	0.000250
FE-7/8-1C	09/03/87	6	1.250	0.125	0.000308	0.000500
FE-7/8-3C	09/11/87	6	3.000	0.125	0.000193	0.001200
FE-7/8-5C	09/11/87	6	4.000	0.125	0.000167	0.001600
FE-9/0-1A	10/19/87	10	2.000	0.250	0.000154	0.000800
FE-9/0-2A	09/29/87	10	3.750	0.250	0.000154	0.001500
FE-9/0-3A	10/19/87	10	5.000	0.250	0.000167	0.002000
FE-9/0-4A	10/19/87	10	5.750	0.250	0.000128	0.002300
FE-9/0-5A	10/19/87	10	6.625	0.250	0.000179	0.002650
FE-9/0-6A	09/29/87	10	7.500	0.250	0.000141	0.003000
FE-9/0-7A	10/19/87	10	1.000	0.250	0.000141	0.000400
FE-9/0-7A	10/19/87	10	1.000	0.250	0.000128	0.000400
FE-9/0-1B	09/29/87	10	2.000	0.250	0.000167	0.000800
FE-9/0-2B	09/29/87	10	3.750	0.250	0.000141	0.001500
FE-9/0-3B	09/29/87	10	5.000	0.250	0.000193	0.002000
FE-9/0-4B	09/29/87	10	5.750	0.250	0.000115	0.002300
FE-9/0-5B	09/29/87	10	6.625	0.250	0.000154	0.002650
FE-9/0-6B	09/29/87	10	7.500	0.250	0.000115	0.003000
FE-9/0-7B	09/29/87	10	1.000	0.250	0.000128	0.000400

References:

[E1] Herning, von Fr., "Untersuchen zum Problem der Kantehunscharfe Bei Normblenden und die Segmentblenden." (Experiments on the Problem of the Edge Sharpness of Standard and Segmental Orifice Plates.) Brenns-Warme-Kraft, 14(3), 119-126, 1962.

[E2] Jepson, P., and Johnson, E. P., "A Method of Measuring Orifice Edge Sharpness (ORIS)." Tech. Rept-ERS.T.415. Killingworth, Newcastle, Gas Council Engineering Research Station, 1971.

[E3] Brain, T. J. S., and Reid, J., "Measurement of Orifice Plate Edge Sharpness," Measurement and Control, 9), 377-383, 1973.

[E4] Benedict, R. P., Wyler, J. S. and Brandt, G. B., "The Effect of Edge Sharpness on the Discharge Coefficient of Orifice Plates," Trans. ASME, J. Eng. for Power, paper no. 74-WA/FM-4, 1974.

[E5] American National Standard/American Petroleum Institute 2530, American Petroleum Institute, Washington, DC.

APPENDIX F
Velocity Profile Measurements*

Although main stream velocities and their distributions reflect only the parameters of the macroscale turbulence, they may affect orifice meter performance if not controlled by proper upstream installations [F1-F3]. For this reason, velocity distributions involved in this orifice testing program were checked to determine if upstream piping elements produced significantly anomalous flow profiles at the orifice union, i.e. at the orifice plate position in the meter tube assembly.

For specific initial or inlet flows, the factors that control velocity profile variations, with downstream distance, are the fluid inertial and viscous effects and the roughness and size of the piping. The presence of flow conditioners and piping geometries can also affect velocity profiles. In dimensionless terms and for specific pipe geometry, the pertinent flow parameters describing pipe flow development to equilibrium conditions, i.e., "fully developed," are Reynolds number and the relative roughness [F3-F5].

To efficiently check the numerous pipe flow conditions that were involved in this orifice testing program, the strategy adopted was to obtain velocity profiles for the "worst case" condition. If for this condition the profiles were satisfactory, there would be no need to test any other.

It is well known that anomalous flow effects propagate into downstream piping with diametral distances that increase with Reynolds Number and decrease with relative roughness, [F4-F6]. Therefore, the largest, smoothest pipe, at the highest flowrate is the configuration considered "worst" - i.e., most likely to permit undesirable upstream conditions to produce anomalous profiles at the orifice union. Following this reasoning, and after careful visual inspection, the PE-0 tube was selected for the velocity profile tests in February 1987. Although the PE-9 tube was originally determined as having the lowest internal wall roughness, it was rejected for the velocity profile measurements because significant patches of rust developed on the inner surface after the completion of the discharge coefficient measurements.

To measure the time-averaged velocity distribution at the orifice union, the pitot tube technique was selected; see [F2]. A pitot-tube traversing fixture was designed and installed in the flow at the orifice union. Two pitot tubes of slightly different construction were used during the measurements to test for possible system errors; both instruments gave coincidental results. For these tests, orifice plates were removed from the pipeline. Two diametral traversing positions (vertical and horizontal) were selected, with measurements repeated on different days.

---

*Dr. G. E. Mattingly and G. P. Baumgarten performed the work described here. Dr. J. J. Ulbrecht assisted Dr. Mattingly in writing this appendix.

The vertical traversing plane was that of the orifice union tappings. The horizontal traversing plane was normal to the vertical plane. The dynamic pressure differences were measured using the same differential pressure transducers and data acquisition system described in the main body of this report. The pitot tube was positioned by means of a graduated-scale indexed to the probe traversing plate.

Results are given in tables F1 and F2, and in the form of the dimensionless plots shown in figure F1 for both traverse orientations. The profiles show no inflection points. The high degree of repeatability evident from the data taken over several days confirms the credibility of these results.

The slight asymmetry of the velocity profiles can be evaluated by analyzing the orifice differential pressure measurements acquired using the same meter tube geometry and the same flow conditions. By examination of the data in table 47F it appears that there is only one set of conditions, namely the highest beta ratios and the highest Reynolds numbers in the PE-O tube, when consistently higher pressure readings were obtained from the upper pressure tap. This trend is perfectly consistent with the apparent asymmetry of the velocity profile. However, this difference (between upper and lower pressure tap readings) is also observed to be numerically small in comparison with the measurement uncertainty associated with each data point. For example, the difference between upper and lower pressure tap readings under the worst conditions (Reynolds Number = 2.7×10^6 and $\beta = 0.75$) does not exceed 6 parts in 2800 (0.21%). In addition to this visual inspection of the data in table 47F, statistical analyses have not shown any consistent trends in differences between the upper and lower pressure tap readings throughout the entire data base (all meter tubes, orifice plates, run conditions, etc.). This, in turn, testifies to the insignificance of the observed asymmetry of the profile.

When power-law formulae are fitted, via the least-squares method, to the data shown in figure F1, the exponent $n=8\pm0.4$ is determined. This value is appropriate for the pipe Reynolds number and the mean relative roughness (based on rms roughness measurements) for this pipeline--see References [F4,F5]. The relative roughness (ϵ/D) was 0.000024, obtained by averaging all rms roughness measurements recorded in table 25 and using the tube diameter given in table 24.

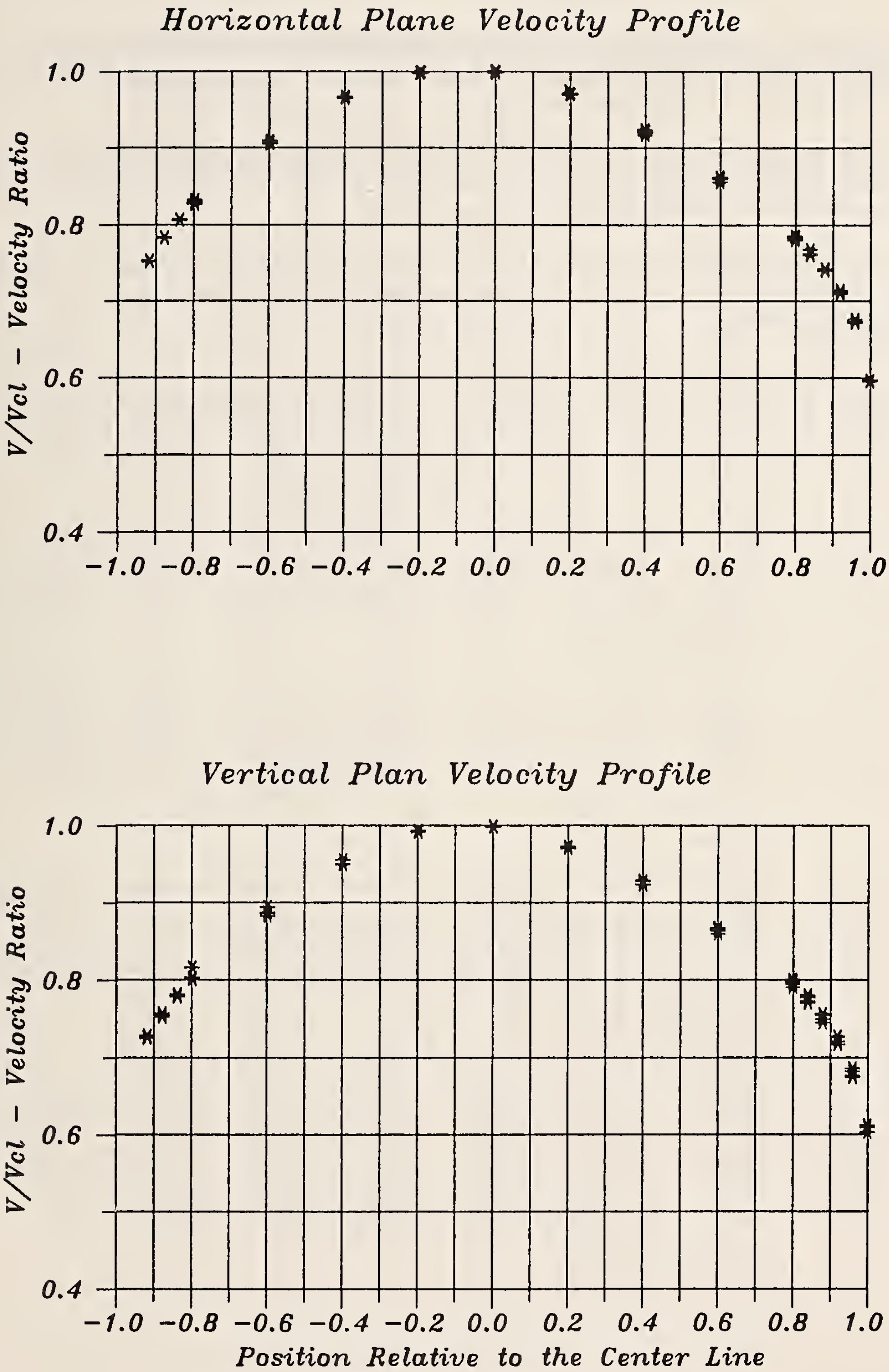


Figure F1. Horizontal and Vertical Velocity Profiles

Table F1. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Horizontal Traverses

The relative position, Y/R, is the radial distance from the meter tube center. Looking downstream Y/R < 0 denotes the upper left portion of the flow field.

The relative velocity V/Vcl is the velocity non-dimensionalized by the velocity measured on the meter tube centerline.

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Rel. Velocity Tr. 2	-- Impact Pressure (psi) -- Transducer 1 Mean	Transducer 1 SD	Tranducer 2 Mean	Tranducer 2 SD
04/16/87	37	-.9178	0.7529	0.7527	3.582	0.0663	3.582	0.0578
04/16/87	38	-.9178	0.7520	0.7518	3.573	0.0658	3.572	0.0594
04/17/87	81	-.9178	0.7518	0.7523	3.409	0.0736	3.415	0.0599
04/17/87	82	-.9178	0.7536	0.7539	3.428	0.0587	3.433	0.0524
		mean	0.7526					
		std. dev.	0.0008					
04/16/87	35	-.8779	0.7837	0.7836	3.898	0.0682	3.899	0.0613
04/16/87	36	-.8779	0.7837	0.7837	3.892	0.0702	3.894	0.0645
04/17/87	79	-.8779	0.7841	0.7842	3.735	0.0609	3.737	0.0503
04/17/87	80	-.8779	0.7824	0.7826	3.720	0.0557	3.723	0.0482
		mean	0.7835					
		std. dev.	0.0007					
04/16/87	33	-.8380	0.8060	0.8063	4.121	0.0696	4.126	0.0603
04/16/87	34	-.8380	0.8066	0.8067	4.128	0.0608	4.132	0.0483
04/17/87	77	-.8380	0.8073	0.8075	3.962	0.0541	3.965	0.0454
04/17/87	78	-.8380	0.8068	0.8070	3.956	0.0608	3.961	0.0543
		mean	0.8067					
		std. dev.	0.0005					
04/16/87	31	-.7981	0.8267	0.8267	4.353	0.0750	4.354	0.0688
04/16/87	32	-.7981	0.8287	0.8288	4.370	0.0520	4.373	0.0441
04/29/87	166	-.7981	0.8277	0.8276	5.118	0.0680	5.119	0.0585
04/29/87	167	-.7981	0.8295	0.8296	5.144	0.0720	5.147	0.0639
04/30/87	204	-.7981	0.8321	0.8319	5.123	0.0618	5.124	0.0521
04/30/87	205	-.7981	0.8281	0.8283	5.072	0.0667	5.077	0.0630
		mean	0.8288					
		std. dev.	0.0019					

Table F1. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Horizontal Traverses -- Continued

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Rel. Velocity Tr. 2	Transducer 1 Mean	Transducer 1 SD	Tranducer 2 Mean	Tranducer 2 SD
					-- Impact Pressure (psi) --			
04/16/87	29	-.5986	0.9067	0.9067	5.255	0.0478	5.257	0.0406
04/16/87	30	-.5986	0.9097	0.9098	5.281	0.0632	5.285	0.0567
04/17/87	73	-.5986	0.9095	0.9096	5.033	0.0365	5.036	0.0305
04/17/87	74	-.5986	0.9086	0.9087	5.019	0.0467	5.023	0.0415
04/29/87	164	-.5986	0.9054	0.9055	6.097	0.0509	6.101	0.0452
04/29/87	165	-.5986	0.9051	0.9051	6.101	0.0533	6.104	0.0484
04/30/87	198	-.5986	0.9054	0.9054	6.051	0.0529	6.055	0.0471
04/30/87	199	-.5986	0.9053	0.9054	6.042	0.0480	6.047	0.0443
		mean	0.9070					
		std. dev.	0.0020					
04/16/87	27	-.3990	0.9684	0.9683	6.009	0.0348	6.010	0.0309
04/16/87	28	-.3990	0.9679	0.9677	6.000	0.0440	6.000	0.0409
04/17/87	71	-.3990	0.9660	0.9659	5.776	0.0379	5.778	0.0304
04/17/87	72	-.3990	0.9677	0.9677	5.795	0.0360	5.798	0.0305
04/29/87	158	-.3990	0.9653	0.9653	6.939	0.0420	6.942	0.0364
04/29/87	159	-.3990	0.9649	0.9649	6.921	0.0437	6.923	0.0392
04/30/87	196	-.3990	0.9637	0.9637	6.844	0.0408	6.849	0.0383
04/30/87	197	-.3990	0.9647	0.9646	6.857	0.0451	6.861	0.0408
		mean	0.9661					
		std. dev.	0.0017					
04/16/87	25	-.1995	1.0005	1.0005	6.426	0.0261	6.429	0.0206
04/16/87	26	-.1995	1.0009	1.0009	6.444	0.0320	6.447	0.0269
04/17/87	69	-.1995	0.9988	0.9990	6.182	0.0245	6.186	0.0224
04/17/87	70	-.1995	0.9998	0.9999	6.188	0.0295	6.191	0.0262
04/29/87	156	-.1995	0.9985	0.9984	7.377	0.0267	7.379	0.0223
04/29/87	157	-.1995	0.9984	0.9986	7.373	0.0313	7.378	0.0265
04/29/87	176	-.1995	0.9981	0.9982	7.317	0.0348	7.322	0.0320
04/29/87	177	-.1995	0.9983	0.9983	7.307	0.0286	7.310	0.0248
04/29/87	184	-.1995	0.9982	0.9982	7.309	0.0413	7.311	0.0366
04/29/87	185	-.1995	0.9992	0.9992	7.320	0.0312	7.323	0.0270
04/30/87	190	-.1995	0.9987	0.9985	7.338	0.0335	7.341	0.0305
04/30/87	191	-.1995	0.9980	0.9979	7.334	0.0403	7.338	0.0373
		mean	0.9990					
		std. dev.	0.0010					

Table F1. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Horizontal Traverses -- Continued

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Rel. Velocity Tr. 2	Impact Pressure (psi) Transducer 1 Mean	Transducer 1 SD	Tranducer 2 Mean	Tranducer 2 SD
04/16/87	1	0.0000	1.0000	1.0000	6.695	0.0346	6.698	0.0303
04/16/87	2	0.0000	1.0001	1.0000	6.677	0.0269	6.679	0.0223
04/16/87	23	0.0000	1.0006	1.0006	6.445	0.0354	6.448	0.0315
04/16/87	24	0.0000	1.0007	1.0007	6.439	0.0290	6.442	0.0243
04/17/87	39	0.0000	1.0000	1.0000	6.602	0.0334	6.605	0.0279
04/17/87	40	0.0000	0.9988	0.9989	6.599	0.0391	6.603	0.0346
04/17/87	67	0.0000	0.9988	0.9988	6.184	0.0307	6.186	0.0269
04/17/87	68	0.0000	0.9988	0.9988	6.182	0.0402	6.184	0.0368
04/29/87	152	0.0000	1.0000	1.0000	7.380	0.0343	7.383	0.0271
04/29/87	153	0.0000	1.0005	1.0005	7.377	0.0252	7.380	0.0213
04/29/87	170	0.0000	0.9989	0.9988	7.358	0.0362	7.359	0.0341
04/29/87	171	0.0000	0.9999	0.9998	7.362	0.0395	7.363	0.0370
04/29/87	174	0.0000	0.9998	0.9998	7.342	0.0485	7.345	0.0444
04/29/87	175	0.0000	0.9988	0.9988	7.327	0.0270	7.330	0.0236
04/29/87	178	0.0000	0.9995	0.9995	7.325	0.0394	7.329	0.0359
04/29/87	179	0.0000	1.0001	1.0001	7.338	0.0279	7.341	0.0257
04/29/87	182	0.0000	0.9998	0.9998	7.326	0.0321	7.330	0.0282
04/29/87	183	0.0000	0.9992	0.9991	7.307	0.0285	7.309	0.0244
04/29/87	186	0.0000	0.9992	0.9992	7.316	0.0249	7.319	0.0216
04/29/87	187	0.0000	0.9993	0.9993	7.323	0.0493	7.328	0.0442
04/30/87	188	0.0000	1.0000	1.0000	7.364	0.0449	7.369	0.0425
04/30/87	189	0.0000	1.0003	1.0001	7.357	0.0367	7.359	0.0328
		mean	0.9997					
		std. dev.	0.0006					
04/16/87	5	0.1995	0.9721	0.9720	6.264	0.0618	6.265	0.0543
04/16/87	6	0.1995	0.9716	0.9714	6.256	0.0357	6.257	0.0297
04/17/87	41	0.1995	0.9714	0.9714	6.162	0.0354	6.164	0.0287
04/17/87	42	0.1995	0.9710	0.9709	6.158	0.0383	6.159	0.0353
04/29/87	154	0.1995	0.9716	0.9715	6.992	0.0387	6.994	0.0339
04/29/87	155	0.1995	0.9723	0.9723	7.001	0.0433	7.004	0.0359
04/29/87	172	0.1995	0.9714	0.9715	6.955	0.0365	6.958	0.0317
04/29/87	173	0.1995	0.9721	0.9722	6.956	0.0410	6.959	0.0352
04/29/87	180	0.1995	0.9705	0.9706	6.911	0.0568	6.916	0.0515
04/29/87	181	0.1995	0.9703	0.9702	6.896	0.0511	6.898	0.0478
04/30/87	192	0.1995	0.9711	0.9711	6.942	0.0426	6.946	0.0391
04/30/87	193	0.1995	0.9711	0.9710	6.945	0.0517	6.949	0.0462
		mean	0.9714					
		std. dev.	0.0006					

Table F1. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Horizontal Traverses -- Continued

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Tr. 2	-- Impact Pressure (psi) -- Transducer 1 Mean	SD	Tranducer 2 Mean	SD
04/16/87	7	0.3990	0.9215	0.9214	5.605	0.0544	5.606	0.0462
04/16/87	8	0.3990	0.9232	0.9232	5.620	0.0649	5.622	0.0561
04/17/87	43	0.3990	0.9172	0.9172	5.490	0.0639	5.492	0.0511
04/17/87	44	0.3990	0.9203	0.9204	5.528	0.0551	5.532	0.0493
04/29/87	160	0.3990	0.9209	0.9212	6.306	0.0598	6.312	0.0492
04/29/87	161	0.3990	0.9216	0.9217	6.315	0.0709	6.319	0.0639
04/30/87	194	0.3990	0.9244	0.9245	6.295	0.0522	6.301	0.0454
04/30/87	195	0.3990	0.9230	0.9231	6.279	0.0466	6.284	0.0395
		mean	0.9215					
		std. dev.	0.0022					
04/16/87	9	0.5986	0.8606	0.8607	4.866	0.0695	4.869	0.0578
04/16/87	10	0.5986	0.8602	0.8602	4.867	0.0538	4.869	0.0451
04/17/87	45	0.5986	0.8563	0.8565	4.718	0.0643	4.721	0.0552
04/17/87	46	0.5986	0.8558	0.8558	4.716	0.0628	4.718	0.0536
04/29/87	162	0.5986	0.8603	0.8604	5.503	0.0641	5.507	0.0544
04/29/87	163	0.5986	0.8605	0.8606	5.511	0.0484	5.514	0.0373
04/30/87	200	0.5986	0.8619	0.8619	5.483	0.0641	5.487	0.0564
04/30/87	201	0.5986	0.8610	0.8610	5.472	0.0714	5.475	0.0625
		mean	0.8596					
		std. dev.	0.0022					
04/16/87	11	0.7981	0.7824	0.7824	4.020	0.0668	4.022	0.0599
04/16/87	12	0.7981	0.7840	0.7842	4.034	0.0522	4.038	0.0491
04/17/87	47	0.7981	0.7813	0.7813	3.927	0.0693	3.929	0.0571
04/17/87	48	0.7981	0.7807	0.7805	3.921	0.0604	3.921	0.0530
04/29/87	168	0.7981	0.7862	0.7864	4.614	0.0624	4.618	0.0573
04/29/87	169	0.7981	0.7859	0.7860	4.615	0.0726	4.618	0.0658
04/30/87	202	0.7981	0.7838	0.7839	4.532	0.0621	4.536	0.0538
04/30/87	203	0.7981	0.7842	0.7843	4.548	0.0650	4.553	0.0543
		mean	0.7836					
		std. dev.	0.0020					

Table F1. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Horizontal Traverses -- Continued

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Rel. Velocity Tr. 2	-- Impact Pressure (psi) -- Transducer 1 Mean	Transducer 1 SD	Tranducer 2 Mean	Tranducer 2 SD
04/16/87	13	0.8380	0.7690	0.7688	3.857	0.0680	3.857	0.0564
04/16/87	14	0.8380	0.7632	0.7633	3.804	0.0699	3.807	0.0612
04/17/87	49	0.8380	0.7609	0.7611	3.726	0.0598	3.729	0.0478
04/17/87	50	0.8380	0.7633	0.7638	3.753	0.0634	3.759	0.0477
		mean	0.7641					
		std. dev.	0.0035					
04/16/87	15	0.8779	0.7434	0.7437	3.599	0.0675	3.604	0.0584
04/16/87	16	0.8779	0.7431	0.7431	3.593	0.0616	3.595	0.0502
04/17/87	51	0.8779	0.7431	0.7430	3.503	0.0728	3.504	0.0619
04/17/87	52	0.8779	0.7404	0.7403	3.491	0.0624	3.492	0.0530
		mean	0.7525					
		std. dev.	0.0014					
04/16/87	17	0.9178	0.7118	0.7118	3.288	0.0669	3.290	0.0599
04/16/87	18	0.9178	0.7155	0.7153	3.318	0.0662	3.318	0.0573
04/17/87	53	0.9178	0.7102	0.7105	3.213	0.0678	3.217	0.0584
04/17/87	54	0.9178	0.7136	0.7136	3.244	0.0744	3.245	0.0707
		mean	0.7128					
		std. dev.	0.0023					
04/16/87	19	0.9577	0.6773	0.6774	2.961	0.0747	2.964	0.0593
04/16/87	20	0.9577	0.6746	0.6748	2.938	0.0504	2.940	0.0445
04/17/87	55	0.9577	0.6724	0.6726	2.856	0.0687	2.859	0.0652
04/17/87	56	0.9577	0.6726	0.6730	2.857	0.0678	2.862	0.0623
		mean	0.6742					
		std. dev.	0.0023					
04/16/87	21	0.9976	0.5974	0.5975	2.298	0.0640	2.300	0.0590
04/16/87	22	0.9976	0.5976	0.5979	2.299	0.0473	2.303	0.0423
04/17/87	57	0.9976	0.5967	0.5970	2.248	0.0626	2.251	0.0566
04/17/87	58	0.9976	0.5955	0.5956	2.239	0.0591	2.241	0.0514
		mean	0.5968					
		std. dev.	0.0009					

Table F2. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Vertical Traverses

The relative position, Y/R, is the radial distance from the meter tube center. Looking downstream Y/R < 0 denotes the upper left portion of the flow field.

The relative velocity V/Vcl is the velocity non-dimensionalized by the velocity measured on the meter tube centerline.

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Rel. Velocity Tr. 2	Impact Pressure (psi) Transducer 1 Mean	Transducer 1 SD	Tranducer 2 Mean	Tranducer 2 SD
04/14/87	92	-.9178	0.7288	0.7290	3.549	0.0656	3.551	0.0545
04/14/87	93	-.9178	0.7259	0.7262	3.545	0.0626	3.549	0.0563
04/15/87	120	-.9178	0.7268	0.7270	3.405	0.0766	3.407	0.0647
04/15/87	121	-.9178	0.7292	0.7291	3.441	0.0891	3.442	0.0758
		mean	0.7277					
		std. dev.	0.0016					
04/14/87	90	-.8779	0.7553	0.7554	3.830	0.0948	3.832	0.0780
04/14/87	91	-.8779	0.7530	0.7530	3.789	0.0653	3.790	0.0544
04/15/87	118	-.8779	0.7576	0.7577	3.678	0.0627	3.679	0.0481
04/15/87	119	-.8779	0.7549	0.7546	3.683	0.0633	3.681	0.0527
		mean	0.7552					
		std. dev.	0.0019					
04/14/87	94	-.8380	0.7797	0.7800	4.087	0.0719	4.091	0.0617
04/14/87	95	-.8380	0.7790	0.7797	4.070	0.0753	4.079	0.0608
04/15/87	116	-.8380	0.7820	0.7820	3.935	0.0663	3.935	0.0576
04/15/87	117	-.8380	0.7797	0.7799	3.917	0.0732	3.920	0.0658
		mean	0.7776					
		std. dev.	0.0035					
04/14/87	86	-.7981	0.8026	0.8024	4.276	0.0695	4.275	0.0572
04/14/87	87	-.7981	0.8041	0.8040	4.315	0.0825	4.316	0.0672
04/15/87	110	-.7981	0.8031	0.8034	4.343	0.0814	4.348	0.0704
04/15/87	111	-.7981	0.8009	0.8009	4.331	0.0909	4.332	0.0795
04/28/87	148	-.7981	0.8159	0.8159	5.253	0.1008	5.255	0.0939
04/28/87	149	-.7981	0.8165	0.8169	5.265	0.0873	5.271	0.0761
		mean	0.8072					
		std. dev.	0.0071					

Table F2. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Vertical Traverses -- Continued

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Rel. Velocity Tr. 2	Impact Pressure (psi) Transducer 1 Mean	Transducer 1 SD	Tranducer 2 Mean	Tranducer 2 SD
04/14/87	84	-.5986	0.8838	0.8841	5.168	0.0666	5.173	0.0591
04/14/87	85	-.5986	0.8871	0.8874	5.207	0.0441	5.212	0.0385
04/15/87	108	-.5986	0.8883	0.8884	5.301	0.0632	5.304	0.0538
04/15/87	109	-.5986	0.8883	0.8883	5.334	0.0567	5.336	0.0490
04/28/87	146	-.5986	0.8949	0.8948	6.446	0.0707	6.447	0.0599
04/28/87	147	-.5986	0.8944	0.8945	6.391	0.0580	6.395	0.0498
		mean	0.8995					
		std. dev.	0.0044					
04/14/87	82	-.3990	0.9498	0.9497	6.032	0.0374	6.034	0.0320
04/14/87	83	-.3990	0.9501	0.9501	6.042	0.0438	6.043	0.0384
04/15/87	102	-.3990	0.9493	0.9495	6.086	0.0482	6.090	0.0430
04/15/87	103	-.3990	0.9509	0.9510	6.101	0.0554	6.104	0.0465
04/28/87	140	-.3990	0.9556	0.9555	7.454	0.0611	7.456	0.0531
04/28/87	141	-.3990	0.9556	0.9556	7.448	0.0560	7.451	0.0508
		mean	0.9518					
		std. dev.	0.0029					
04/14/87	80	-.1995	0.9919	0.9918	6.523	0.0314	6.525	0.0278
04/14/87	81	-.1995	0.9928	0.9928	6.532	0.0368	6.533	0.0329
04/15/87	100	-.1995	0.9922	0.9924	6.695	0.0603	6.700	0.0524
04/15/87	101	-.1995	0.9930	0.9930	6.645	0.0419	6.647	0.0358
04/28/87	138	-.1995	0.9943	0.9944	8.229	0.0472	8.232	0.0418
04/28/87	139	-.1995	0.9946	0.9946	8.278	0.0429	8.281	0.0364
		mean	0.9931					
		std. dev.	0.0011					
04/14/87	58	0.0000	1.0000	1.0000	7.100	0.0910	7.102	0.0759
04/14/87	59	0.0000	0.9994	0.9995	7.142	0.0990	7.145	0.0886
04/14/87	78	0.0000	0.9990	0.9990	6.678	0.0256	6.680	0.0213
04/14/87	79	0.0000	0.9997	0.9997	6.634	0.0355	6.636	0.0319
04/15/87	96	0.0000	1.0000	1.0000	6.708	0.0398	6.710	0.0355
04/15/87	97	0.0000	1.0000	1.0000	6.694	0.0366	6.696	0.0321
04/28/87	134	0.0000	1.0000	1.0000	8.377	0.0465	8.379	0.0410
04/28/87	135	0.0000	0.9993	0.9994	8.391	0.0382	8.393	0.0339
		mean	0.9997					
		std. dev.	0.0004					

Table F2. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Vertical Traverses -- Continued

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Rel. Velocity Tr. 2	Impact Pressure (psi) Transducer 1 Mean	Transducer 1 SD	Tranducer 2 Mean	Tranducer 2 SD
04/14/87	60	0.1995	0.9738	0.9740	6.935	0.0937	6.940	0.0802
04/14/87	61	0.1995	0.9731	0.9728	6.884	0.1083	6.883	0.0924
04/15/87	98	0.1995	0.9733	0.9735	6.387	0.0575	6.392	0.0472
04/15/87	99	0.1995	0.9710	0.9712	6.443	0.0534	6.448	0.0435
04/28/87	136	0.1995	0.9732	0.9732	7.886	0.0571	7.888	0.0509
04/28/87	137	0.1995	0.9739	0.9738	7.927	0.0388	7.928	0.0347
		mean	0.9731					
		std. dev.	0.0011					
04/14/87	62	0.3990	0.9238	0.9240	6.208	0.0938	6.211	0.0811
04/14/87	63	0.3990	0.9237	0.9236	6.236	0.0810	6.236	0.0730
04/15/87	104	0.3990	0.9239	0.9237	5.760	0.0602	5.759	0.0502
04/15/87	105	0.3990	0.9243	0.9246	5.821	0.0592	5.826	0.0536
04/28/87	142	0.3990	0.9290	0.9289	7.042	0.0632	7.043	0.0544
04/28/87	143	0.3990	0.9276	0.9276	6.999	0.0594	7.001	0.0539
		mean	0.9254					
		std. dev.	0.0023					
04/14/87	64	0.5986	0.8616	0.8616	5.459	0.0877	5.460	0.0744
04/14/87	65	0.5986	0.8612	0.8608	5.482	0.1065	5.479	0.0938
04/15/87	106	0.5986	0.8651	0.8652	5.094	0.0783	5.097	0.0701
04/15/87	107	0.5986	0.8661	0.8663	5.060	0.0515	5.064	0.0418
04/28/87	144	0.5986	0.8661	0.8662	6.099	0.0639	6.102	0.0528
04/28/87	145	0.5986	0.8687	0.8689	6.158	0.0768	6.163	0.0630
		mean	0.8648					
		std. dev.	0.0029					
04/14/87	66	0.7981	0.7914	0.7914	4.541	0.0794	4.543	0.0667
04/14/87	67	0.7981	0.7914	0.7916	4.475	0.0912	4.478	0.0781
04/15/87	112	0.7981	0.7998	0.7997	4.090	0.0740	4.090	0.0607
04/15/87	113	0.7981	0.7951	0.7951	4.015	0.0768	4.016	0.0627
04/28/87	150	0.7981	0.8011	0.8011	5.062	0.0654	5.063	0.0615
04/28/87	151	0.7981	0.7974	0.7975	4.981	0.0711	4.983	0.0625
		mean	0.7960					
		std. dev.	0.0041					
04/14/87	68	0.8380	0.7736	0.7736	4.270	0.0943	4.271	0.0770
04/14/87	69	0.8380	0.7714	0.7718	4.181	0.0948	4.186	0.0782
04/15/87	114	0.8380	0.7784	0.7783	3.881	0.0773	3.881	0.0656
04/15/87	115	0.8380	0.7815	0.7815	3.938	0.0696	3.938	0.0593
		mean	0.7837					
		std. dev.	0.0033					

Table F2. Summary of Relative Velocities and Positions and Observed Mean Impact Pressures and Standard Deviations of the Mean for Vertical Traverses -- Continued

Date	Run No.	Relative Position	Rel. Velocity Tr. 1	Rel. Velocity Tr. 2	Transducer 1 Mean	Transducer 1 SD	Tranducer 2 Mean	Tranducer 2 SD
					-- Impact Pressure (psi) --			
04/14/87	70	0.8779	0.7462	0.7463	3.996	0.1122	3.998	0.0957
04/14/87	71	0.8779	0.7511	0.7510	4.014	0.0841	4.015	0.0673
04/15/87	122	0.8779	0.7575	0.7571	3.720	0.0652	3.717	0.0563
04/15/87	123	0.8779	0.7564	0.7566	3.688	0.0675	3.690	0.0545
		mean	0.7528					
		std. dev.	0.0052					
04/14/87	72	0.9178	0.7183	0.7185	3.623	0.0763	3.625	0.0690
04/14/87	73	0.9178	0.7222	0.7226	3.691	0.1008	3.696	0.0894
04/15/87	124	0.9178	0.7286	0.7287	3.416	0.0566	3.418	0.0492
04/15/87	125	0.9178	0.7282	0.7286	3.449	0.0915	3.454	0.0783
		mean	0.7243					
		std. dev.	0.0050					
04/14/87	74	0.9577	0.6775	0.6779	3.261	0.0765	3.265	0.0656
04/14/87	75	0.9577	0.6751	0.6748	3.235	0.0898	3.233	0.0760
04/15/87	126	0.9577	0.6872	0.6871	3.047	0.0633	3.047	0.0551
04/15/87	127	0.9577	0.6830	0.6830	2.994	0.0660	2.994	0.0552
		mean	0.6807					
		std. dev.	0.0055					
04/14/87	76	0.9976	0.6005	0.6005	2.536	0.0672	2.537	0.0565
04/14/87	77	0.9976	0.6041	0.6047	2.587	0.0603	2.592	0.0576
04/15/87	128	0.9976	0.6128	0.6126	2.409	0.0521	2.408	0.0469
04/15/87	129	0.9976	0.6100	0.6104	2.395	0.0577	2.399	0.0502
		mean	0.6769					
		std. dev.	0.0056					

References:

[F1] Starrett, P. S., Nottage, H.B., and Halfpenny, P. F. "Survey of Information Concerning the Effects of Non-Standard Approach Conditions Upon Orifice and Venturi Meters," ISA Preprint of ASME paper 65-WA/FM-5, 1965.

[F2] Mattingly, G. E., Fundamental Flow Research-Potential for Contributing to Orifice Meter Technology, appears in Mattingly, G. E., et al., Workshop on Fundamental Research Issues in Orifice Metering, GRI Report 84/0140, September 1984.

[F3] Davis, R. and Mattingly, G. E., Numerical Modeling of Turbulent Flow through Thin Orifice Plates, NBS SP484/2, 1977.

[F4] Goldstein, S., Modern Developments in Fluid Dynamics, Dover Press,New York, NY, 1965.

[F5] Schlichting, H., Boundary Layer Theory, McGraw-Hill Book Co., New York, NY, Sixth Edition, 1968.

[F6] Streeter, V. L., Fluid Mechanics, McGraw-Hill Book Co., New York, NY, 5th Edition, 1971.

NBS-114A (REV. 2-80)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See instructions)	1. PUBLICATION OR REPORT NO. NIST/TN-1264	2. Performing Organ. Report No.	3. Publication Date June 1989

4. TITLE AND SUBTITLE

Measurements of Coefficients of Discharge for Concentric Flange-Tapped Square-Edged Orifice Meters in Water Over the Reynolds Number Range 600 to 2,700,000

5. AUTHOR(S) James R. Whetstone, William G. Cleveland, George P. Baumgarten, Samuel Woo, and M. Carroll Croarkin

6. PERFORMING ORGANIZATION (If joint or other than NBS, see instructions)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
(formerly NATIONAL BUREAU OF STANDARDS)
U.S. DEPARTMENT OF COMMERCE
GAITHERSBURG, MD 20899

7. Contract/Grant No.

8. Type of Report & Period Covered

Final

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (Street, City, State, ZIP)

American Petroleum Institute
1220 L Street, NW
Washington, DC 20005

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

Presented here is a description of the measurement procedures and standards, data acquisition systems, and data bases developed in the American Petroleum Institute (API)-sponsored orifice discharge coefficient data base project performed at the National Bureau of Standards (NBS) primary water flow rate measurement facility. Measurements were performed on five orifice meter sizes, 2, 3, 4, 6, and 10 inches, over the beta ratio range of 0.08 to 0.75. The measurement systems and procedures were designed to provide full documentation of the relation between the observations comprising the data base developed and U.S. national measurement standards.

Data acquisition procedures were automated to minimize human error in data recording, particularly for differential pressure observation. Laboratory-quality transducers and pressure standards were used and data acquisition was automated for observation of differential pressure, flowing fluid temperature, collected mass of water, and time of collection. Only a few parameter observations were made manually and entered into the data base. A large data base stored in computer-accessible form has resulted. This data base consists of the recorded raw data and the results calculated from them.

To realize the full potential of the transduction equipment used in the project, appropriate working standards were incorporated into the measurement systems to allow calibration of differential pressure transducers, thermometers, length-measuring devices, and weigh scales. These working standards were, in turn, calibrated against U.S. national working standards over the course of the project and are described in detail. Gravimetric measurement of the mass flow rate through the orifice meters utilized the NBS primary water mass flow rate measurement system. Documentation of the measurements, standards, and procedures utilized in this project is given in an NBS report to be published shortly. The data base will be available from NBS and API.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

discharge coefficient database; orifice metering; Pipe Reynolds Number; water flowrate measurement

13. AVAILABILITY

☒ Unlimited

☐ For Official Distribution. Do Not Release to NTIS

☐ Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

☐ Order From National Technical Information Service (NTIS), Springfield, VA. 22161

14. NO. OF PRINTED PAGES

546

15. Price

NIST Technical Publications

Periodical

Journal of Research of the National Institute of Standards and Technology—Reports NIST research and development in those disciplines of the physical and engineering sciences in which the Institute is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Institute's technical and scientific programs. Issued six times a year.

Nonperiodicals

Monographs—Major contributions to the technical literature on various subjects related to the Institute's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NIST, NIST annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

Applied Mathematics Series—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NIST under the authority of the National Standard Data Act (Public Law 90-396). NOTE: The Journal of Physical and Chemical Reference Data (JPCRD) is published quarterly for NIST by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements are available from ACS, 1155 Sixteenth St., NW., Washington, DC 20056.

Building Science Series—Disseminates technical information developed at the Institute on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NIST under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NIST administers this program as a supplement to the activities of the private sector standardizing organizations.

Consumer Information Series—Practical information, based on NIST research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

Order the **above** *NIST publications from: Superintendent of Documents, Government Printing Office, Washington, DC 20402.*

Order the **following** *NIST publications—FIPS and NISTIRs—from the National Technical Information Service, Springfield, VA 22161.*

Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NIST pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NIST Interagency Reports (NISTIR)—A special series of interim or final reports on work performed by NIST for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Service, Springfield, VA 22161, in paper copy or microfiche form.

U.S. Department of Commerce
National Institute of Standards and Technology
(formerly National Bureau of Standards)
Gaithersburg, MD 20899