Accuracy of In-Service Water Meters at Low and High Flow Rates

Subject Area: Infrastructure

Accuracy of In-Service Water Meters at Low and High Flow Rates

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FOREWORD

The Water Research Foundation (Foundation) is a nonprofit corporation that is dedicated to the implementation of a research effort to help drinking water utilities respond to regulatory requirements and address high-priority concerns of the water sector. The research agenda is developed through a process of consultation with Foundation subscribers and other drinking water professionals. Under the umbrella of a Strategic Research Plan, the Board of Trustees and Board-appointed volunteer committees prioritize and select research projects for funding based upon current and future needs, applicability, and past work. The Foundation sponsors research projects through the Focus Area, Emerging Opportunities, and Tailored Collaboration programs, as well as various joint research efforts with organizations such as the U.S. Environmental Protection Agency and the U.S. Bureau of Reclamation.

This publication is a result of one of these sponsored studies, and it is hoped that its findings will be applied in communities throughout the world. The following report serves not only as a means of communicating the results of the water industry's centralized research program but also as a tool to enlist the further support of the nonmember utilities and individuals.

Projects are managed closely from their inception to the final report by the Foundation's staff and large cadre of volunteers who willingly contribute their time and expertise. The Foundation serves a planning and management function and awards contracts to other institutions such as water utilities, universities, and engineering firms. The funding for this research effort comes primarily from the Subscription Program, through which water utilities subscribe to the research program and make an annual payment proportionate to the volume of water they deliver and consultants and manufacturers subscribe based on their annual billings. The program offers a cost-effective and fair method for funding research in the public interest.

A broad spectrum of water supply issues is addressed by the Foundation's research agenda: resources, treatment and operations, distribution and storage, water quality and analysis, toxicology, economics, and management. The ultimate purpose of the coordinated effort is to assist water suppliers to provide the highest possible quality of water economically and reliably. The true benefits are realized when the results are implemented at the utility level. The Foundation's trustees are pleased to offer this publication as a contribution toward that end.

Roy L. Wolfe, Ph.D.
Chair, Board of Trustees
Water Research Foundation

Robert C. Renner, P.E.
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A portion of this project was also dependent on the cooperation of several water utilities located in the United States. A complete list of the participating utilities can be found in the Executive Summary of this report. Without the assistance from these utilities, portions of this project would not be possible.

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EXECUTIVE SUMMARY

OBJECTIVES

The objective of this project was to evaluate the accuracy of in-service flow meters (5/8 x 3/4- to 2-inch sizes) over a wider range of flow rates than is currently specified within AWWA standards. Specifically, it was desired to gain a more detailed understanding of the low flow accuracy of the meters being tested to improve the accuracy of water accounting models and to aid in future meter standard revisions. The project was organized so that several specific questions regarding the accuracy of modern day in-service water meters could be answered. To this end, the project was given two major focus areas. These were a) investigating the accuracy of commercially available new off-the-shelf meters and b) investigating the effects of age, throughput, and particulates on meter accuracy degradation.

New Meter Accuracies

The first focus of the project was to investigate and compare the accuracy of new, off-the-shelf flow meters (5/8 x 3/4-inch through 2-inch meter sizes) against current AWWA standards across a full range of flows (including extreme low and extreme high flow rates). It was expected that by testing the meters for this study at much lower and higher flow rates than the AWWA standard requires (down to 1/64gpm for a 5/8 x 3/4-inch meter and up to 150gpm for a 2-inch meter), the results would highlight meter types that perform accurately well below and above what is specified in the standards. In addition, the new meter portion of the research project was performed to provide an essential benchmark for subsequent meter tests so that differences in meter accuracy resulting from degradation, age, and particulates during later testing could be determined from the meter's new condition. Without accurate knowledge of what each meter was capable of doing in the new condition, there would be little basis for conclusions regarding aging and sensitivity to particulates on registry accuracy.

Meter Accuracies with Age, Wear and Throughput

The same meters that were tested during the new meter accuracy tests were also tested during the project phases that focused on the accuracy degradation effects caused from age, wear, and throughput. The objective of this second project focus was to find correlations between meter baseline accuracies and the degraded accuracies caused by throughput and particulates passing through the meter. Not only were new meters subjected to endurance testing and particulate injection testing in the laboratory, but meters were also included in the project from utilities across the United States so that a representative sample of pulled meters could be tested over a diverse range of water qualities, meter types, meter sizes, and water use patterns. By dismantling meters and inspecting the interiors of the meters during this part of the study, it was also expected that correlations could be determined between accuracy and certain debris types and mechanical wear patterns within the meter.

One valuable aspect of this study was that all of the accuracy testing for the study was performed at a single hydraulic laboratory in which quality control was given careful attention.

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This ensured that the same equipment, the same reference accuracies, the same procedures, and the same personnel were used throughout the project.

BACKGROUND

There are many meter manufacturers in the United States and throughout the world, yet six of these manufacturers sell the majority of the residential and commercial flow meters in the United States used for utility billing. They are Sensus, Neptune, Hersey, Badger, Master Meter, and Amco (Ron Koch, Master Meter, Director of Business Development, personal interview, June 2006). Also, approximately eighty-five percent of all utility billing flow meters sold in the United States are the positive displacement design with approximately fifteen percent being the multi-jet design (Ron Koch, personal interview, June 2006). The remaining meter technologies are estimated to have less than 1 to 2 percent usage in the United States.

Municipalities may have meter testing and replacement programs which are commonly based upon variables such as the number of years the meter has been in service, the totalized registered volume, the decision to upgrade existing flow measurement equipment with more state-of-the-art devices, and meter replacement due to meter failures and maintenance problems. Some meter designs are inherently more susceptible to wear, because they contain more moving parts or have closer tolerances between parts. These meter types may need to be replaced more often than meters that are less susceptible to wear. It is understood that particulates can damage, accelerate wear, or become lodged in the flow meter, thus compromising accuracy (Arregui 2005).

Certainly, a municipality would not want to consider replacing a flow meter solely to upgrade their flow measurement devices to a more user-friendly drive-by readout device if the new meter associated with the new electronics does not comply with AWWA accuracy standards. It would also be unnecessary to replace a meter based only upon years in service or the registry total if experimental data showed that the meter type was accurate for a longer life. Additionally, it has been unclear if the flow meters need to be replaced more often than usual in systems where particulates are a problem. Relatively little is known about the effects of particles upon meter accuracy.

APPROACH

To meet the two major focuses of this study, the project was divided up into three major phases of work. These included a preparation phase, a new meter testing phase, and a third phase that investigated meter accuracy degradation when the meters are subjected to age, throughput, and particulates.

Prior to the performance of any actual flow meter tests, a great deal of study and preparation was necessary to a) fully understand the AWWA metering standards, b) design and construct test benches that would be used during the study, c) develop procedures that followed approved quality assurance, and d) locate and purchase meters that were available and being used in the United States marketplace and were being advertised by the individual manufacturers as being AWWA compliant. As part of the first phase of work, 450 individual meters from fifteen different manufacturers were carefully selected and purchased.

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The second phase of the project included testing for accuracy and comparing new commercially available off-the-shelf flow meters (5/8 x 3/4-inch to 2-inch) against current AWWA standards. The new meters were tested at current AWWA standard test flows as well as extreme low and high flow rates that were outside the AWWA standard test flows. Accuracy test results were given pass/fail grades depending on whether the test results fell within (pass) or outside of (fail) the published AWWA standards as specified for each meter type.

Finally, as part of the third phase of work, all meters that were accuracy tested in their new condition, were then endurance tested. During the endurance testing, each meter was subjected to a cyclic-type flow rate until the meter odometer had reached a pre-determined expected life. Accuracy tests were then performed at 25, 50, 75, and 100 percent of the theoretical expected life to evaluate possible accuracy degradation as it relates to meter throughput. In addition, several utilities around the United States donated meters (being routinely replaced according to their replacement program) to the project for accuracy testing. These meters were tested at the three AWWA test flow rates; minimum, intermediate, and maximum. If the meter passed the AWWA flow rates for accuracy, incrementally lower flow rates were tested until the meter registered less than 95% accurate. Following the accuracy test for each pulled meter, the meter was disassembled and carefully examined for particulates, deposits, lime scale, and wear. Any particulates captured or lodged in the meter were photographed and then removed and weighed. Also, any extreme wear was photographed and logged. This data was recorded so that applicable trends regarding accuracy could be documented. The third phase of work also addressed how particulates in a municipal water system may affect the accuracy of water meters. Seventy-five of the same 5/8x3/4-inch meters tested during the new meter testing were subjected to a slug of quartzite sand, which was allowed to pass through the meter. Following the sand injection, baseline accuracy testing and endurance testing as described above were performed.

RESULTS/CONCLUSIONS

For this study, in which 450 new meters were tested, the results clearly illustrated that a larger-than-expected number of new meters do not meet the AWWA flow registry standard applicable to that meter type (see meter type descriptions in Chapter 1 of this report). Of the technologies represented during this study, it is evident that not all meter types are created equal and some manufacturers produce a superior product. Some meter types passed the AWWA registry standard tests more consistently than other meter types. Surprisingly, test results also indicated that most manufacturers that publicize AWWA standard compliancy do not consistently meet AWWA metering standards.

Test results illustrate that some meter types were capable of accurately measuring flow at flow rates well below and well above the AWWA standard flow rates and that other meter types were not capable of measuring these same flows. Test results indicate that the fluidic oscillator type meter consistently met the AWWA maximum accuracy standard at new condition and after the full life of throughput even at flow rates much greater than the AWWA maximum. The new nutating disc and piston type meters most consistently indicated registry accuracies above 95% at the minimum AWWA flow rate compared to the other meter types. Degradation trends for individual meter types were most apparent at low flow rates after testing the meters over full life cycles. The nutating disc type meters maintained the most consistent low flow accuracy results

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from the new to the full life condition, while the multi-jet and single-jet meters had the largest reduction in registry accuracies (at low flows) from the new to the full life condition.

The accuracy testing of 595 pulled meters (shipped to the UWRL from water utilities across the United States) indicated that potable water quality from the different utilities had less of an effect on meter accuracy than did sand and other particulates found in the utility's water system. Generally, most of the degradation trends for the pulled meter tests correlated very closely to the new meter laboratory endurance degradation trends and there were very few notable correlations between interior meter wear and indicated meter accuracy with the exception some extreme wear cases.

Particulate test results also indicate that the subject meters had a surprisingly high percentage of meters that passed the AWWA flow rate registry tests in spite of the fact that a relatively large slug of sand had been passed through them. Measurable accuracy degradation was noted, however, for the piston type meters at the AWWA minimum flow rate.

APPLICATIONS/RECOMMENDATIONS

The results from this work will provide a basis for water utility managers to make decisions regarding meter accuracy, meter use and meter replacement. Meter type should be an important component in the decision process for meter selection. The results of this study have not only comprehensively quantified meter accuracies at current AWWA standard flow rates, but also at flow rates that are much lower and higher than the standard specifies. The effects of age and particulates in the water on flow meter accuracy were also assessed. With this information, utilities can improve meter replacement programs and prepare more accurate cost-based calculations of water value as it relates to meter type and degradation, which are both important components of utility rate structures.

RESEARCH PARTNERS

Matching funds were provided for this project by Utah State University. Cost-Share funds in the amount of $165,870.00 were provided to this project by Utah State University, using Utah Water Research Laboratory state appropriated funds.

PARTICIPANTS

Phase III/Component 2 of the project relied on the participation of many water utilities across the United States. These included:

- Anchorage Water and Wastewater Utility, Alaska
- City of Phoenix Water Services Department, Arizona
- South Central Connecticut Regional Water Authority, Connecticut
- Orlando Utilities Commission, Florida
- City of Rochester Bureau of Water and Lighting. New York
- City of Greensboro, Water Resources Department, North Carolina
- WaterPro Inc., A Draper Irrigation Company, Utah
- City of Logan Water and Wastewater Division, Utah
- City of Mendon, Utah

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- Ogden City Corporation Public Utilities Division, Utah
- City of Orem Department of Public Works, Utah
- Salt Lake City Department of Public Utilities, Utah

These participating utilities pulled meters from service within their utility and shipped them to the Utah Water Research Laboratory for accuracy testing and analysis. A wide range of meter types, sizes, water qualities, meter ages and meter throughputs were represented in the meter sampling.

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CHAPTER 1 – INTRODUCTION

FLOW METERING

Current standards for water meters have been in place for many years, but in recent years, many new manufacturers and new flow measurement technologies have joined the marketplace suggesting a need for additional in-service water meter performance data.

> "*The practice of charging for water by metering was questioned by water utilities for several years. One of the chief objections was that occupants of metered homes would attempt to keep water charges at a minimum by not using enough water for sanitary purposes. It was even reported that some users placed a tub under a faucet and allowed water to drip into the tub at a rate too slow for the meter to register. Water was dipped from the tub with a pail as needed"*
>
> "*This problem was solved by establishing a monthly minimum charge, for which enough water was furnished to provide for reasonable sanitary needs. No carryover of unused allowance to the next month was permitted. This method opened the way to universal metering, once improved meters were available, and it was determined that the total cost of operating a metered system was less than the cost without meters, because water usage was reduced."*(AWWA 1999)

While the problem of people intentionally trying to store dripping water for later use is no longer a problem, very slow household leaks may still go unmetered. When this happens the leak goes unnoticed and often does not get repaired. Meter accuracy at low flow rates is important to alleviate this type of problem.

History

Meter standards began in the United States in 1913. "*An AWWA committee, appointed in 1913, proposed the adoption of standards on overall lengths and connections for disc meters 1915… However, no official action was taken on [the] proposal. In 1916, the meter manufacturers organized a meter standards committee, on which most manufacturers were represented.*" In 1920 the AWWA committee along with the New England Water Works Association (NEWWA) made a draft of the "Standard Specifications for Cold-Water Meters, Disc Type", which was approved by AWWA and NEWWA in 1921. This standard has since been revised and other meter types have been introduced and have their own standard. Standards are also reaffirmed or revised at least every five years (AWWA 1999).

Benefits

"*Accurate water measurement is the means by which water utilities produce revenue to cover expenses, charge each customer equitably, prevent waste of water and minimize the load on wastewater facilities. This concept is universally accepted today, but it took thousands of years for the science of water supply and distribution to reach its present state.*" (AWWA 1999)

Properly monitoring limited water supplies through accurate flow measurement helps to conserve valuable water resources and encourages responsible water use. Even small errors in

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the accuracy of residential, commercial and industrial water meters can create shortfalls in water utility revenues or result in over-billing of customers.

In some municipal water systems, especially older ones, a significant portion of the distributed water is unaccounted for as a result of metering accuracy errors, leaks in the distribution system, fire-fighting, pipe flushing and theft (Hunaidi 2000). Accurate metering aids municipal water districts in determining water volumes attributed to all aspects of water use and loss. Foremost, the accurate metering of consumed water encourages personal accountability, water conservation, and equity in billing rates.

Water metering has become an important tool in water conservation and in billing water consumers fairly. According to the American Water Works Association, "no tool available to water utilities has played a greater part in the conservation of water than the water meter" (AWWA 2002a).

PROJECT METERING

Meter Type Descriptions

Several different types of water meter types were included in this study. Included are the multi-jet (MJ), single-jet (SJ), fluidic oscillator (FO), turbine (TU), propeller (PR), and two positive displacement meters, the nutating disc (ND) and displacement piston (DP).

There are two main types of water meters, inferential-type and volumetric. Inferential-type meters use a linear relationship between the velocity of the water flowing through the meter and the rotational speed of the rotor or propeller (AWWA 2005b). The number of rotations can then be calibrated to the meter register to measure the flow going through the meter. Volumetric meters directly measure the volume of water that passes through the meter in discrete volumes as it passes through the metering chamber. The water fills and rotates the measuring device as it travels through. Each rotation is correlated to a specific volume of water passing through the meter.

Positive Displacement

The most common type of residential water meter used in utilities throughout the United States is the positive displacement meter. Positive displacement meters use a volumetric method for measuring flow. Two positive displacement meters are used in residential water metering today: the nutating disc and the oscillating piston (AWWA, 2002a). Figure 1.1 shows the metering chamber of an oscillating piston meter. As the water enters the meter, it rotates the piston as it passes through the metering chamber, causing the shaft to make a circular pattern which rotates a magnet coupled to the meter's register. A similar principle governs the nutating disc meter shown in Figure 1.2.

The difference between the nutating disc type and oscillating piston type is that the disc, which is the moving device in the nutating disc meter, is fixed horizontally and rotates about the center as the edge of the disc move vertically allowing the water to pass. The oscillating piston meter's moving part is a piston, which is fixed vertically and can move horizontally. As the water fills the piston, it forces the piston to rotate as the water exits the meter.

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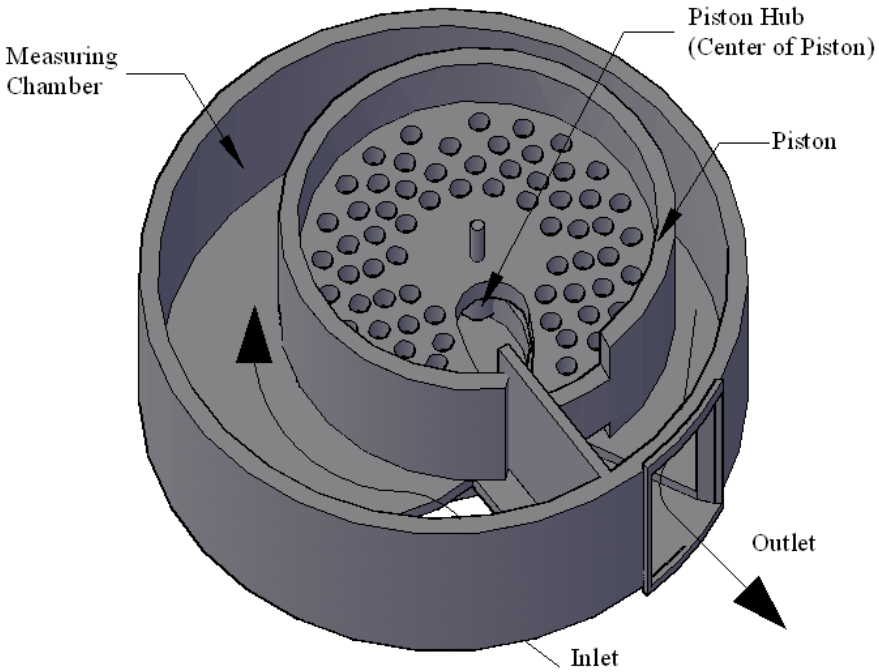

Figure 1.1 Oscillating piston metering chamber

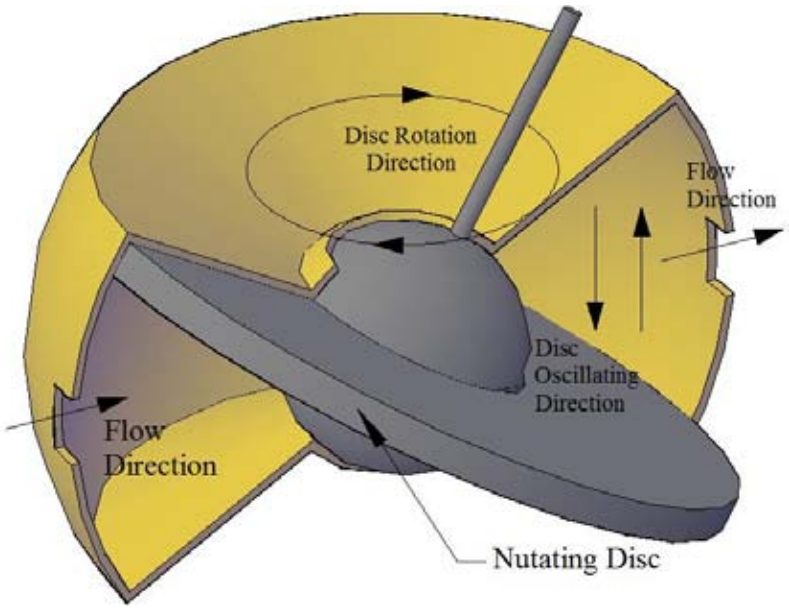

Figure 1.2 Side view of nutating disc meter

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Jet Meters

Multi-jet and single-jet meters are inferential-type meters. As shown in Figure 1.3 and Figure 1.4, the moving element is the rotor. The principle behind this type of meter is that the velocity of water that goes through the meter has a linear relationship with the rotational speed of the rotor (AWWA 2002a). The register is calibrated to match the flow going through the meter. The single-jet meter is shown in Figure 1.3 and multi-jet meter is shown in Figure 1.4. As the names imply, the difference is that the single-jet meter has one stream of water that directly contacts the rotor. In the multi-jet meter, the flow is separated by an outer casing around the rotor, which causes several streams to make contact with the rotor from multiple directions.

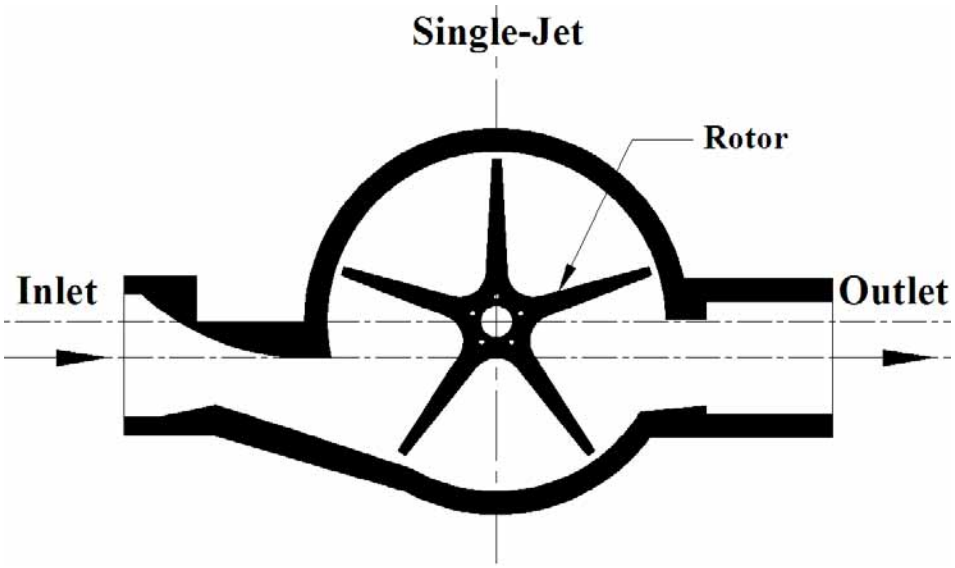

Figure 1.3 Plan view of single-jet meter

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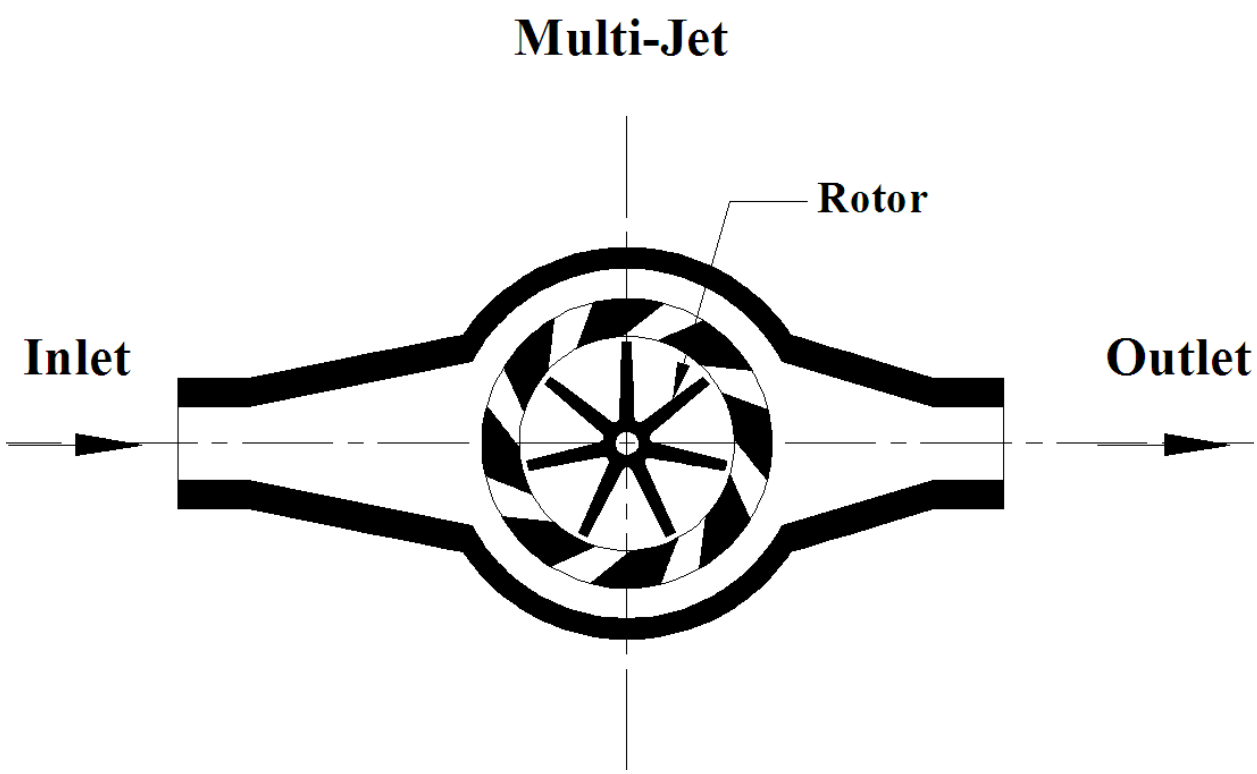

Figure 1.4 Plan view of multi-jet meter

Fluidic Oscillator

The fluidic oscillator meter uses a method of measuring flow that is relatively new to the AWWA Standards. Most traditional flow methods use a mechanical device for registering flow, such as the rotor in the jet-meters and the piston and disc in the positive displacement meters. The fluidic-oscillator meter, however, uses a transducer element (powered by a battery) that measures the oscillations (due to the Coanda effect) the fluid makes as it passes through the meter (AWWA 2005a). The Coanda effect is the tendency of a fluid jet to be attracted to a nearby surface. The number of oscillations detected is then calibrated to the volume of water passing through the meter; in this sense, a fluidic oscillator is also an inferential-type meter. A fluidic oscillator type meter is shown in Figure 1.5.

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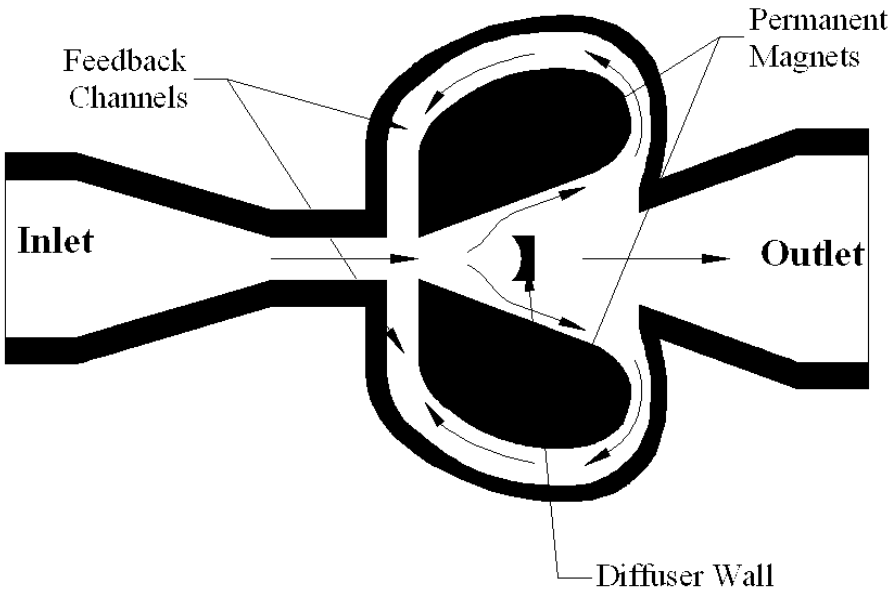

Figure 1.5 Fluidic oscillator

Turbine

Turbine meters are inferential-type meters and are similar to the jet-meters; the turbine replaces the rotor in jet-meters for turbine meters. Turbine meters are divided into Class I and Class II. Both of these classes of turbine meters measure water flow by means of a turbine that is forced to rotate by the flow of water; the number of revolutions is then recorded by the register. Class I meters include vertical-shaft and low-velocity horizontal-shaft turbine models. Class II includes the high-velocity horizontal-axis turbine that is in-line. Class II turbine meters usually have a lower head loss and also operate at a wider flow range than the Class I turbine meters (AWWA 2007). A schematic of the turbine flow meter can be seen in Figure 1.6.

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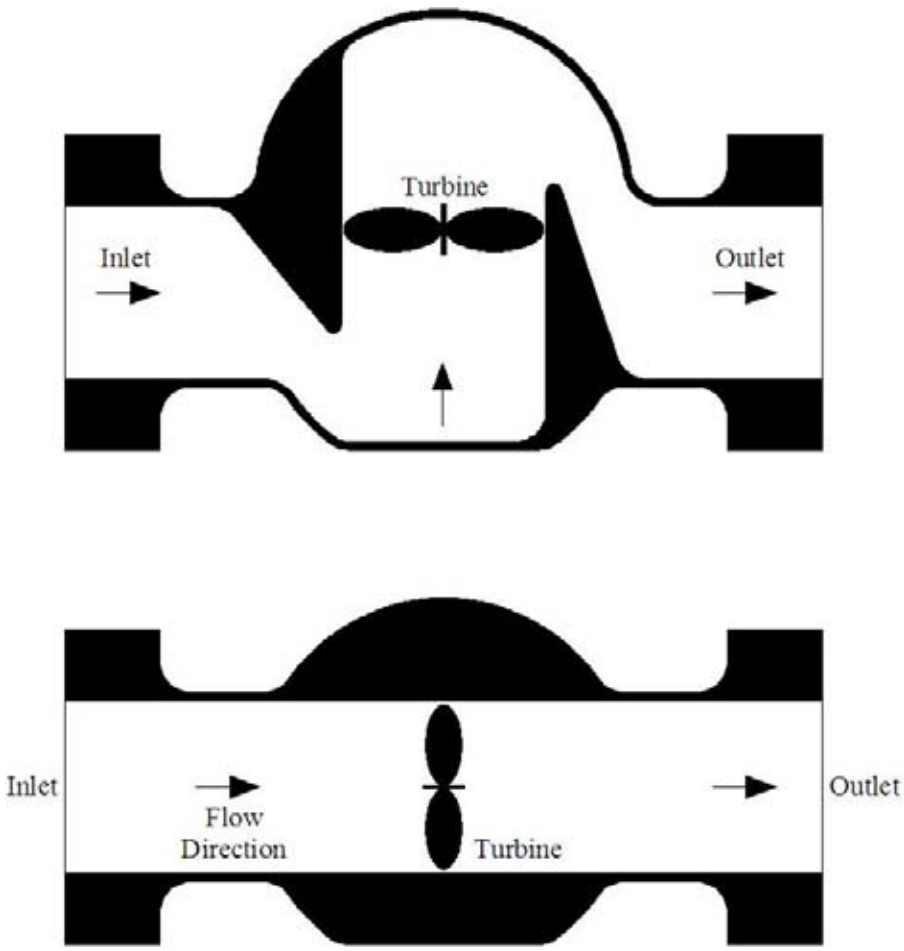

Figure 1.6 Turbine flow meter

Propeller

The propeller meter is an inferential-type meter. Propeller meters are very closely related to the turbine meter. It is stated in the AWWA Standard for propeller meters, that "confusion results from having two standards for what is essentially the same type of meter, and considerable judgment is required in the selection of one or the other." (AWWA 2002b) The difference between the two types is that the propeller operates directly within the pipeline or within the main meter body. The need for a separate standard comes from the fact that, because of the difference in design, the flow range, friction losses, and capacities change.

Project Meter Selection Process

After all of the available meter types and technologies were identified, a matrix was prepared to summarize the meters based on size, manufacturer, and technology. The matrix reviewed available meters in the marketplace that comply with AWWA standards so that meter manufacturer, size and type were appropriately represented in the project. The resulting breakdown of meters purchased for the project is summarized in Chapter 2 of this report. Without listing the manufacturers, Table 1.1 summarizes the meters purchased for the project in

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terms of meter type, meter size, the number of identical meters purchased for the project (by meter model), and the representative meter manufacturer listed by number (15 manufacturers represented).

Table 1.1
Manufacturers of meters purchased

Meter type	Meter size	Quantity	Manufacturer
Displacement piston	5/8" x 3/4"	9	2
Displacement piston	5/8" x 3/4"	9	2
Displacement piston	5/8" x 3/4"	9	4
Displacement piston	5/8" x 3/4"	9	4
Displacement piston	5/8" x 3/4"	9	8
Displacement piston	5/8" x 3/4"	9	13
Displacement piston	5/8" x 3/4"	9	14
Displacement piston	5/8" x 3/4"	9	14
Displacement piston	3/4"	6	2
Displacement piston	3/4"	6	4
Displacement piston	3/4"	6	13
Displacement piston	3/4"	6	14
Displacement piston	3/4"	6	14
Displacement piston	1"	6	2
Displacement piston	1"	6	4
Displacement piston	1"	6	13
Displacement piston	1"	6	14
Displacement piston	1"	6	14
Displacement piston	1 1/2"	1	4
Displacement piston	1 1/2"	1	14
Displacement piston	2"	1	2
Displacement piston	2"	1	4
Displacement piston	2"	1	14
Multi-jet	5/8" x 3/4"	9	1
Multi-jet	5/8" x 3/4"	9	6
Multi-jet	5/8" x 3/4"	9	8
Multi-jet	5/8" x 3/4"	9	8
Multi-jet	5/8" x 3/4"	9	13
Multi-jet	5/8" x 3/4"	9	13
Multi-jet	5/8" x 3/4"	9	14
Multi-jet	3/4"	6	6
Multi-jet	3/4"	6	8
Multi-jet	3/4"	6	13
Multi-jet	3/4"	6	13
Multi-jet	3/4"	6	14

(continued)

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Table 1.1 (Continued)

Meter type	Meter size	Quantity	Manufacturer
Multi-jet	1"	6	5
Multi-jet	1"	6	6
Multi-jet	1"	6	8
Multi-jet	1"	6	13
Multi-jet	1"	6	14
Multi-jet	1 1/2"	1	6
Multi-jet	1 1/2"	1	8
Multi-jet	1 1/2"	1	13
Multi-jet	1 1/2"	1	14
Multi-jet	2"	1	6
Multi-jet	2"	1	8
Multi-jet	2"	1	13
Multi-jet	2"	1	14
Nutating disc	5/8" x 3/4"	9	3
Nutating disc	5/8" x 3/4"	9	3
Nutating disc	5/8" x 3/4"	9	7
Nutating disc	5/8" x 3/4"	9	12
Nutating disc	5/8" x 3/4"	9	12
Nutating disc	3/4"	6	3
Nutating disc	3/4"	6	7
Nutating disc	3/4"	6	12
Nutating disc	1"	6	3
Nutating disc	1"	6	7
Nutating disc	1"	6	12
Nutating disc	1 1/2"	1	2
Nutating disc	1 1/2"	1	3
Nutating disc	1 1/2"	1	7
Nutating disc	1 1/2"	1	12
Nutating disc	2"	1	3
Nutating disc	2"	1	7
Nutating disc	2"	1	12
Single-jet	5/8" x 3/4"	9	1
Single-jet	5/8" x 3/4"	9	5
Single-jet	5/8" x 3/4"	9	10
Single-jet	5/8" x 3/4"	9	11
Single-jet	3/4"	6	1
Single-jet	3/4"	6	10
Single-jet	1"	6	10
Single-jet	1 1/2"	1	10
Single-jet	2"	1	1

(continued)

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Table 1.1 (Continued)

Meter type	Meter size	Quantity	Manufacturer
Single-jet	2"	1	10
Fluidic oscillator	5/8" x 3/4"	9	15
Fluidic oscillator	3/4"	6	15
Turbine type I	3/4"	6	7
Turbine type I	1"	6	7
Turbine type I	1 1/2"	1	7
Turbine type I	2"	1	6
Turbine type I	2"	1	7
Turbine type II	1 1/2"	1	3
Turbine type II	1 1/2"	1	12
Turbine type II	2"	1	3
Turbine type II	2"	1	8
Turbine type II	2"	1	12
Turbine type II	2"	1	14
Propeller	2"	1	9

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CHAPTER 2 – METHODS AND MATERIALS

PROJECT OVERVIEW

The project was divided into three phases in order to organize progression. Phase I, as summarized in Figure 2.1, included the preliminary work that was to be done before testing began. This included literature review, historical AWWA standard research, and identifying meters used in the United States that claimed to meet the AWWA standards. Phase I also included constructing test benches, purchasing new meters, and making arrangements with participating utilities for pulled meter donation. Also included in Phase I was the preparation of the database that was to include all the meter data.

Phase II included the new meter testing and is summarized in Figure 2.2. This phase included the initial testing of all the new meters in their new condition. Phase II also included entering the data into the database and getting initial comparison data.

Phase III was broken up into three components. Component 1 is summarized in Figure 2.3 and included the endurance testing of the new meters that were tested in Phase II. Component 2 of Phase III was the pulled meter testing and included the accuracy testing, disassembly of the pulled meters, and entering the pulled meter data into the database. Phase III/ Component 2 is summarized in Figure 2.4. Phase III/Component 3 included the particulate testing. This component is a combination of the new meter testing and endurance testing. After the meters were tested in their new condition, they were injected with sand, after which they were endurance tested in a similar manner to that described in Component 1 of Phase III. This component is summarized in the diagram in Figure 2.5

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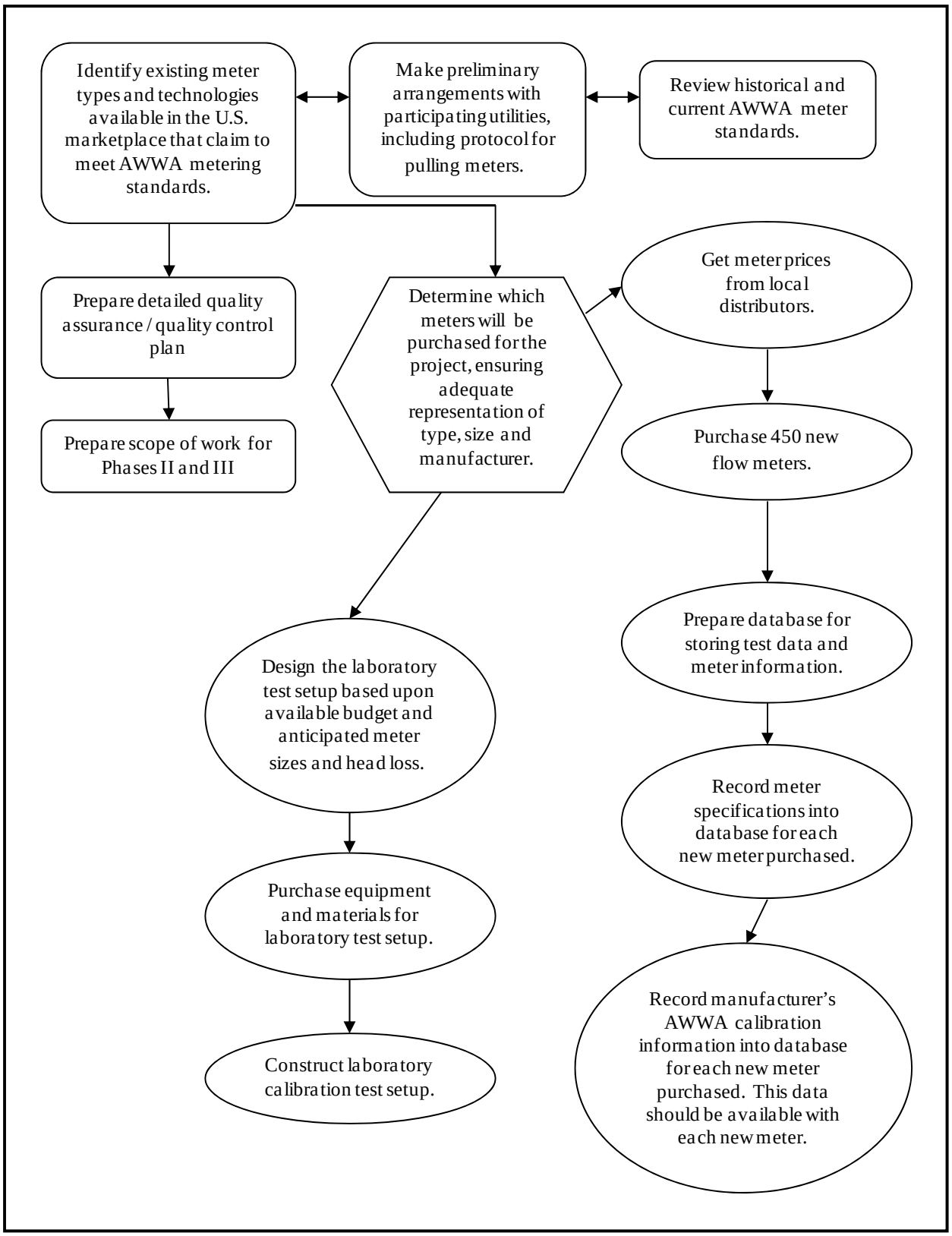

Figure 2.1 Phase I: Preparation and setup

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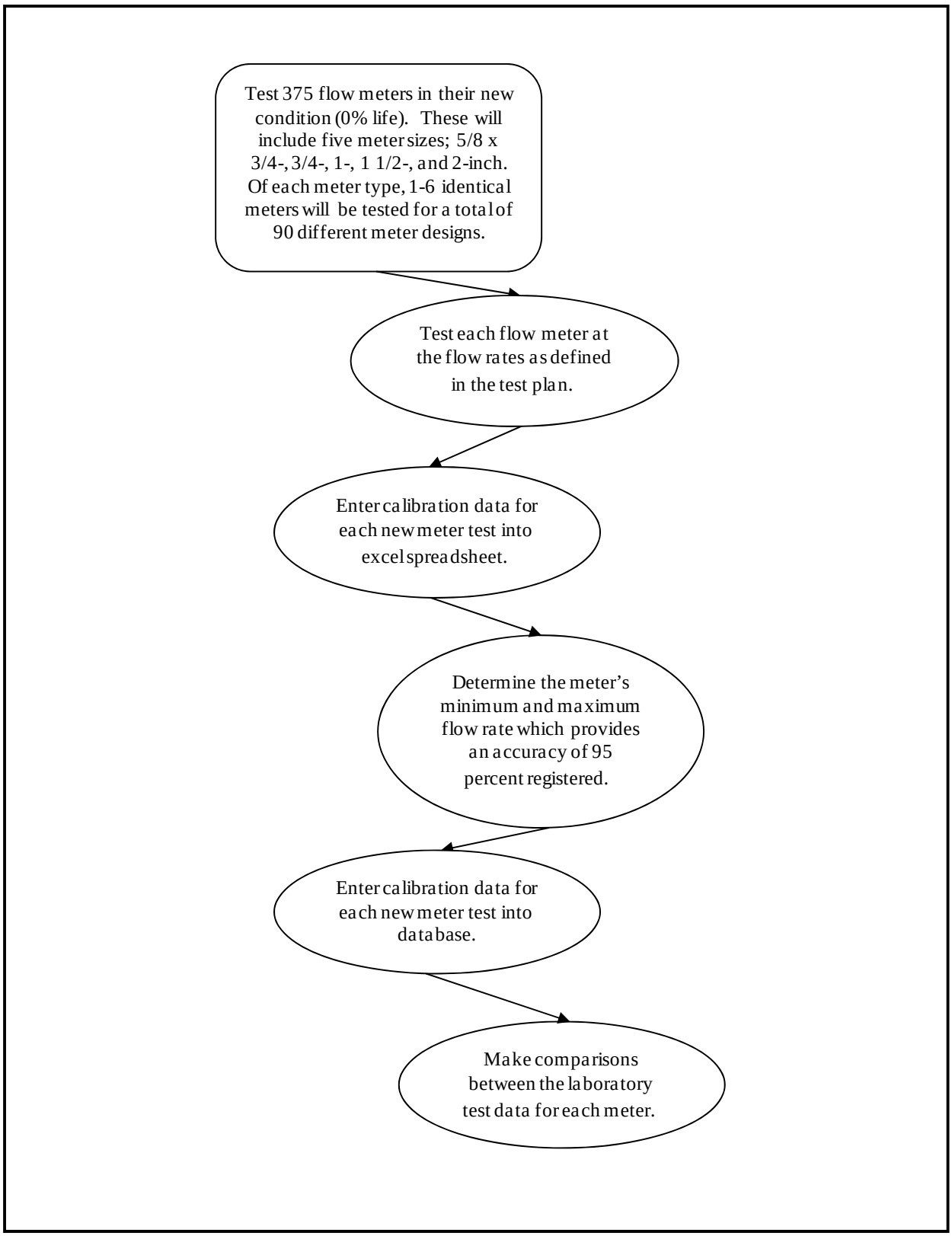

Figure 2.2 Phase II: new meter tests

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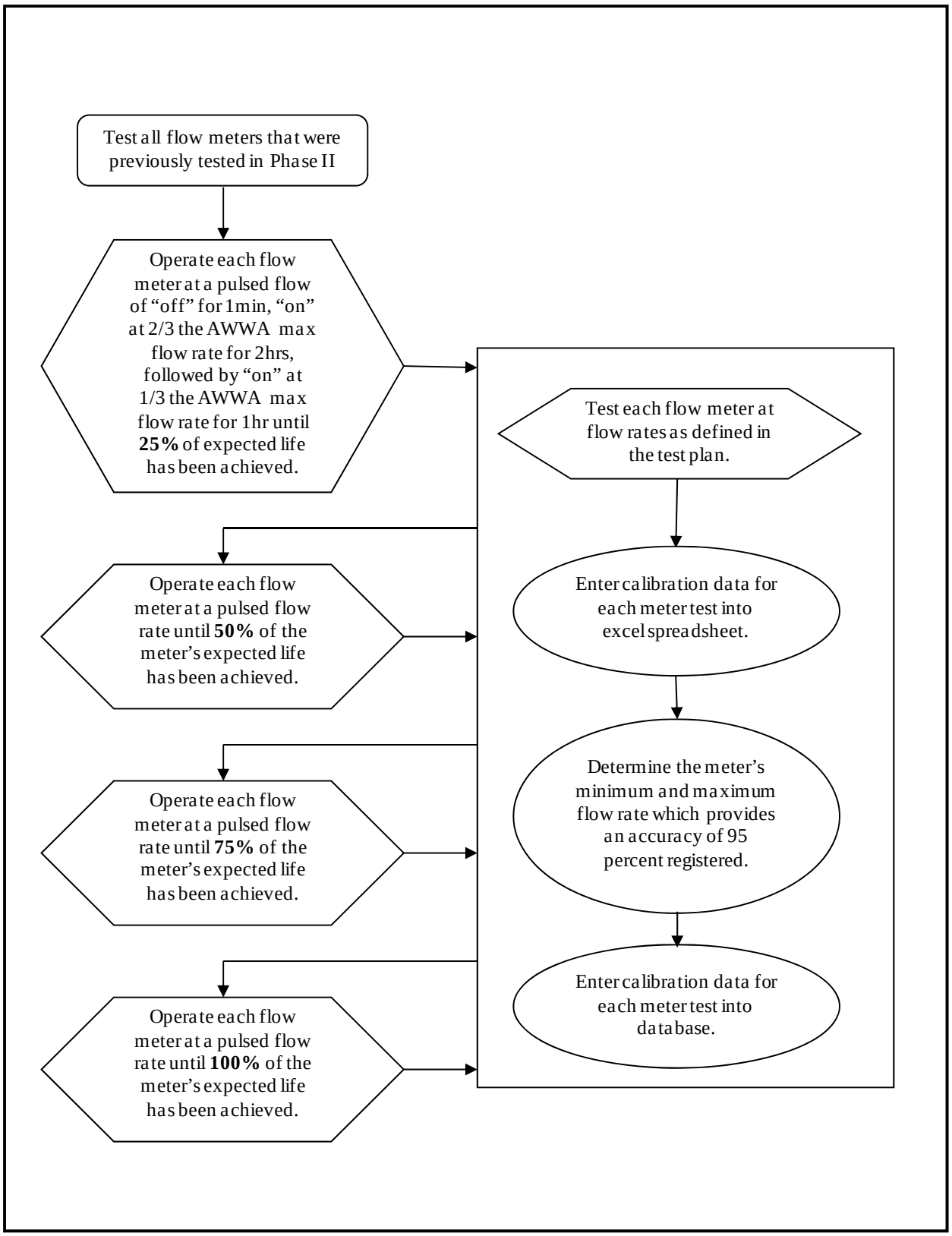

Figure 2.3 Phase III/Component 1: laboratory endurance testing

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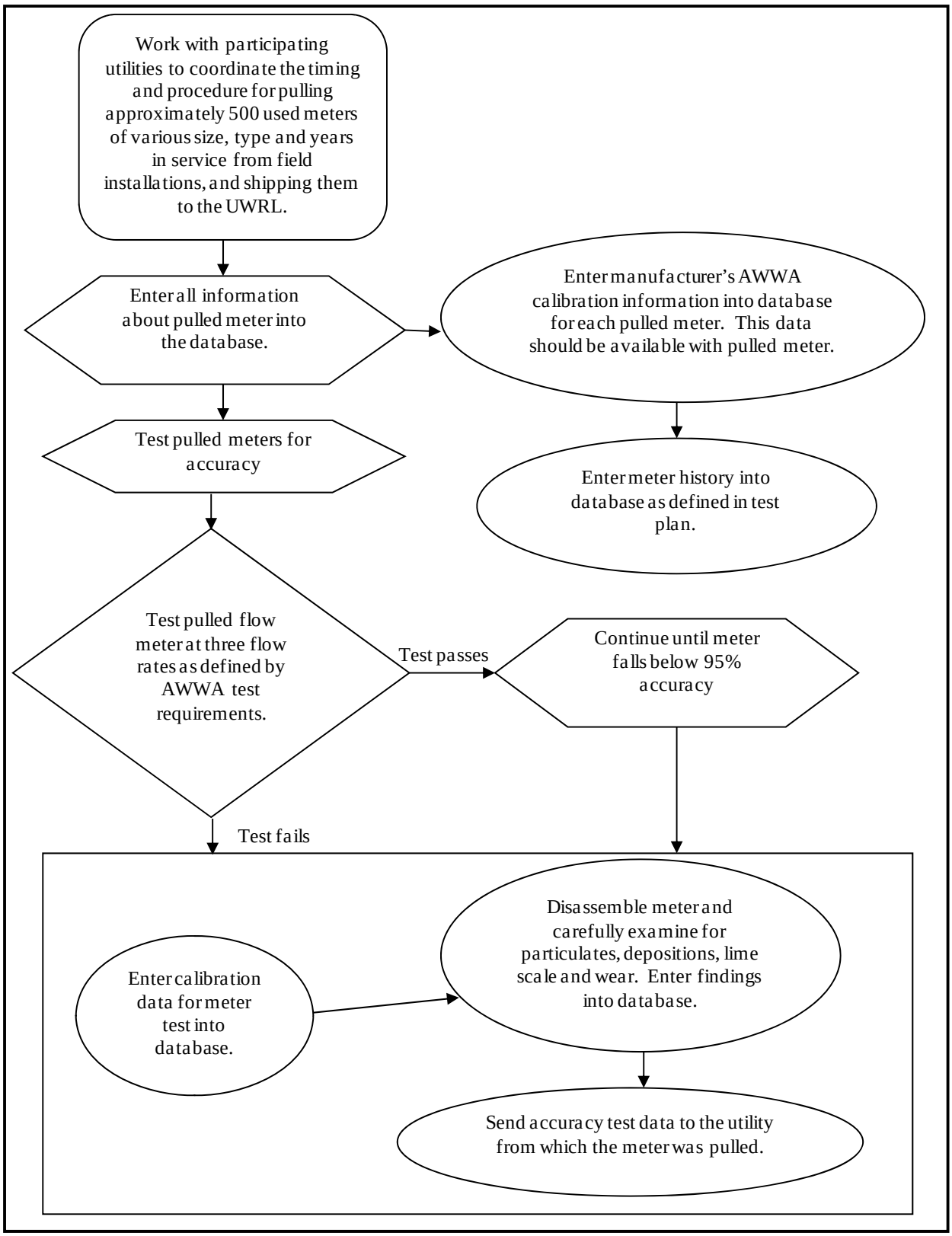

Figure 2.4 Phase III/Component 2: pulled meter testing

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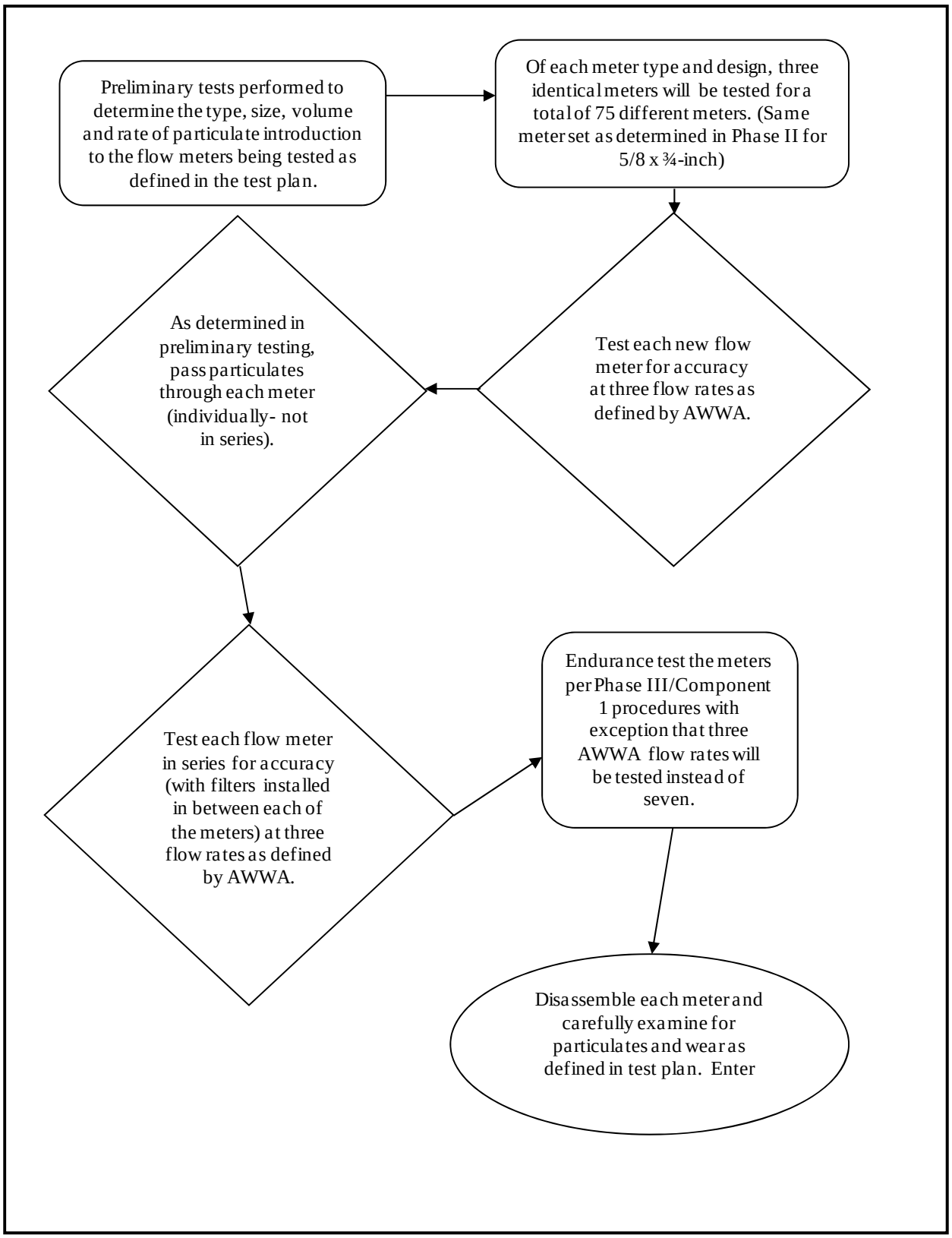

Figure 2.5 Phase III/Component 3: particulate testing

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DATABASE

Because of the large volume of data associated with this project, a database was deemed necessary to efficiently organize, retrieve, and analyze the large volumes of meter data. A project database was constructed using Microsoft Access to store all significant information so that retrieval, review, and reporting were simplified. The database included relevant forms, switchboards, tables, and queries. The data entry form for an individual meter is shown in Figure 2.6.

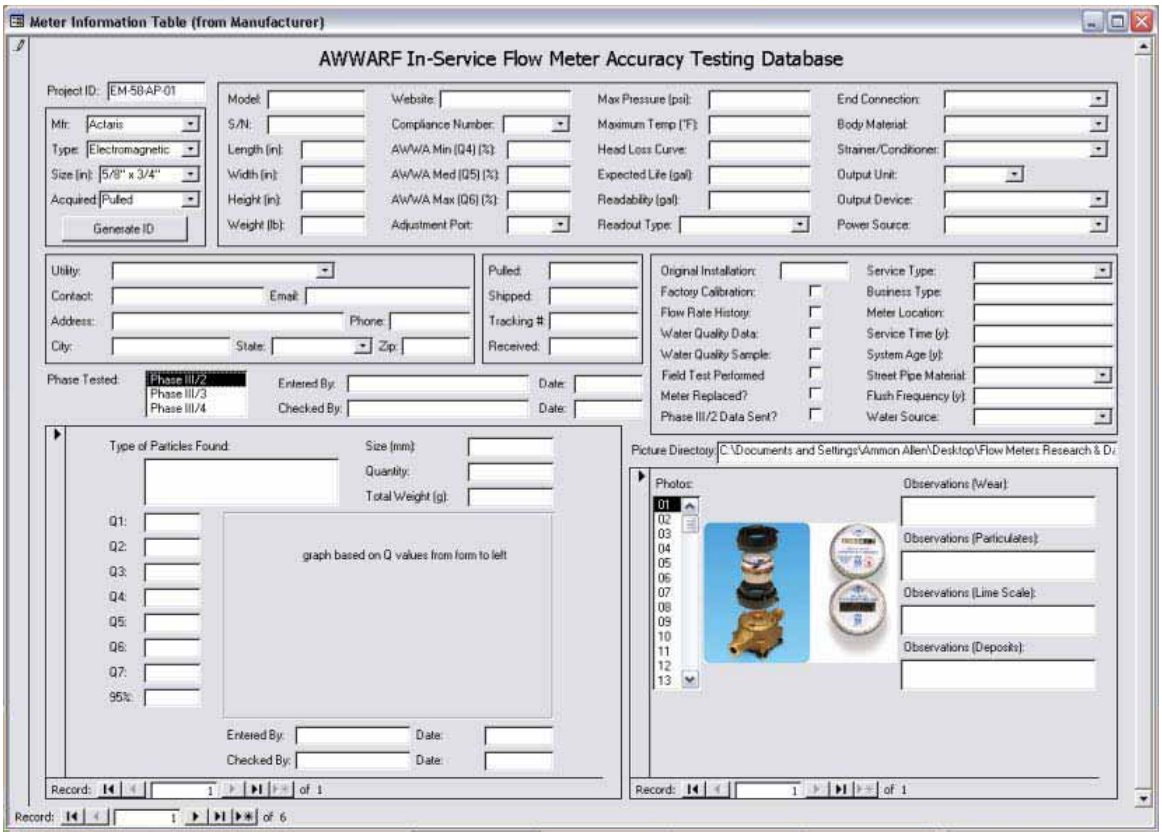

Figure 2.6 Database meter entry form

The project database holds information for each meter investigated for the project. This database was necessary because of the large amount of specification and test information that has been recorded on each new and pulled meter. The database also links each meter picture to its data set. Once meter data was entered into the database, queries could be easily made to look up information about a meter or to view the meter photo.

The primary objective for organizing the data into a database was to provide a simple mechanism for retrieving and subsequently presenting the large amounts of data that was collected during the project.

As a result of procedures for the pulled meters, from which the number of data points tested could vary with each meter, it was required that the database test forms also be constructed to allow flexibility in the number of data points entered for each meter test. The project database was a reliable tool for storing, organizing and accessing meter information. Queries were made when specific meter data needed to be compared. While the graphing tools within Microsoft

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Access were not as useful as hoped, the data was easily exported to Microsoft Excel, where graphs and tables could be developed for reporting purposes.

TEST MEASUREMENTS

Flow Measurements

The meter accuracies for this project were determined using NIST traceable weights to calibrate gravimetric scales which were used to measure actual volumes passing through the meters. Gravimetric methods utilize both the actual weight of the water and the water temperature to calculate water volumes. The temperature of the water is needed for measurement accuracy, because the density of the water changes with temperature.

Another measurement method, the volumetric method, is also a commonly used measurement within utilities to calibrate culinary meter accuracies. This method is accomplished by recording the time necessary to accumulate a known volume of water, while also accounting for water density from fluid properties and water temperature. The gravimetric method was selected for this project because it allowed researchers to run tests over a wide range of flow rates and volumes for different meter sizes while accurately using only two laboratory gravimetric scales that meet the necessary flow volumes to minimize measurement uncertainty during the test.

The weight tanks, located on the gravimetric scales, were emptied before each accuracy test was started. The valve that drains the weight tank was then closed to ensure that no water leaked during the test. At this point, the scales were zeroed, and the test started. When the target test volume was collected in the weight tank, the test was stopped and the final weight was recorded. This weight was then converted to volume using a density chart that included the affects of temperature. This volume was then compared to the volume read by each meter to document the meter accuracy.

Evaporation Measurements

Since many of the low-flow test measurements performed during this study required weight tank collection times as high as 17 hours, evaporation measurements were performed to determine the effect of evaporation on the accuracy testing. Results from these tests suggested that the evaporation volume occurring during the time period of the lowest target flow was found to be less than the resolution of the weight tank scales. Therefore, no correction for evaporation was deemed necessary during the project, although evaporation rates were periodically monitored.

Odometer Readings

It was determined that the odometer readings could be mis-read by 10 or 100 gallons (depending on the meter size), because researchers were sometimes unsure if the odometer had rolled over. As can be seen in the example shown in Figure 2.7, the meter odometer has not yet rolled over (when the main dial was at the top). Each meter design was different, as some meter odometers would roll over quickly while others rolled over an extended period of time. This

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created the potential for a meter reading error that was only justified after the data was entered into the Excel spreadsheet and obvious errors became apparent.

Because researchers were aware of this issue, the meters with this type of readout were carefully monitored during each test to keep track of odometer position. Furthermore, each meter was inspected during testing to ascertain whether or not it was registering flow.

Figure 2.7 Meter odometer turning over

Other Measurements

During all tests it was necessary to accurately monitor the temperature. This was done with a digital thermometer installed directly into the test line that provided continuous temperature readings. Between one and three temperature readings were taken during each test. For long test periods (tests longer than 20 minutes), three readings were made and an average temperature was used, and for the short test periods, one temperature reading was made.

To set the flow rate for each test, a magnetic flow meter was installed in series with the meters being tested, and it was used to set the flow rate. The valve used to start the test was turned on in a smooth manner, and a stopwatch was started at the same time that the valve first moved. After the test, the stopwatch was stopped as the valve started to close and the valve was shut smoothly and at the same speed that it was turned on. Recording the time of the test allowed the researchers to double check the flow rate with the magnetic flow meter that was in-line and was used to set the test flow rate. Care was always taken to never open the valve so that the flow exceeded the target flow rate because this condition would provide opportunity for individual meters to register flow higher than prescribed.

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The magnetic flow meter was not accurate enough to set the lower flow rates; however, it was used to get the flow rate close to the target flow. Then, using a stopwatch and the weight tank, the exact low flow rate was set. An isolation valve was then closed and smoothly opened such that the desired flow rate was established. As an additional verification of flow rate, the total measurement time was recorded.

PHASE I: PREPARATION AND SETUP

Literature Review

The first phase of work for the project included a full literature review on currently available water meters that claim to meet the current AWWA standards. The literature review evaluated both the historical and current water metering standards and documented the meters that were commercially available in the United States in sizes ranging from 5/8 x 3/4-inch up to 2-inch.

Test Bench Preparation

Before constructing laboratory test stands to be used for both endurance and accuracy testing, it was necessary to perform a thorough hydraulic analysis on preliminary conceptual designs for the benches. An analysis was completed on three separate benches that were each built to test varying sizes of meters. The analysis was completed using a numerical pipe network solver. The analysis factored in the expected pressure losses of each meter, pipe, filter, valve, and fitting for the expected flow rates. The analysis enabled the conceptual design to be verified and improved and allowed the proper sizing of the pipes, filters, valves, and pumps for the test benches.

After the conceptual test benches were analyzed and found to be hydraulically sound, a parts list was needed so that purchases could be made. In addition to the benches, a flow metering station, consisting of a large measurement tank (5000lb) and a small measurement tank (500lb) was also designed and constructed. The flow metering station or weight station is gravimetrically based and is capable of measuring flow rates up to 200 gallons per minute in the large tank, and down to 1/128 gallon per minute in the smaller tank.

After performing a hydraulic analysis to aid in the selection of pumps, individual elements of the test benches, piping systems, and data collection station, the benches were designed and working drawings were created. The steel support structures for the weight station were designed and constructed at the UWRL. Layout of the test benches and the flow metering station was carefully considered in order optimize project work space and allow accuracy and efficiency when performing meter tests, and it can be seen in Figure 2.8.

The accuracy test benches for this study were organized as follows:

- Test bench #1: All 5/8 x 3/4-inch and 3/4-inch meter accuracy tests
- Test bench #2: 1-inch meter accuracy tests and particulate meter tests
- Test bench #3: 1½-inch, 2-inch, and particulate meter tests
- Test bench #4: Pulled and high flow rate meter tests

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Figure 2.8 illustrates the general layout of the test benches in relation to the weight station and other testing components for the project. The same weight station shown in the schematic is used for all four test benches.

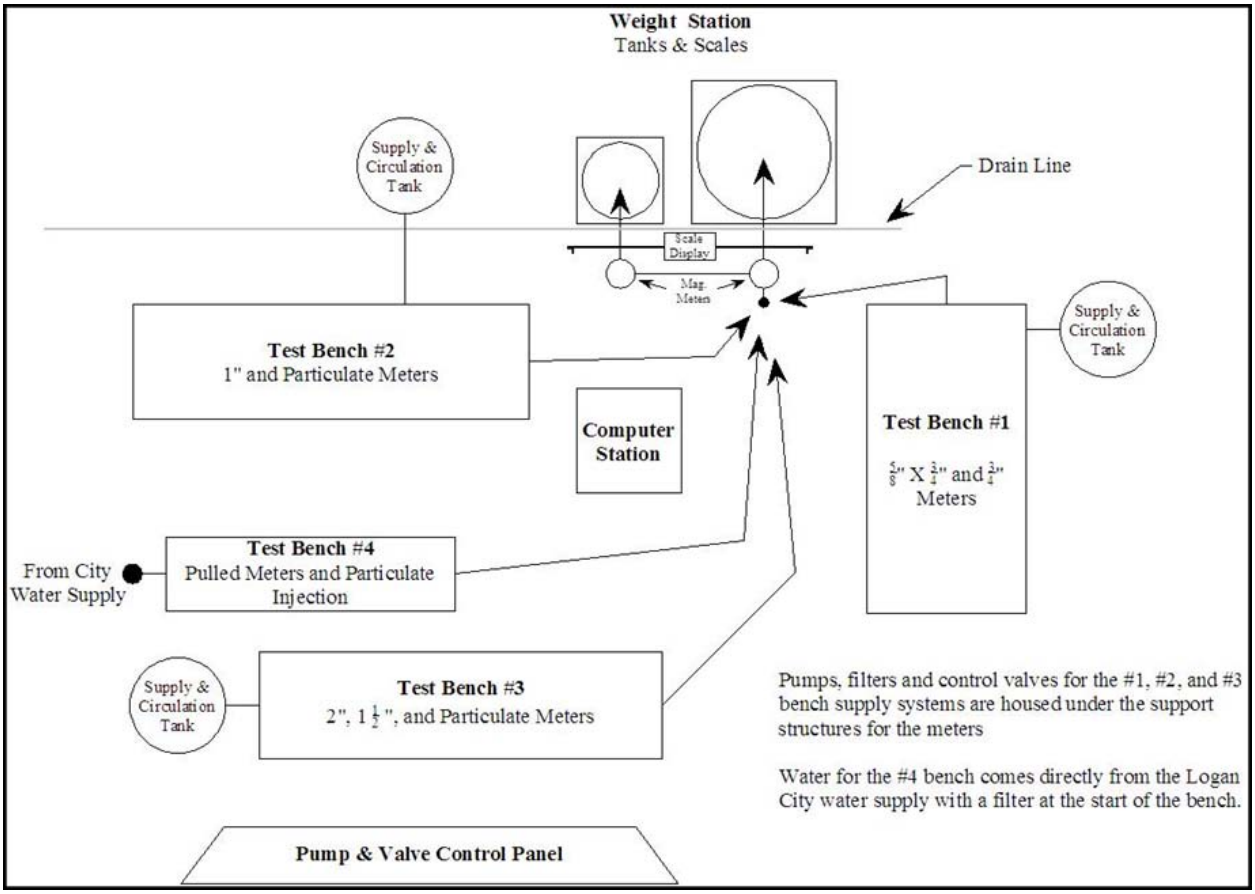

Figure 2.8 Schematic of test benches

Meters were installed into the test benches so that each row of meters had nearly the same head loss. The meters were arranged according to the pressure losses included in the manufacturer's pressure loss graphs obtained during the initial literature review. A valve was also installed to vent any air that was captured when the lines were drained and refilled. A redundant brass ball valve was installed in each leg of the test bench to provide assurance that each leg of meters being tested was completely isolated from the others. Each time meters were removed or new connections were made in the test bench, the system was carefully inspected for leaks and repaired if necessary. As much as possible, the floor of the testing area and the test bench were allowed to dry prior to tests, making any potential leaks quickly visible. Weight tank scales were monitored with all valves closed to ensure the drain valves sealed completely. Visual inspection was also performed to ensure that there were no drips into the weight tanks when system valves were closed. The accuracy of the five thousand and five hundred pound capacity certified scales were regularly calibrated per the project QAPP with traceable weights. Water for all accuracy and endurance tests was supplied from Logan City's municipal drinking water supply.

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A small gravity supply system was constructed to provide constant low flow rates for extremely low flow measurements. A pre-filter was installed in this system to remove any potential particulates that could cause problems for the meters in their new condition. This gravity supply system is shown in Figure 2.9.

Fresh water supply lines were installed to provide clean water directly to each test bench's supply tank. These lines had connections to provide water to the gravity supply system and connections that provided clean cool water to the circulation tanks to maintain the temperature during endurance flows at less than 80 degrees Fahrenheit. Figures 2.9 and 2.10 illustrate schematically a generic test bench for both accuracy tests at high flows and endurance tests (Figure 2.10) and low flow accuracy tests (Figure 2.9). The gravity supply system (for low flow accuracy tests) was integrated as one of the water supplies and is capable of providing constant flow at low flow rates to each of the four benches.

As illustrated by the flow arrows in Figure 2.10, the discharge water was able to be directed to either the weight tanks for high flow accuracy tests, or to the circulation tank for endurance tests. For endurance tests, all of the flow meters in the test bench were facing the same direction as can be seen by the flow arrows.

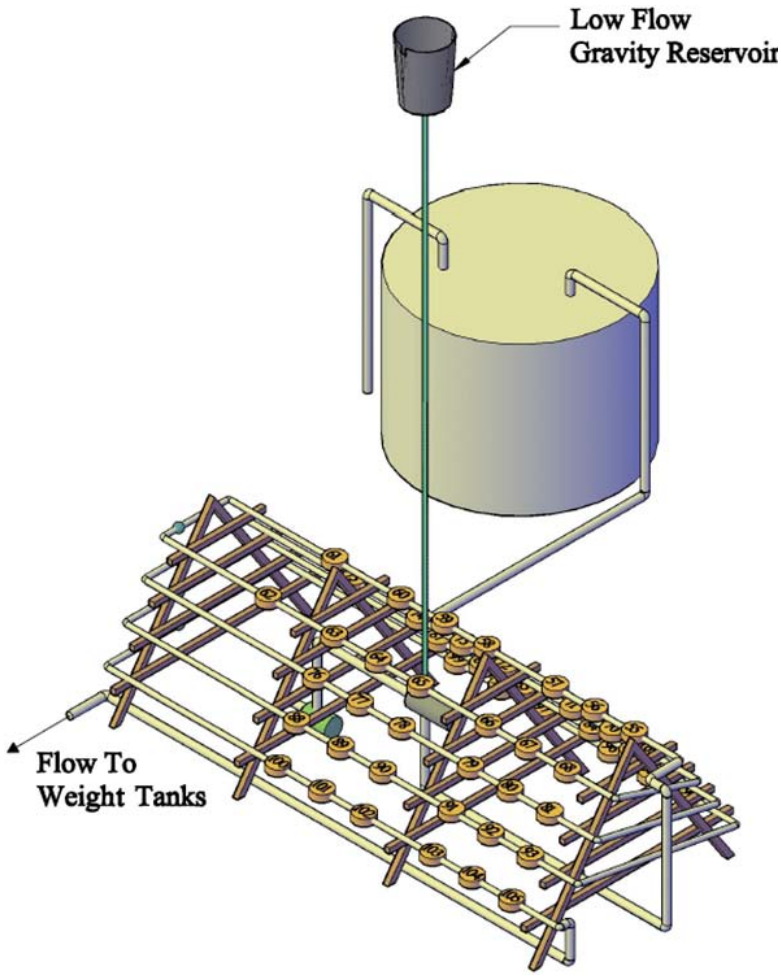

Figure 2.9 Low flow test set-up

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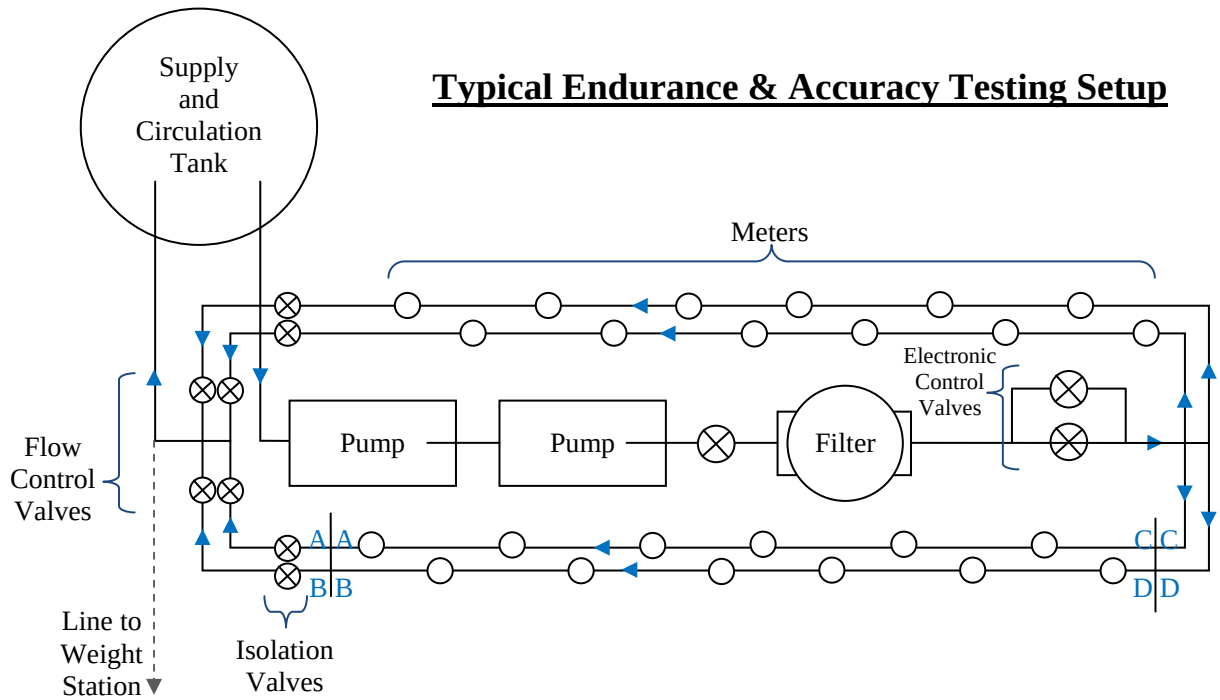

Figure 2.10 Schematic of and Accuracy Test Setup

For very small flow rates, the gravity supply system was used to provide a very constant supply head to the test bench and all of the meters were put in series. In order to test all meters in a bench simultaneously, the entire leg of meters on one side of the bench were disconnected, rotated end for end and then the leg was reinstalled with the line or meters in reverse order. This allowed a circular flow pattern and maintained correct flow direction through all meters. Figure 2.9 illustrates how the meters on one side of the test bench were rotated as a unit for the low flow tests.

The cool-water refreshing line brass valves were occasionally replaced to avoid a valve failure, thereby ensuring an uninterrupted supply of fresh water. Any other problems were addressed or repaired as they occurred to ensure uninterrupted and accurate testing. Calibration of flow measurement instrumentation and equipment was done on a regular basis as described in the quality assurance plan for this project.

Weight Station

Components that were purchased for the weight station included the scale readouts, miscellaneous valves, two magnetic flow meters used to set target flows, and drain line piping used to carry away discharged water. The two weight tanks were fitted with drain valves and piping was run to accommodate accuracy testing of the meters. Electrical supply lines were installed to accommodate the weight tank control panel, the pump starters and the test bench valve controllers. The weight station is shown in detail in Figure 2.11.

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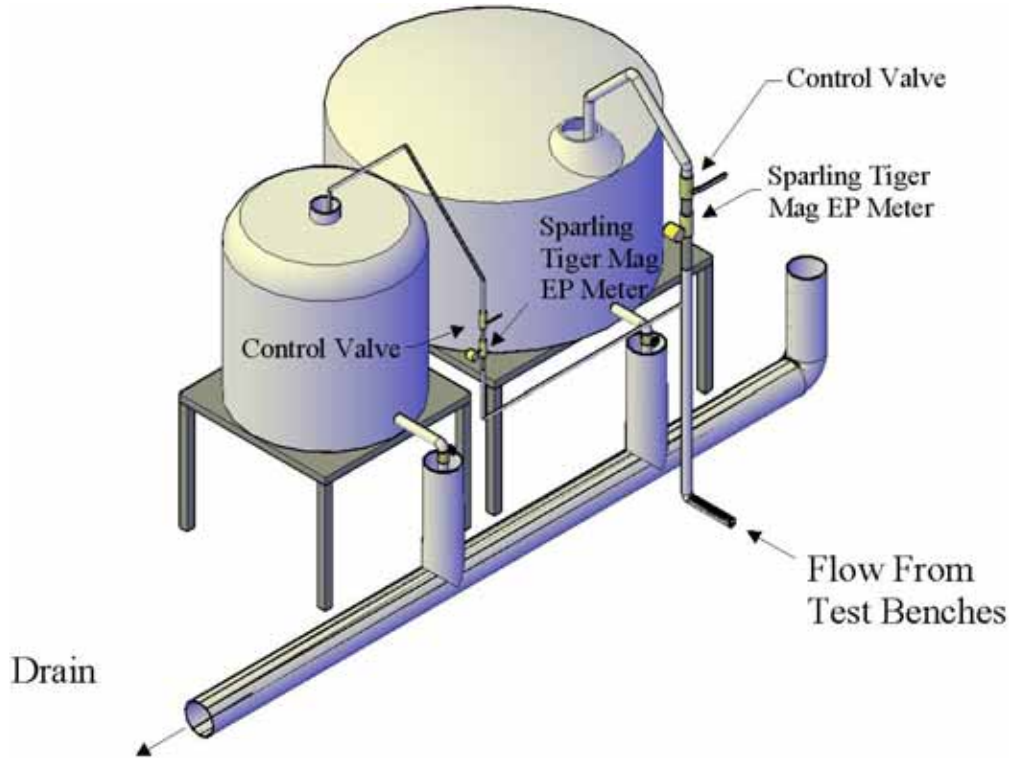

Figure 2.11 Weight station

Test Bench #1

The decision was made to build test bench #1 first and independently of the other test benches to work through any constructability issues and eliminate errors in successive benches. Based upon the conceptual designs, a parts list was compiled for the first of the 5/8 x 3/4-inch and the 3/4-inch meter bench, along with a parts list for the flow metering station, drain lines, and major purchases common to each test loop. The completed test bench #1 can be seen in Figure 2.12.

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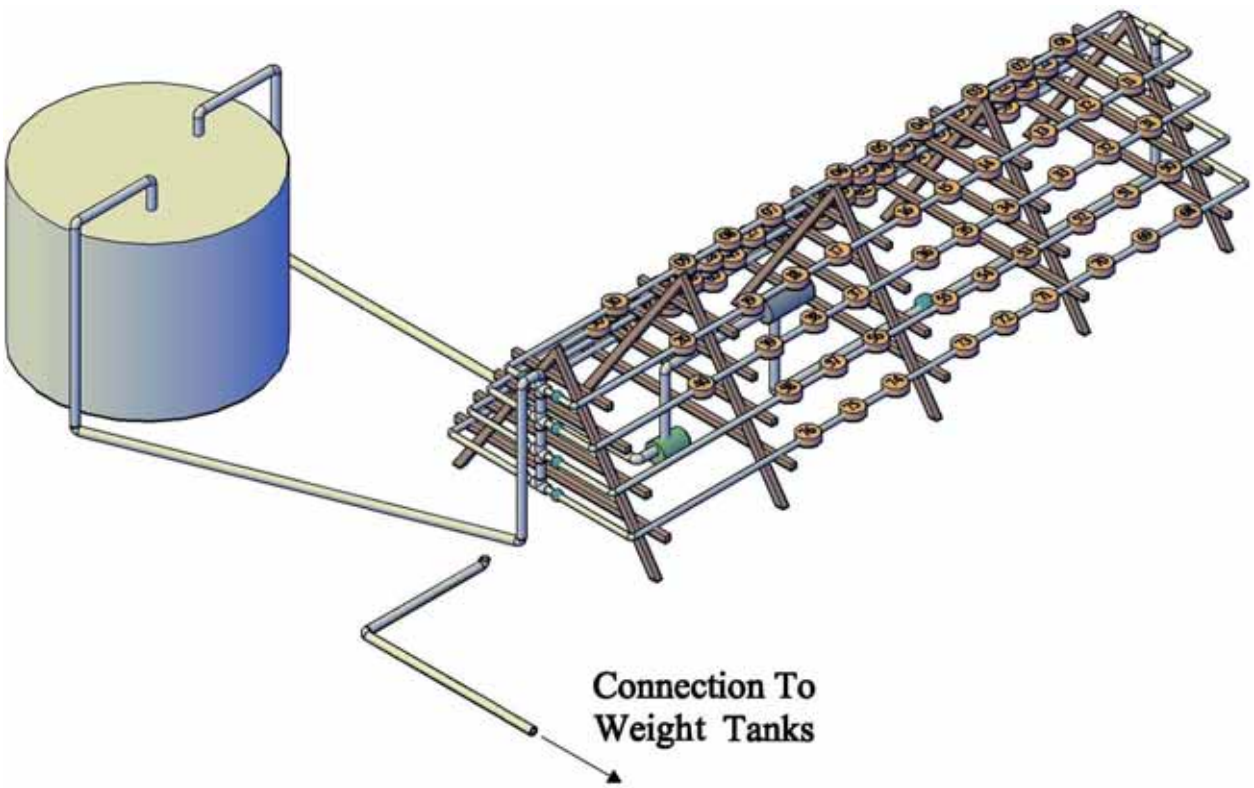

Figure 2.12 Test bench #1

Test Bench #2

The Phase II, 1-inch meters were installed in the #2 test bench in such a way that near uniform head loss occurred through each leg of the test bench. The meters were initially arranged according to the loss characteristics provided from manufacturer pressure loss estimates, but the published pressure loss values were not accurate and the meters had to be rearranged to provide head loss uniformity between legs in the test bench. Because the meter bench was designed so that the meters could be quickly and efficiently moved and because all of the 1-inch meters had a uniform length, rearranging the meters was not a difficult process. Determining which meters were creating more head loss than expected was a trial and error process. Brass couplings (rather than PVC) were used in test bench #2 to minimize the possibility for leaks and to provide better support for the heavier meters. As with bench #1, a redundant brass ball valve was installed in each leg of the test bench to provide assurance that each leg of meters being tested was completely isolated from the others. Also, the same precautionary measures that were developed during the accuracy tests on test bench #1were also utilized during the testing of the 1-inch meters to prevent and eliminate leaks. Test bench number #2 is illustrated in Figure 2.13.

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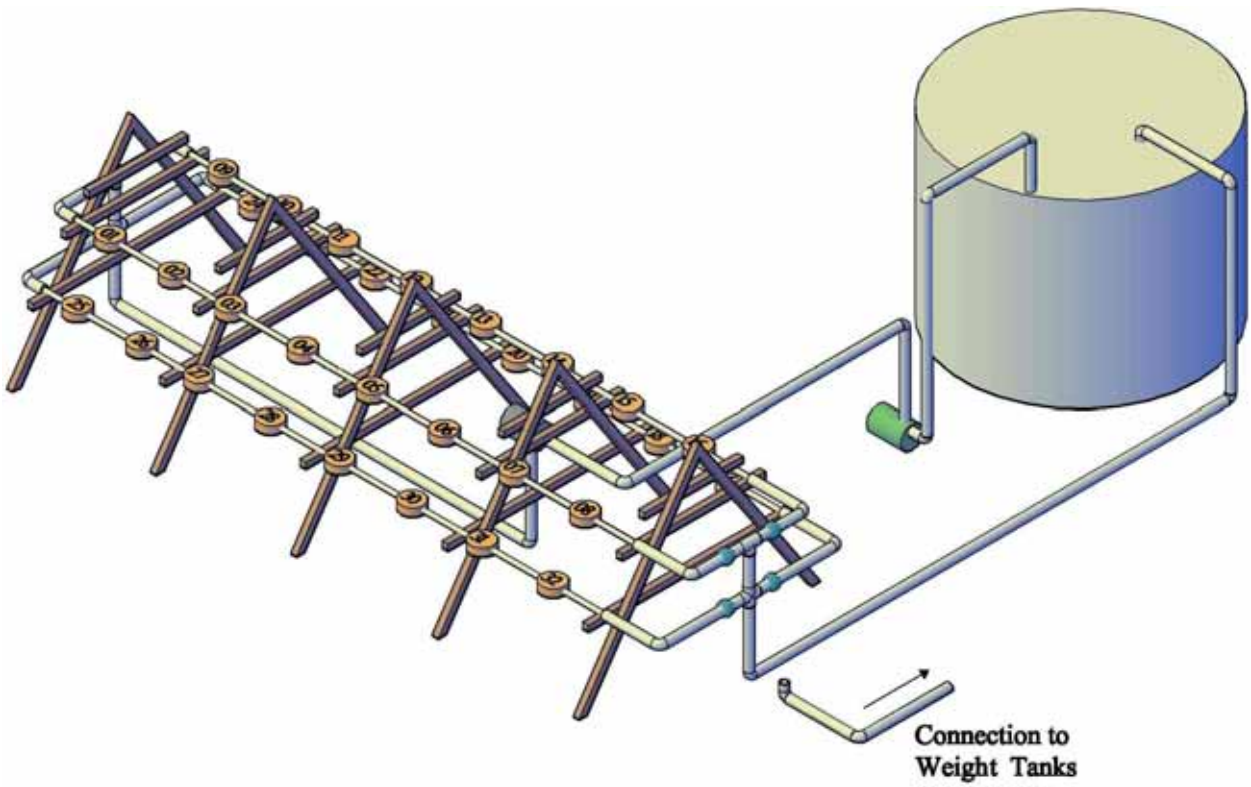

Figure 2.13 Test bench #2

Test Bench #3

Test bench #3 (Figure 2.14) was designed to ensured that appropriate upstream and downstream straight pipe length requirements for each meter were met when the bench was constructed. The manufacturer's head loss data for each meter was also considered, so that the head loss in each leg of the test bench was similar when the meters were installed in the bench. Due to space constraints, the bench design was modified slightly from the previously completed benches to allow for the extra straight pipe lengths that were needed between the test meters. Also, since the 2-inch meters were significantly larger than the 1-inch and smaller meters, the design change in test bench #3 primarily allowed for various testing configurations to take place by adjusting only piping and without rearranging the meters, though the same basic elements of multiple isolation valves, filtering, and automated control valves remained the same. Additionally, because of higher flow rate demands, larger diameter piping was required for the supply piping and supply tank for test bench #3. It was determined that, due to the large meter sizes and the variances in meter type in test bench #3, test bench #4 (pulled meter test bench) would be used to accomplish the highest test flows. The first set of tests helped to determine the most efficient meter configuration possible to test multiple 2-inch meters, minimizing the number of tests, while avoiding significant head loss at the highest flow rates. Procedures used on the other test benches were continued on bench #3 in order to minimize leaks and ensure accurate testing.

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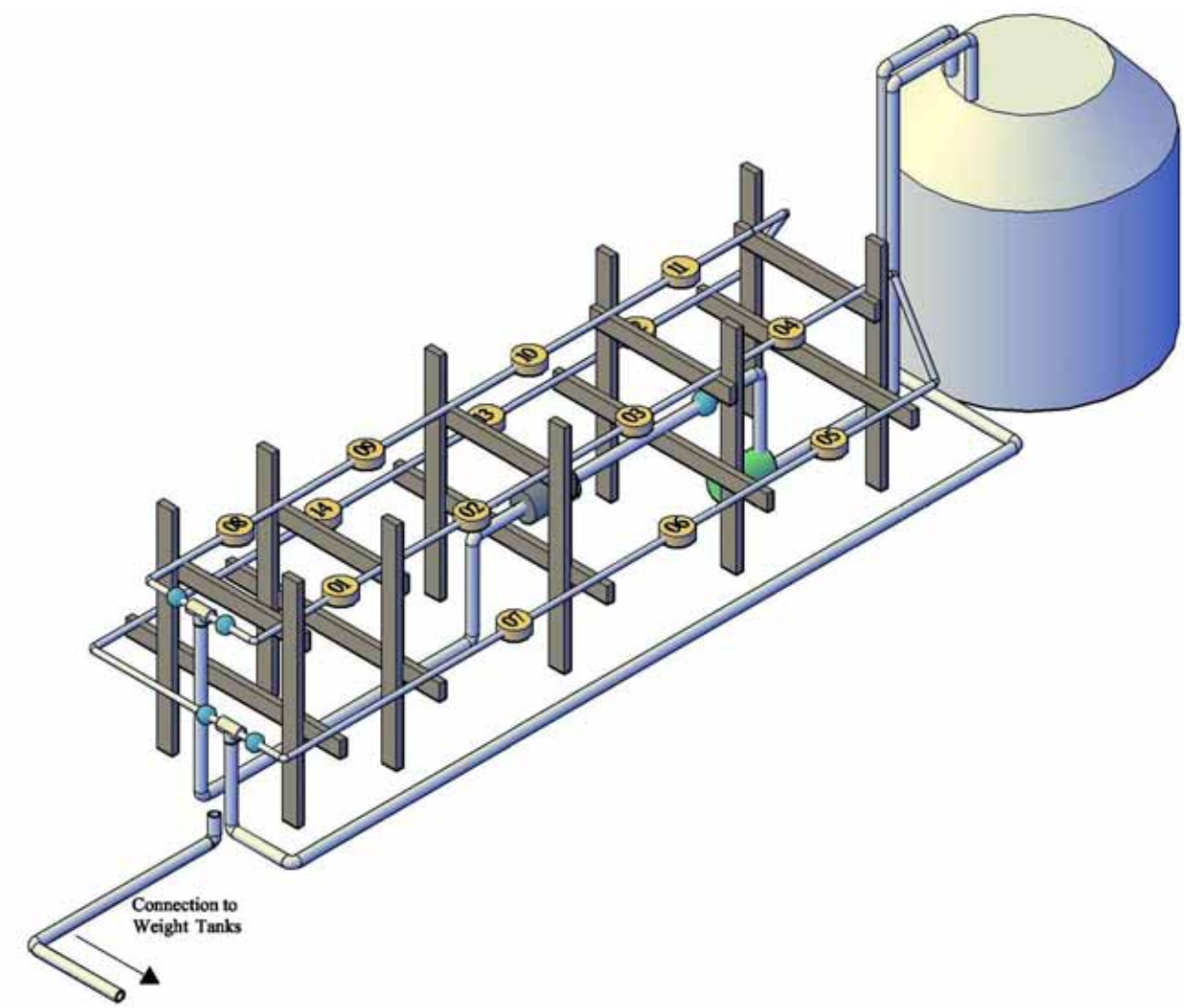

Figure 2.14 Test bench #3

Test Bench #4 Pulled Meters

After test bench #4, or the pulled meter bench, was constructed, it was checked to determine the maximum flow that could be passed through its piping. This flow rate was determined to be 210 gpm. Two adjustable sections in bench #4 allowed for multiple meters of various lengths to be tested simultaneously. Filters were also acquired for test bench #4 to be placed downstream of each pulled meter being tested so that any internal debris that may be dislodged during testing was prevented from affecting neighboring downstream meters. The laboratory 3-inch city water supply line used to supply water to test bench #4 was installed with a 3-inch filter so that all supply water for the pulled meter tests was free of possible particulate contamination. Downstream of the 3-inch filter was an isolation valve, which can be seen in Figure 2.15. The control valve for the test bench was located at the weight station at the end of the line.

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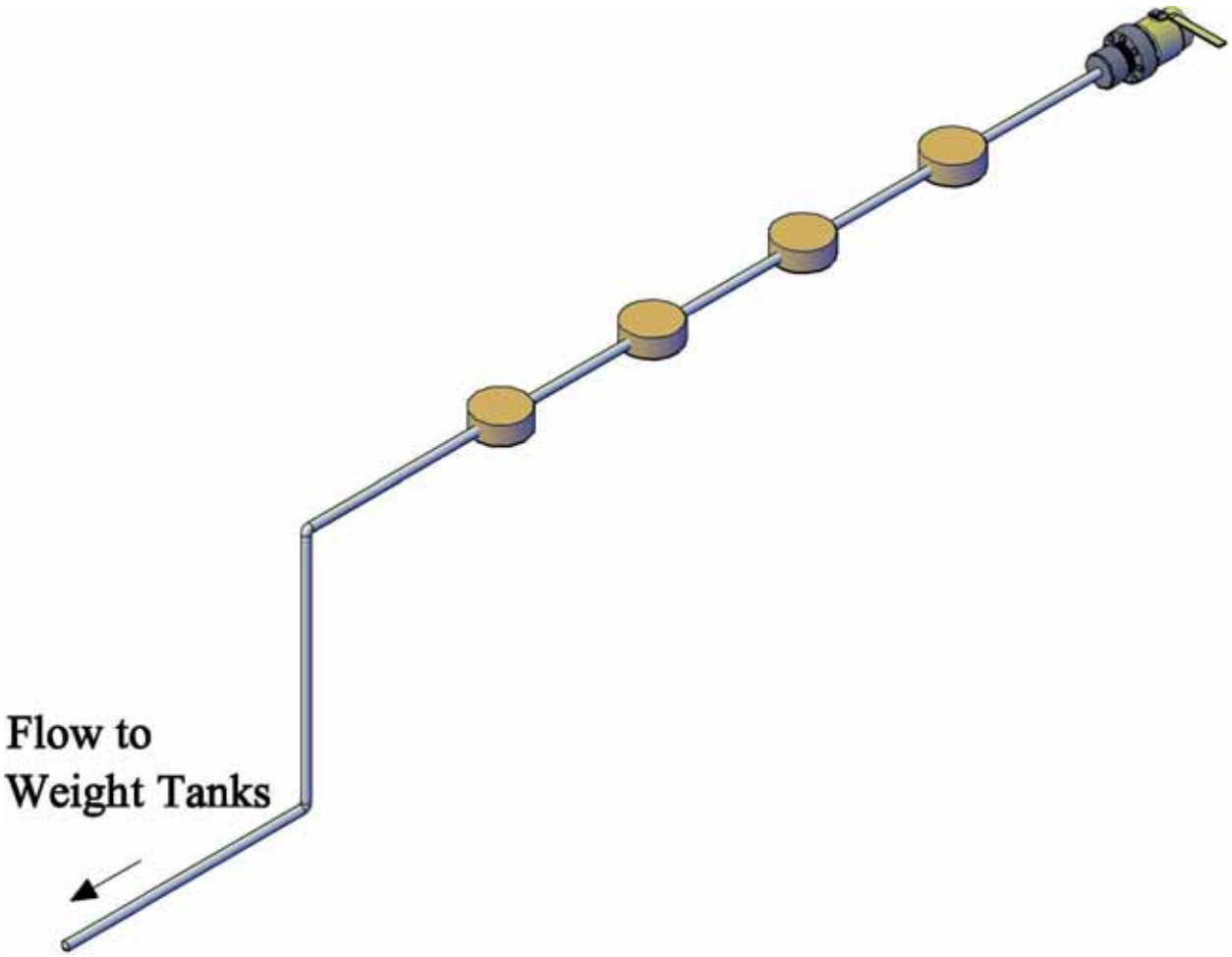

Figure 2.15 Test bench #4

Test bench #4 (pulled meter bench) was used to introduce the particulates into the meters for the Phase III/Component 3 (particulate testing) portion of the project. An additional attachment was made for the particulate bench to direct particulates away from the weight tanks. This attachment could be removed so that the pulled meter attachment could be replaced for further pulled meter testing. This new arrangement was considered test bench #5 and can be seen in Figure 2.16.

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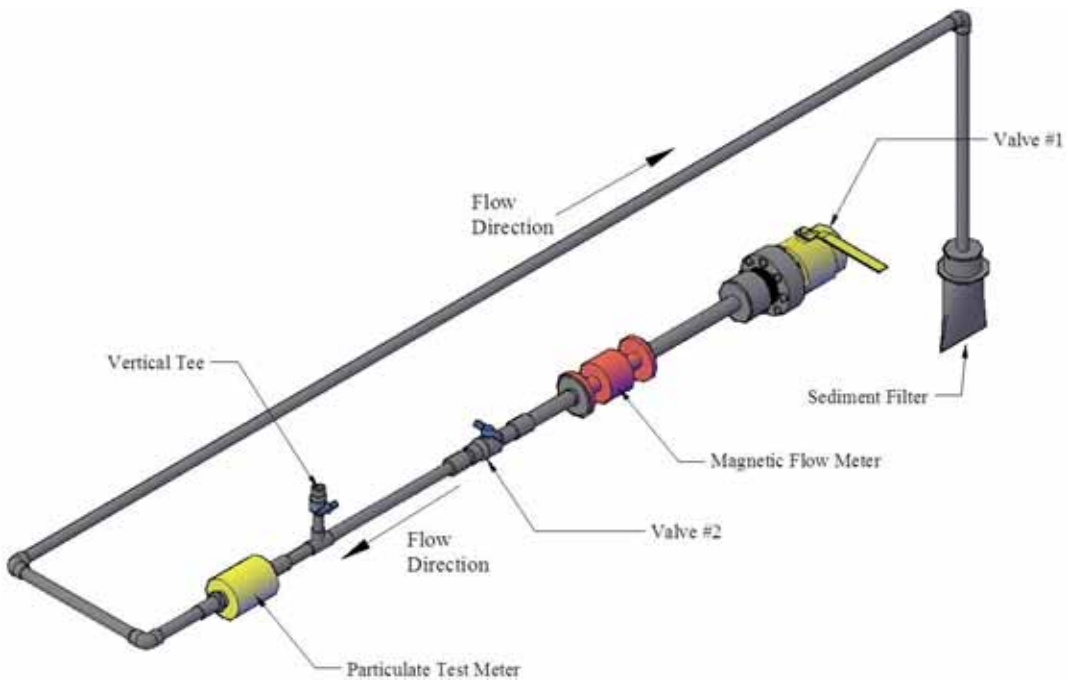

Figure 2.16 Test bench #5 – particulate injection bench

Particulate Benches/Procedures

It was determined that test bench #4 (pulled meter bench) would be used to accuracy test the particulate meters in their new condition before the particulates were introduced. The particulate injection bench (test bench #5) was then used to inject the slug of sand into each meter. The particulate phase of the study began after the last set of 1-inch meters were tested at the final bench mark of full life throughput. The pump, pipes, and wood stands from test bench #2 and #3 were modified (particulate endurance bench) so that they would hold the 75 meters and filters that were needed for the endurance testing of the particulate meters. Individual filters were installed in between each of the 75 meters to prevent dislodged particulates moving from one meter to the next. During operation, these filters were regularly checked to determine if cleaning was necessary. Additional pipe and fittings were needed to lengthen the bench to accommodate the filters installed between the meters. Prior to the purchase of the filters, head loss tests were performed on different micron filter screens, to help determine the appropriate filter size to purchase. Additionally, a sieve analysis was performed on the sand that was used as the particulate during the tests; it is included in the particulate section of this report.

Quality Control

Equipment Calibrations

Two Weigh Tronix gravimetric scales, model numbers DSL 6060-05 and BS, and Serial Numbers 56609 and 7263 respectively, were used to weigh the water during accuracy tests. The scales were calibrated once a year by the State of Utah and every month throughout the duration of the project by a researcher using calibrated weights.

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Two Tiger Mag magnetic flow meters with a model number of FM626 (Serial numbers M113360307; M130154008), were used during the project to set target flow rates. The magnetic meters were not accurate enough to get within 0.5% of the target flow rate. Therefore, they were used to set the flow rate as close as possible to the target flow, after which the flow was fine tuned using the gravimetric scales and a stop watch.

Two Hunter solenoid valves were installed on each test bench and were controlled using a common sprinkler clock to automatically cycle between off and two different flows. The valves were set to 1/3 and 2/3 the AWWA maximum flow rate and would alternate for 1 hour at 1/3 the maximum flow rate and 2 hours at 2/3 the maximum flow rate and then turn off for one minute. The same cyclic flows loop repeatedly throughout the entire endurance cycles for both the new meter endurance tests and the particulate endurance tests.

The debris scale was an Acculab scale, model number VIC-123. It was used for weighing debris that was found inside the disassembled meters. It came with a calibration weight and was calibrated periodically with the automated calibration setting that came with the scale.

The timer used during the project was a Survivor 3 stop watch, and it was used to time all tests and to set all flows.

The thermometer, model number 61220-416 and serial number 51319417, was used for all temperatures taken during tests. The thermometer was purchased specifically for the project and came with a certified calibration certificate.

Data Entry, management and Review

Database. A procedure was implemented by the project team to preserve the integrity of the database and to prevent data loss in the event of file corruption. The procedure effectively required that a copy of the database be used for modifying and adding data so that the original file remained protected. After it was proven that the file copy was not corrupted, the original file would be replaced. This redundant procedure was proven successful. As a reminder, both the original and a copy of the hand-written data were also stored as a secondary data backup.

Project Data. Because of the risk of data loss, the principal investigators also implemented a program wherein all project data was stored on a computer that was located off site. The off-site computer allowed access from any computer connected to the University network (with the appropriate password), so that any team member could access the data. The benefits of offsite storage were that the offsite computer was backed up every night and archived, the computer was secure, and the computer was protected by the latest antivirus software. In addition, the off-site storage allowed for an additional back up file copy that was remotely located from the on-site computer.

The raw data from the accuracy tests were written on a sheet similar to that shown in Figure 2.17. The sheet included the date that the test was performed, the name of the calibrator, the initial meter readings, the final meter readings, the temperatures, and the weight of the water. After this data were collected it was entered immediately into an Excel spreadsheet where obvious measurement or recording errors could be easily identified. After the tests were completed, the Excel spreadsheet and raw data sheets were taken to the laboratory project office where the Excel spreadsheet was saved onto the off-site computer as described earlier and the data was checked again against the raw data. The data was checked one value at a time to assure

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that no typing errors occurred. After the accuracy of the data was confirmed, the actual meter accuracies were copied and pasted into the project database for the appropriate meter.

Date:		gpm				gpm				gpm			
		Initial Weight	Final Weight	Water Temp.		Initial Weight	Final Weight	Water Temp.		Initial Weight	Final Weight	Water Temp.	
Calibrator:		(lbs)	(lbs)	(deg F)		(lbs)	(lbs)	(deg F)		(lbs)	(lbs)	(deg F)	
				1				1				1	
				2				2				2	
				3				3				3	
Row	Meter	Initial Reading	Final Reading			Initial Reading	Final Reading			Initial Reading	Final Reading		
		(gallons)	(gallons)			(gallons)	(gallons)			(gallons)	(gallons)		
S1	1												
S1	2												
S1	3												

Figure 2.17 Example of raw data sheet

Meter Acquisition

All of the meters for this project were acquired by one of two means depending on the portion of the project for which they would be used. Meters were either acquired new by purchases through meter distributors or pulled from participating water utilities for the "pulled" portion of the project. The new meters were used for new meter testing, endurance testing, and particulate testing, or Phase II, Phase III/1, and Phase III/3 respectively. The pulled meters were used in the pulled meter testing, or Phase III/2.

Since a varied array of new meters could be selected for the project (especially the smaller sizes since there was a minimal cost barrier), a full variety of meters were purchased that represented the currently available meters commercially available in the United States. However, as for the pulled meters, the researchers did not have control over what the participating utilities could contribute, and therefore were somewhat at the mercy of what was donated by the utilities. Even though not all meters types were donated during the pulled meter portion of this study, the researchers still believe that the data are beneficial because a real snapshot of in-the-field accuracy of the donated meters was created.

A meter identification number was assigned to each new or pulled meter once it was received at the laboratory. An example meter ID number is #ND-58-BA-P-29, from which the research team could readily note that this meter was a nutating disc meter type (ND), a 5/8 x 3/4-inch size (58), manufactured by Badger (BA), the meter was pulled (P, N for "new"), and the 29th meter with that combination.

New Meters

The project proposal stated *"every flow meter technology claiming to meet current AWWA standards and commonly used in the United States will be represented in this study"*. The project team did their best to include all of the current commercially available U.S. meters in the study. Unfortunately, after determining which meters were commercially available and selecting a distribution of meters for purchase, it was discovered that some meters were overly expensive, that others were not available for U.S. distribution or did not meet current AWWA standards, and that one company gone out of business, while others had merged.

The first proposed meter purchase distribution was designed to offer a diverse set of technologies over a variety of sizes and manufacturers. The proposal stated that *"distinctly different meters will be purchased in sets of three"*. In pulling together costs, it was found that

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larger (1-1/2 and 2-inch) meters were 5 to 12 times the cost of the smaller meters. Of the 2-inch meters that were selected for the project, two were found to cost more than $1000 and seven were between $500 and $1000. The project budget was not able to afford multiples of these larger meters. Additional research determined that the largest majority of meters used in residential systems are between 5/8 x 3/4-inch and 1-inch, so it was decided that a correspondingly similar distribution of test meters would be appropriate. Although larger meters would still be included in the test distribution to provide a comparison to smaller meter sizes, most of the meters would be in the smaller and less expensive sizes. It was therefore determined that the meter size purchase distribution should follow a pattern of 5/8- x 3/4-inch and 3/4-inch meter sizes being purchased in multiples of three, 1-inch in multiples of two, and 1-1/2- and 2-inch meters in multiples of one. Table 2.1 is a summary of the original purchase distribution for the project.

Table 2.1
New meters originally purchased

	Size (in)					
Technology	5/8 x 3/4	3/4	1	1 1/2	2	Total
Single jet	12	6	2	1	2	23
Multi jet	22	18	13	4	4	61
Piston	24	15	10	3	3	52
Turbine	0	3	2	2	6	13
Propeller	0	0	0	0	1	1
Nutating disc	15	9	6	3	3	39
Fluidic oscillator	3	0	0	0	0	3
Total	76	51	33	13	19	192

As shown in Table 2.1, the majority of the meters purchased were in sizes 5/8 x 3/4-inch and 3/4-inch, with the most popular technologies being displacement (comprising of piston and nutating disc) and single-jet and multi-jet.

Additional Meter Purchases. During the first quarter of the project, the researchers feared that the validity of the survey would be questioned if not enough duplicate meters were tested during this study, especially when or if a meter failed. If a meter failed with only three identical meters represented, the question was raised, how would it be shown that it was an expected occurrence as opposed to the distinct possibility that the failure was an anomaly? It was decided that additional flow meters be tested to improve the statistical basis of the test results. After a very comprehensive study of meter cost, project budget and scheduling constraints, and with a desire to select a purchasing distribution that was consistent with the size distribution of "installed" meters within United States water utilities, additional meters were selected for purchase.

Table 2.2 represents the final purchase of meters used in Phase II (new meter testing) and Phase III/Component 1 (endurance meter testing). Table 2.3 summarizes the meters that were purchased for the Phase III/Component 3 (particulate tests). This set of meters includes three identical meters from each of the meter models represented in the 5/8 x 3/4-inch meter set.

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Table 2.2
Final meter purchasing statistics

	Size (in) - Set size					
Technology	5/8x3/4 - 6	3/4 - 6	1 - 6	1 1/2 - 1	2 - 1	Total
Single-jet	24	12	6	1	2	45
Multi-jet	42	30	30	4	4	110
Piston	48	30	30	3	3	114
Turbine	0	6	6	3	6	21
Propeller	0	0	0	0	1	1
Nutating disc	30	18	18	3	3	72
Fluidic oscillator	6	6	0	0	0	12
Total	150	102	90	14	19	375

Meter Inventory. Upon receipt of the new and pulled meters, each meter was carefully unpacked and logged on a meter data sheet. The meter data sheet included meter type, size, acquisition (new or pulled), model number, serial number, length, registry for low, intermediate, and high flows, body material, register type (mechanical or digital), register accuracy, and presence of an adjustment port or strainer. This information was then entered directly into the project database, where a meter identification number was created. The number was then written on the meter body or on a sticker that was then adhered to the meter body (Figure 2.18). A picture was taken of each meter (Figure 2.19) to assist the project team in categorizing and keeping track of the large meter inventory. The meters were stored in a locked room at the UWRL (Figure 2.20).

Figure 2.18 New meters after being marked with a project ID number

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Figure 2.19 Individual new meter photograph

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Figure 2.20 New and pulled meter storage

Two major difficulties presented themselves during meter purchasing. The project proposal indicated that meters *"will be obtained through normal supply lines, and purchased through local distributors"* and *"meters that are not listed by the manufacturer as meeting current AWWA standards are not included"*. Local distributors could not be found for some manufacturers, including Actaris, Clark, DLJ, Metron-Farnier, and Performance Meters. In these cases, the meters were purchased directly through the manufacturer. No information on the project was given to these or any other sellers in order to avoid receiving hand selected meters.

Additionally, many sources indicated that single-jet meters in sizes smaller than 1-1/2 inches were AWWA certified. Under this assumption, twelve 5/8 x 3/4-inch, six 3/4-inch, and

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two 1-inch single-jet meters were originally purchased. Although not AWWA certified, the smaller single-jet meters have met multi-jet standards in manufacturer tests. These meters were used in the project because it was expected they will be included in a future revision (Paul Olsen, a standards engineer with the AWWA, Personal Communication, 5 Feb 2007).

The new meters purchased for Phase III/3 were identical to the 5/8x3/4-inch meters purchased for Phase II and III/1 (new meter, endurance testing), but were purchased in sets of three instead of sets of six identical meters. This amounted to 75 meters that were purchased for the particulate portion of the project as shown in Table 2.3.

Table 2.3
New meters purchased for particulate testing

Technology	Number of 5/8x3/4-inch meters
Single-jet	12
Multi-jet	21
Piston	24
Turbine	0
Propeller	0
Nutating disc	15
Fluidic oscillator	3
Total	75

Pulled Meters

The pulled meters used for this project were acquired from various willing utilities around the United States. These participating utilities were asked to send meters that they would be pulling according to their utility's meter replacement program. It was asked that the meters be functioning, so that accuracy testing could be done on each meter sent by the utilities. Letters (as shown) were sent to each participating utility. Also, specific pulling instructions were sent to each utility so that meters could ultimately be tested close to the same condition as when they were pulled.

Request to Participating Utilities for "Pulled" Meters. The first letter (by email) went out to all participating utilities requesting, when a meter or meters are being pulled within the utility, that a note be forwarded to the USU project manager. This was to inform the project team of upcoming meter removals so that USU could request certain of these meters to be shipped to the UWRL for testing. The letter that was sent is shown as follows:

Dear participating utility member,

I would like to thank all of you again for your willingness to participate in the AWWARF flow meter project. As a reminder, it is Project #4028, and you can see from the web site, that each of you are listed as participating utilities:
http://www.awwarf.org/research/TopicsAndProjects/projectSnapshot.aspx?pn=4028

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As a reminder, we will be looking for specific pulled meters during the next couple of years that we will have you ship to us at our expense for calibration at the Utah Water Research Laboratory. The process will take place as follows with your help.

1. Starting March 1, 2007, we request that each of you send me emails informing me of upcoming meters that will be pulled from your utility. Please be aware that we are looking for meters of all types and condition in sizes 5/8- through 2-inch. Please note that we are looking for aged meters, but they need to be functioning. A great deal of specific information is not necessary in your email. It could say something like this: "Steve, We will be replacing 20 5/8-inch and 3/4-inch Sensus multi-jet meters in April. They have been in service since 1974." That is all the information I need.

2. With this information from each of you, I will then request that certain meters be designated for the AWWARF project. At the end of the project, I need to have tested approximately 500 pulled meters of all types, sizes and condition. 500 divided by 14 utilities, equals an average of 35 meters per utility. Of course, some of you will not provide that many because, a) we may not request them or b) you may not be in the act of replacing meters. Hopefully, it will all balance out and we will end up with a nice diversity of meter types and sizes for testing. Incidentally, there may be circumstances when we request a meter and you cannot ship it to us for some reason. Throughout the project, we are trying to minimize the effort needed by each of you, but we still need your help to make the project successful.

3. If we request a certain meter(s) to be shipped to our facility, then we ask that you follow the guidelines below as closely as you can: (this comes from the project QAQP document.)

Procedure for Pulling Meters. As part of the first email to utilities, a uniform procedure for pulling meters was included so that the utilities would use a consistent pulling, packaging and shipping procedure and so that the meters would arrive at the UWRL in the same condition as they were when they were pulled. The message sent to utilities was as follows:

Meters that are pulled will follow a standard procedure that ensures that particles lodged in the meter or deposits on the wall of the meter are not broken loose in shipment. A specific procedure will direct the participating utility on removing, packaging and shipping the requested meters. Meters will be organized and stored on shelves in a locked room at the UWRL (when tests are not being performed) in such a way that an individual meter can be found quickly again if needed. Although there are no data measured during the actual "pulling" of field installed meters, the following procedure prepared for the participating utilities is necessary, so that the method to pull meters is standardized and the meters arrive at the UWRL for accuracy testing in the same condition as when they were pulled. This procedure will be provided to each participating utility and reviewed with the supervisor, so that as much as possible, the meters are protected from damage and the particulates and deposits that have formed within the meter are not broken loose. The procedure is as follows:

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1. Through on-going communication between the project manager and the participating utility, determine which meter or meters are to be subjects of the study.

2. Through on-going communication between the project manager and the participating utility, determine when the meter or meters of interest are scheduled to be replaced.

3. When and if the meter or meters of interest are being replaced as a result of the utility's regularly scheduled meter replacement program, the project manager will review the procedure for pulling the meter with the contact person at the utility.

Pulling the meter:
4. Perform normal procedures to remove the meter from the system piping, except keep the meter in its installed orientation at all time. In other words, keep the meter upright and do not tip or turn the meter on its side or upside down.

5. Place the plugs or end caps from the new meter on the ends of the pulled meter to prevent the interior of the pulled meter from drying out.

6. Place the meter in a plastic bag and use tape or a tie to close the end of the plastic bag.

7. Place the meter in either a wooden or cardboard box that has a minimum of two inches of clearance from the interior sides of the box (top, sides and bottom).

8. Ensure that when the meter is placed in the box, that the meter is still oriented in the same position as when it was installed (upright orientation).

9. Fill the remaining space in the box with Styrofoam or plastic packing material.

10. Seal the box and mark the top of the box with the words, "THIS SIDE UP". This is to notify the shipper that the box needs to remain upright.

11. Place the following address on the box:

Steven L. Barfuss
Utah Water Research Laboratory
1600 Canyon Road
Logan, Utah 84321

12. Use FedEx ground shipment. A FedEx number will be provided to you for charges.

13. Record FedEx Tracking number.

14. Email (barfuss@cc.usu.edu) the FedEx tracking number, date of shipment, and the following information about the pulled meter: meter manufacturer, meter type, meter size, date the meter was installed, type of connection (residence or commercial), and if

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commercial, define the type of business for each pulled meter. Also describe in the email message, the pipe material in the street adjacent to the pulled meter location, the age of the street piping, the source of the culinary water supply (i.e. spring, water treatment plant, pumped aquifer, etc), and the frequency that the street piping is flushed in the area where the meter was pulled. In all cases, project funds will pay for the shipment of the meter to the Utah Water Research Laboratory. Once we receive the "pulled" meter from your utility, we will accuracy test the meter at three flow rates as defined by current AWWA accuracy test procedures. If the meter passes, it will be tested at four additional flow rates (extreme high and low) to find accuracy limits. Each meter will then be disassembled and a complete examination and inventory of particulates, depositions, lime scale and wear will be made and recorded.

15. As promised, when we discussed your participation in this project, a copy of the data for your meter will be given to you for your records. Also, credit for your participation will be given on the AWWARF website, as well as in the final report for the project. The objective of this project is to fully evaluate the accuracy of residential meters in the US under new and aged conditions over a wider range of flow rates than is currently prescribed by AWWA. I thank each of you again for your participation and help on this project. Much of the success of this project depends on you. The data from this project will help utilities across the US to make better flow metering decisions. I look forward to hearing from each of you soon. I will send reminder emails or make reminder phone calls about monthly requesting current information about future meter replacements. I hope to receive an email from each of you about once a month indicating which meters may be available. Our goal is to complete the "pulled meter" portion of the study by the end of 2008.

Thank you all,

The participating utilities were contacted monthly or as often as deemed necessary.

Upon arrival, the exterior of the pulled meter was gently washed, and a utility knife was used to scrape deposits from the serial number. Additionally, a project ID was created and assigned to each meter. The utility was also asked to provide meter data including the date the meter was installed, date pulled, and sometimes more data if able, such as connection type (residential or commercial), business type (if commercial), street pipe material, pipe installation date, water source, pipe flush frequency, meter location, and a copy of the most recent Consumer Confidence Report (CCR). This information either accompanied the meters as a hardcopy or was emailed. The data was entered into the database for each meter and was used to search for accuracy trends based on meter use.

Following the pulled meter accuracy tests, the data for each test was sent to the utility that donated the meter to the project. This process allowed the utilities to receive important information about the meters they donated. The following is an example of a copy of the form letter that was sent to each utility summarizing the test procedure and results for their meters.

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*On **DATE**, the UWRL received **#** meters from **UTILITY** as part of the AWWARF study "Accuracy of In-Service Water Meters at Low and High Flow Rates." Upon receipt, these meters were washed externally, catalogued, and tagged with a project ID. The meters were then installed into a test bench. Filters were installed between each meter to minimize possible negative impacts from dislodged particulates. The meter registries were then documented. Meter testing took place over the flow rates presented in Table 1.*

Table 1

Size (in)	Below Min Q (gpm)	Near Min Q (gpm)	Below Min Q (gpm)	AWWA Low (gpm)	AWWA Med (gpm)	AWWA High (gpm)	20 fps (gpm)
	1	2	3	4	5	6	7
5/8x3/4	1/32	1/16	1/8	1/4	2	15	20
¾	1/16	1/8	1/4	1/2	3	25	28
1	3/32	3/16	3/8	3/4	4	40	50
1 ½	3/16	3/8	3/4	1 1/2	8	50	110
2	1/8	1/4	1/2	2	15	100	150

To facilitate testing a large number of meters, it was decided that all meters would be tested against the AWWA multi-jet standard. The three AWWA flow rates were tested first. If the meter passed the AWWA high flow rate, one higher rate was tested. The meter was tested over subsequently lower flow rates until it dropped below 95% registry or reached the final test flow. In a few cases, the meters were tested over just the AWWA flow rates before they were disassembled. Test data was entered into a spreadsheet where it was verified by a second party. The following tables provide some of the meter information and the test results.

Table 1 Meter Information

ID	Manufacturer	Meter Type	Meter Size (in)	Model Number	Serial Number	Register on Arrival	Output Unit	Service Time (yr)
1	#######	DP	5/8x3/4	###	########	######.#	##	##
2								
3								

Table 2 Test Results

ID	Registry						
	1	2	3	4	5	6	7
1	-	-	##.##%	##.##%	##.##%	#.##%	#.##%
2							
3							

Table 2.4 summarizes a final listing of the pulled meters that were received for testing from the participating utilities. The manufacturers for the donated meters are not listed in the table.

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Table 2.4
Pulled meter distribution

Technology	Size	Quantity	Utility	Throughput (thousands of gallons)	Service time of each pulled meter (yr)
Piston	3/4"	3	SLC	1659, 848, 1311	7.42, 6.65, 6.73
Piston	3/4"	2	SLC	716, 522	2.84, 1.64
Piston	5/8"	4	SLC	5063, 2613, 3800, 692	24.52, 21.67, 24.94, 24.94
Piston	3/4"	15	SLC	3567, 2885, 2203, 4203, 1357, 6533, 1295, 1038, 2072, 1887, 1414, 1526, 1265, 3617, 2668	17.18, 17.19, 19.13, 19.13, 17.20, 19.62, 17.19, 17.19, 17.19, 17.19, 17.21, 17.19, 17.19, 25.94, 25.94
Piston	1"	1	SLC	48	22.43
Disc	5/8"	6	Orlando	1112, 999, 1170, 653, 1387, 359	14.65, 8.95, 9.01, 14.04, 15.26, 13.77
Piston	1"	2	Orlando	868, 566	9.88, 8.41
Piston	5/8"	6	Orlando	619, 290, 242, 436, 985, 445	21.50, 20.70, 19.30, 18.75, 22.44, 25.08
Piston	1"	3	Orlando	2512, 467, 4530	5.88, 30.64, 17.44
Piston	5/8"	5	Phoenix	426, 1369, 1006, 2669, 835	6.16, 7.28, 7.51, 6.08, 8.91
Piston	1"	1	Phoenix	322	6.11
Disc	1"	2	Phoenix	5911, 218	20.42, 20.63
Piston	1"	1	Phoenix	3604	13.6
Disc	5/8"	7	Phoenix	142, 3929, 1440, 4184, 0.5, 3751, 6630	2.09, 12.23, 12.66, 10.18, N/A, 12.72, 13.35
Disc	3/4"	2	Phoenix	145, 0.8	N/A, 0.03
Disc	1"	4	Phoenix	2703, 2539, 5238, 5870	10.12, 5.05, 12.99, 11.25
Disc	1 1/2"	6	Phoenix	0.9, 71167, 2663, 271, 3885, 938	7.03, 12.85, N/A, N/A, 8.07, 9.75
Disc	2"	6	Phoenix	1029, 1851, 1313, 1233, 16726, 7439	8.07, 11.62, 8.07, 8.07, N/A, 9.75
Piston	1"	3	Logan	868, 2297, 5106	21.56, 14.95, 22.02
Piston	1"	2	Logan	559, 1498	5.43, 11.07
Disc	1"	25	Logan	342, 2291, 1441, 211, 1670, 1602, 3417, 1509, 807, 50, 733, 1935, 1236, 5261, 1869, 2662, 2044, 2028, 1966, 2486, 2465, 1264, 7320, 6464, 8485	17.21, 15.37, 11.02, 18.07, 12.50, 18.32, 15.08, 10.33, 9.22, 9.08, 12.21, 7.36, 16, 19, 18, 18, 18, 18, 18, 18, 18, 20, 18.86, 18.86, 16.94
Multijet	1"	2	Orem	352, 198	Between 10 and 20 years each
Multijet	5/8"	9	Orem	932, 7544, 6637, 7947, 8610, 1347, 301, 532, 2712	Between 10 and 20 years each
Multijet	5/8"	16	Orem	515, 461, 421, 707, 381, 368, 420, 293, 320, 268, 5958, 2415, 8771, 7356, 2814, 450	Between 10 and 20 years each

(continued)

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Table 2.4 (Continued)

Technology	Size	Quantity	Utility	Throughput (thousands of gallons)	Service time of each pulled meter (yr)
Disc	5/8"	2	Orem	921, 1378	Less than 5 years each
Disc	1"	1	Draper	124	0.03
Disc	5/8"	6	Mendon	3606, 705, 679, 844, 4, 763	20, 33, 33, 33, 33, 33
Disc	3/4"	2	Ogden	1830, 1233	17.30, 10.05
Disc	1"	2	Ogden	2712, 8229	13.39, 16.32
Piston	3/4"	1	Ogden	3268	15.19
Piston	1"	3	Ogden	3311, 7853, N/A	31.02, 23.30, 25.60
Disc	5/8"	6	Ogden	2993, N/A, 2502, 2317, 1466, 2687	15.75, 16.92, 17.23, 8.49, 6.38, 17.92
Disc	3/4"	1	Ogden	4310	10.99
Disc	1"	1	Ogden	4064	14.36
Disc	3/4"	1	Ogden	966	15.31
MJ	3/4"	1	Ogden	2700	20.77
Piston	5/8"	1	SLC	4780	6.16
Piston	1"	1	SLC	4813	8.17
Piston	3/4"	15	SLC	1579, 1128, 1033, 942, 978, 640, 809, 1159, 1723, 632, 1083, 1823, 1157, 1473, 3315	6.25 each
Piston	1"	1	SLC	6419	9.39
Piston	1"	7	SLC	4630, 1518, 1664, 3035, 2362, 3468, 3512	6.25, 6.24, 6.25, 6.25, 6.24, 6.24, 6.24
Disc	1"	3	Anchorage	755, 2229, 2101	10 to 12 each
Disc	3/4"	1	Anchorage	412	10 to 12
Piston	1"	2	Logan	1594, 4645	5.92, 5.92
Disc	5/8"	3	Logan	1343, 2413, 1944	20.01, 20.01, 3.00
Disc	5/8"	1	Greensboro	4120	22.31
Disc	5/8"	5	Greensboro	1563, 1483, 1831, 2237, 2024	22.3, 21.39, 24.05, 25.48, 25.47
MJ	1"	6	Greensboro	3224, 1536, 814, 926, 87, 610	9.18, 10, 13.33, 13.27, 14.7, 14.7
MJ	1"	6	Greensboro	400, 1072, 1501, 981, 84, 577	3.65, 5.36, 13.78, 13.76, 2.71, 5.1
Disc	5/8"	12	Greensboro	37, 120, 359, 144, 402, 183, 349, 55, 155, 630, 357, 373	6.1, 6.1, 5.78, 6.21, 5.20, 3.80, 4.19, 3.56, 4.92, 4.28, 5.79, 5.88,
Disc	3/4"	4	Greensboro	1177, 1318, 158, 362	13.5, 3.86, 4.03, 4.73
Disc	5/8"	11	Greensboro	779, 81, 1352, 375, 1372, 1740, 1292, 298, 376, 1186, 430	12.93, 16.85, 19.35, 12.93, 15.10, 16.76, 19.10, 16.35, 18.18, 18.26, 10.42
Disc	5/8"	1	Greensboro	1205	20.43

(continued)

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Table 2.4 (Continued)

Technology	Size	Quantity	Utility	Throughput (thousands of gallons)	Service time of each pulled meter (yr)
Disc	3/4"	12	Greensboro	249, 547, 560, 925, 1346, 508, 1741, 500, 1588, 1648, 966, 1225	12.60, 14.02, 9.10, 12.01, 9.17, 14.35, 15.10, 11.59, 12.10, 15.01, 14.76, 13.50
Disc	3/4"	1	Greensboro	641	9.84
Disc	1"	1	Greensboro	6986	13.54
Piston	5/8"	8	Greensboro	2201, 2445, 497, 675, 121, 387, 1246, 1188	22.54, 22.62, 22.28, 23.04, 22.56, 9.79, 17.79, 23.12
Piston	5/8"	4	Greensboro	1317, 1338, 1815, 1309	22.12, 22.12, 21.70, 22.45
Piston	3/4"	1	Greensboro	1460	22.62
Piston	5/8"	2	Greensboro	473, 384	10.53, 6.30
Piston	1"	1	Logan	4274	20.01
Disc	1"	13	Logan	1101, 1970, 1456, 278, 4470, 2185, 2141, 1892, 3340, 9216, 5062, 2321, 4007	15.11, 17.75, 17.75, 17.75, 17.76, 16.96, 8.61, 17.75, 17.16, 19.63, 19.64, 15.11, 7.03
Disc	1"	8	Anchorage	3595, 261, 939, 0.1, 683, 226, 43, 27	15 to 20 each
Disc	5/8"	3	Orlando	968, 2701, 5426	12.54, 13.67, 9.88
Piston	1"	2	Orlando	2054, 315	17.34, 14.55
Piston	5/8"	6	Orlando	270, 404, 793, 647, 4009, 27	14.17, 21.17, 21.03, 14.55, 13.90, 21.17
Piston	5/8"	3	Orlando	221, 312, 554	6.29, 2.41, 17.34
Disc	1"	2	Orlando	3917, 1234	9.85, 9.41
Disc	5/8"	6	Orlando	1318, 3545, 1042, 1576, 622, 816	10.46, 14.19, 14.04, 9.41, 10.54, 14.19
Disc	5/8"	17	New Haven	1190, 490, 1609, 1103, 93, 2817, 188, 578, 762, 2221, 1300, 946, 1140, 184, 936, 455, 7	0.36, 17.68, 15.72, 14.48, 1.05, 14.66, 14.87, 15.31, 14.64, 15.16, 15.27, 15.67, 14.71, 14.66, 15.9, 15.41, 0.12
Piston	5/8"	1	New Haven	709	15.25
Piston	5/8"	1	New Haven	501	30.15
Disc	5/8"	6	Rochester	1458, 1137, 674, 1119, 410, 392	9.71, 13.57, 9.81, 7.75, 15.24, 4.64
Disc	3/4"	5	Rochester	145, 0.02, 0.5, 47, 4120	7.32, 1.72, 1.43, 0.003, 13.23
Disc	1"	5	Rochester	535, 795, 4887, 108, 2127	8.76, 12.77, 13.93, 14.56, 8.93
Disc	2"	1	Rochester	1800	11.64
Piston	5/8"	3	Rochester	1248, 916, 634	32.88, 37.43, 33.47
Piston	5/8"	1	Rochester	265	17.3
Piston	5/8"	2	Rochester	1328, 1243	11.53, 11.59
Piston	3/4"	1	Rochester	1775	12.27

(continued)

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Table 2.4 (Continued)

Technology	Size	Quantity	Utility	Throughput (thousands of gallons)	Service time of each pulled meter (yr)
Piston	1"	1	Rochester	4155	29.56
Piston	1 1/2"	4	Rochester	11688, 4614, 392, 1109	17.68, 37.21, 23.39, 25.47
Piston	2"	1	Rochester	11970	11.24
Piston	2"	1	Rochester	2845	22.87
Disc	1"	4	Anchorage	9082, 703, 5726, 4119	10-15
Disc	3/4"	6	Anchorage	698, 105, 3360, 746, 8746, 6550	10-15
Piston	5/8"	M	Orlando	534, 789, 988, 838, 968, 784, 677, 1362, 2727, 1385, 648, 627	30, 30, 30, 30, 30, 30, 30, 20, 20, 20, 20, 20
Piston	5/8"	85	Orlando	ranges from 526-5816*	ranges from 10-20*
Piston	5/8"	125	Orlando	ranges from 565-9129**	ranges from 1-10**

*For a list of throughputs and ages, refer to Table 2.5
** For a list of throughputs and ages, refer to Table 2.6

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Table 2.5
Orlando meter type #1

Meter	Throughput (gallons)	Service time (yr)	Meter	Throughput (gallons)	Service time (yr)
1	1654000	20	44	1794000	14
2	2612000	20	45	3924000	14
3	2048000	20	46	2387000	14
4	1746000	20	47	1271000	14
5	4585000	20	48	1289000	14
6	3422000	20	49	534000	14
7	3036000	20	50	526000	14
8	3082000	20	51	657000	14
9	2130000	20	52	1592000	14
10	2124000	20	53	3944000	14
11	1279000	20	54	3881000	14
12	2712000	20	55	1115000	14
13	688000	20	56	2642000	14
14	2461000	20	57	3060000	14
15	4325000	20	58	3245000	14
16	966000	17	59	2412000	13
17	1187000	17	60	4368000	13
18	3340000	17	61	4646000	13
19	2748000	17	62	4431000	13
20	3448000	17	63	3403000	13
21	1082000	17	64	1535000	13
22	1474000	17	65	2777000	13
23	782000	17	66	2937000	13
24	1813000	17	67	679000	13
25	1913000	17	68	1989000	13
26	5816000	17	69	2144000	13
27	1901000	17	70	2108000	13
28	2565000	17	71	779000	13
29	2053000	17	72	917000	13
30	3137000	17	73	1686000	13
31	4561000	17	74	1265000	13
32	2459000	17	75	1731000	13
33	4504000	17	76	3511000	13
34	4335000	17	77	1460000	13
35	1177000	17	78	3553000	13
36	2683000	17	79	3577000	10
37	2148000	17	80	1690000	10
38	2411000	14	81	2014000	10
39	1838000	14	82	2997000	10
40	3438000	14	83	3062000	10
41	2831000	14	84	2670000	10
42	3254000	14	85	1496000	10
43	2246000	14			

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Table 2.6
Orlando meter type #2

Meter	Throughput (gallons)	Service time (yr)	Meter	Throughput (gallons)	Service time (yr)
1	2529000	10	64	1901000	7
2	3022000	10	65	4407000	7
3	585000	10	66	2546000	7
4	2036000	10	67	1959000	7
5	1034000	10	68	1171000	7
6	999000	10	69	759000	7
7	3437000	10	70	1744000	7
8	4390000	10	71	1013000	7
9	2140000	10	72	2097000	7
10	1720000	10	73	3298000	7
11	4139000	10	74	4437000	7
12	1400000	10	75	4217000	7
13	1208000	10	76	2732000	7
14	4268000	10	77	1168000	7
15	596000	9	78	1563000	7
16	2570000	9	79	3190000	7
17	1141000	9	80	2948000	6
18	668000	9	81	665000	6
19	2931000	9	82	1600000	6
20	3531000	9	83	3665000	6
21	4444000	9	84	4462000	6
22	4286000	9	85	720000	6
23	2334000	9	86	903000	6
24	4009000	9	87	2315000	6
25	4312000	9	88	2900000	6
26	1128000	9	89	2498000	6
27	1254000	9	90	3134000	6
28	3089000	9	91	1062000	6
29	3211000	9	92	4547000	6
30	2027000	9	93	1090000	6
31	1674000	9	94	1713000	6
32	883000	9	95	3417000	6
33	1982000	9	96	1833000	6
34	2830000	9	97	2409000	6
35	3083000	9	98	1576000	6
36	2116000	9	99	2716000	6
37	2674000	8	100	2159000	5
38	3183000	8	101	2577000	5
39	2086000	8	102	3361000	5
40	811000	8	103	2785000	5
41	3284000	8	104	4414000	5
42	4047000	8	105	2215000	5
43	2227000	8	106	565000	5
44	3648000	8	107	4646000	5
45	4400000	8	108	1189000	5
46	2468000	8	109	4299000	5
47	1634000	8	110	1641000	5
48	1806000	8	111	2391000	5
49	953000	8	112	1771000	5
50	2762000	8	113	3305000	5
51	666000	8	114	1365000	5
52	1190000	8	115	570000	5
53	1619000	8	116	3102000	5
54	1357000	8	117	2667000	5
55	2509000	8	118	1119000	5
56	2767000	8	119	903000	5
57	2344000	7	120	1357000	5
58	2045000	7	121	6513000	3
59	1191000	7	122	6685000	3
60	3163000	7	123	1549000	2
61	4326000	7	124	9129000	2
62	2653000	7	125	4244000	1
63	810000	7			

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PHASE II: NEW METER TESTS

The new meter tests were performed to evaluate the accuracy of brand new, off-the-shelf meters. All of the new meter tests were performed according to the manufacturer's installation specifications and were tested with pristine water. Additionally, a filter was installed upstream of each tested meter to ensure that no debris potentially released into the test bench setup, went through the meters.

Test Procedures

Each new meter was tested according to Table 2.7. Table 2.7 summarizes the flow rates that were tested and the specific test bench number in which the meter was installed. Note that there are two intermediate AWWA flow rates listed in the table. This is to accommodate a lower intermediate AWWA flow rate for the multi-jet and single-jet meters. The lower flow rates were tested by arranging all the meters on the bench in series as shown in Figure 2.9. For the higher flow rates where the head loss was too great for all the meters to be placed in series, one row of meters was tested at a time. Depending on the bench, during high flow rate tests the meters were tested in sets ranging from four to eight meters in total.

Table 2.7
Summary of test measurement flow rates

Meter size (in)	Additional flows tested (gpm)						AWWA flows (gpm)				Bench	Number of groups
							Min	Int1	Int2	Max		
5/8x3/4	1/64	1/32	1/16	1/8	1/2	20	1/4	1	2	15	#1	2
3/4	1/32	1/16	1/8	1/4	1	28	1/2	2	3	25	#1	2
1	-	-	3/64	3/16	3/8	50	3/4	3	4	40	#2	3
1 1/2	-	3/32	3/16	3/8	3/4	110	1 1/2	5	8	50	#3	1
2	1/8	1/4	1/2	1	8	150	2	4	15	100	#3	1

Prior to the test, the meters were flushed to insure that all the air was out of the pipes and meters. Then the flow control valves, as illustrated in Figure 2.11, were closed and the meters were read. Two researchers would record the initial meter readings. One researcher would read the odometer from the meter display while the second would write the value down and then double check the reading.

The nominal target flow rate was then set by adjusting the flow control valves while monitoring the magnetic flow meter. Once the nominal target flow rate was set, a stop watch was used to calculate the timed volume of water that passed through all of the meters. A temperature was also recorded (since different temperatures of water change the volume of water). After the appropriate testing volume had passed through the meter, the flow control valve was closed and the stop watch stopped. Then meter odometer readings were once again recorded by the researchers.

For longer tests (or low flow rates), the magnetic flow meter was still used to set the flow rate; however, a stop watch was used to obtain a more precise flow rate. When test measurements where longer than 20 minutes, three temperatures were recorded: one each at the beginning, middle, and end of the test. Very low flow rates were tested by using a gravity supply

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instead of the pumped system. This included a five gallon bucket that was placed above the meters as a constant head tank. This method of supplying water to the meters created a very constant flow rate.

Table 2.8 summarizes the flow rate and the corresponding time for the measurement. As can be seen in the table, smaller flow rates required much longer testing times to accumulate the required volume to minimize measurement uncertainties.

Table 2.8
Test measurement times

Flow rate	Meter size	Target test volume (gal)	Time (min)	Time (hours)
150	> 1-inch	400	2.67	0.04
110	> 1-inch	300	2.73	0.05
100	> 1-inch	300	3.00	0.05
50	> 1-inch	200	4.00	0.07
15	> 1-inch	100	6.67	0.11
8	> 1-inch	100	12.50	0.21
5	> 1-inch	100	20.00	0.33
4	> 1-inch	100	25.00	0.42
2	> 1-inch	100	50.00	0.83
1 1/2	> 1-inch	100	66.67	1.11
1	> 1-inch	100	100.00	1.67
3/4	> 1-inch	100	133.33	2.22
1/2	> 1-inch	100	200.00	3.33
3/8	> 1-inch	100	266.67	4.44
1/4	> 1-inch	100	400.00	6.67
3/16	> 1-inch	100	533.33	8.89
1/8	> 1-inch	100	800.00	13.33
3/32	> 1-inch	100	1066.67	17.78
50	<= 1-inch	100	2.00	0.03
40	<= 1-inch	100	2.50	0.04
28	<= 1-inch	100	3.57	0.06
25	<= 1-inch	100	4.00	0.07
20	<= 1-inch	100	5.00	0.08
15	<= 1-inch	100	6.67	0.11
4	<= 1-inch	10	2.50	0.04
3	<= 1-inch	10	3.33	0.06
2	<= 1-inch	10	5.00	0.08
1	<= 1-inch	10	10.00	0.17
3/4	<= 1-inch	10	13.33	0.22
1/2	<= 1-inch	10	20.00	0.33
3/8	<= 1-inch	10	26.67	0.44
1/4	<= 1-inch	10	40.00	0.67

(continued)

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Table 2.8 (Continued)

Flow rate	Meter size	Target test volume (gal)	Time (min)	Time (hours)
3/16	<= 1-inch	10	53.33	0.89
1/8	<= 1-inch	10	80.00	1.33
1/16	<= 1-inch	10	160.00	2.67
3/64	<= 1-inch	10	213.33	3.56
1/32	<= 1-inch	10	320.00	5.33
1/64	<= 1-inch	10	640.00	10.67

Data Collection

After each test, the collected data was immediately entered into an on-site computer. This allowed the researchers to see the accuracies and the recorded times so that any outliers could be instantly highlighted. If any of the data were out of line with what was expected compared to the other meters at the same flow rate, the meter reading would be checked again. Taking this approach minimized reading errors. Additionally, if the time recorded for the volume of water that passed through the meters did not correspond with the correct flow rate, a retest was performed.

Excel spreadsheets were used to provide an organized and consistent method of data storage. A spreadsheet was created for the new condition testing, which consisted of a tab for each flow rate tested. These spreadsheets were linked to an analysis spreadsheet where graphs were generated for each manufacturer/size/type combination. Within this spreadsheet, the average registry and standard deviation were calculated for each meter set. An average shift was also calculated, which determined the change in the average from one endurance life period to the next for each meter set.

The spreadsheets that contained the accuracy data was then moved from the laboratory computer to an office computer where the data was again checked against the raw hand-written data sheets. That file was then uploaded to the off-site computer for safe storage. After the data was checked for the second time, the data was entered into the project database, which was also saved on the off-site computer.

PHASE III: LABORATORY ENDURANCE TESTING

This portion of the project was necessary to determine the effect that water throughput has on the meters. It was projected that this data would help illustrate how meter technologies differ and which are more susceptible wear. All of the meters were tested to “full life”. The volume estimates for “full life” can be based on the following for the 5/8x3/4-inch meter size:

- 100 gallons per person per day (indoor use only)
- 4 persons per household (this is probably high)
- 100gal/day/person*4persons*365days/yr*15yrs = 2.19MG (This was rounded down to 2MG)

For the other meter sizes, the researchers simply set the 2/3 and 1/3 AWWA max flow rates and put a volume through them that would finish up in about the same time that the

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5/8x3/4-inch meters would finish. This method was fairly consistent except for the 1.5-inch and 2-inch meters, which probably should have been at about 12MG and 20MG of throughput. That amount of throughput, however, would have doubled the time required for the endurance testing, so 6MG and 12MG were used as 100% life for the 1.5-inch and 2-inch meters. Table 2.9 summarizes the calculated throughput volumes that were passed through each meter size.

Table 2.9
Throughput volumes for each meter size

	Throughput (million gallons)			
Meter size	1/4-Life	1/2-Life	3/4-Life	Full-Life
5/8x3/4	1/2	1	1 1/2	2
3/4	3/4	1 1/2	2 1/4	3
1	1 1/4	2 1/2	3 3/4	5
1 1/2	1 1/2	3	4 1/2	6
2	3	6	9	12

Test Procedures

The meters were accuracy tested four times during the endurance testing. These tests occurred at 1/4 of the full life, 1/2 of the full life, 3/4 of the full life, and after full life was completed. Each accuracy test was performed using the same procedure as described in the Phase II, new meter test procedure.

Data Collection

Data collection for the endurance accuracy tests followed the Phase II, new meter tests. One spreadsheet was created for each set of tests (1/4, 1/2, 3/4, and full life).

PHASE III: PULLED METER TESTING

Five hundred and ninety five (595) meters were pulled from their field installation, shipped to the Utah Water Research Laboratory, tested for accuracy, and dismantled so that the internal components of the meter could be analyzed for this component of Phase III. The protocol developed to ensure that pulled meters were shipped so as to arrive at the UWRL in the same condition as when they were pulled was discussed earlier under meter acquisition.

The researchers originally wanted to select meters that would incorporate a wide range of years in service and water quality and match the sizes and types of those meters already tested during the new meter and endurance testing; however, after pulled meter acquisition began, the researchers found that they were not able to be selective and were required to accept any meters the utilities were willing to offer. Additionally, a complete history of each meter, which included installation date, location, typical usage history, bench tested data, water quality, serial number, meter type, meter manufacturer, water utility, etc., was to be documented if the information was available from the utility. In many cases, only the time that the meter was in service was provided.

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The intent of this phase of testing was to performance test meters that had been in service and possibly had some wear on components or build up of lime scale. The testing was intended to demonstrate how accurate water meters might be after years of service in varied conditions.

It should be noted that pulling aged meters from service and calibrating them for accuracy in the lab does not indicate how the meter has degraded with time. The lab results simply show how accurately a meter pulled from service performs after a specific number of years in service and corresponding flow throughput. It is nearly impossible to know what has gone through a meter removed from service prior to its being removed for testing; however, the tests performed during this portion of the project provided validation and comparison of laboratory tests done on the same meter during endurance testing, and trends in accuracy with varying service times and throughput were investigated.

Test Procedures

Upon receipt of a pulled meter, if the meter was found to be incapable of registering flow or if the meter leaked, steps were taken to fix the problem. Many leaks were fixed by simply tightening the freeze plate. In some cases, if the meter continued to leak or had other problems, it was not tested but set aside for disassembly. In most instances, disassembling the meter clearly showed why the meter had failed to register, and these reasons were noted.

The pulled meters were tested in the same manner as the new meters, with the exception that they were not tested in the same bench or at all of the same flow rates. Pulled meters were tested up to six at a time (refer to Figure 2.15. The accuracy tests for the pulled meter testing began with the 3-part AWWA calibration (minimum, intermediate, and maximum flow rates). Following these tests, if the meter failed the AWWA standards then testing did not continue. If the meter passed the 3-part AWWA calibration, the meter was then tested at 1/2 the minimum flow rate, and if this condition passed, the meter was again tested at 1/2 of that flow rate and so forth until the meter accuracy fell below 95%.

Data Collection

The pulled meter accuracy data was collected in the same manner as the new meter accuracy data. Similarly, Excel spreadsheets were used to calculate accuracies and organize data directly after testing was performed. A “master” Excel spreadsheet for each meter size was created and stored on the off-site computer. During the tests, data were entered into a “testing” spreadsheet, which was similar to the master spreadsheet, except that each testing spreadsheet contained testing data from only one utility. The file was then saved with a name that included the utility from which the meters came and a date. The file was then transferred from the laboratory computer to the office computer, and from there it was uploaded to the off-site computer. The pulled meter accuracy data was also updated on the database.

A disassembly data sheet is shown in Figure 2.21. After a meter was disassembled each applicable aspect was rated according to the numeric scale mentioned above. If there were any notable findings outside of the categories on the data sheets, these were recorded in the “Other Notes” section. The information from the data sheets was then entered into the database, and any photographs were uploaded to the database.

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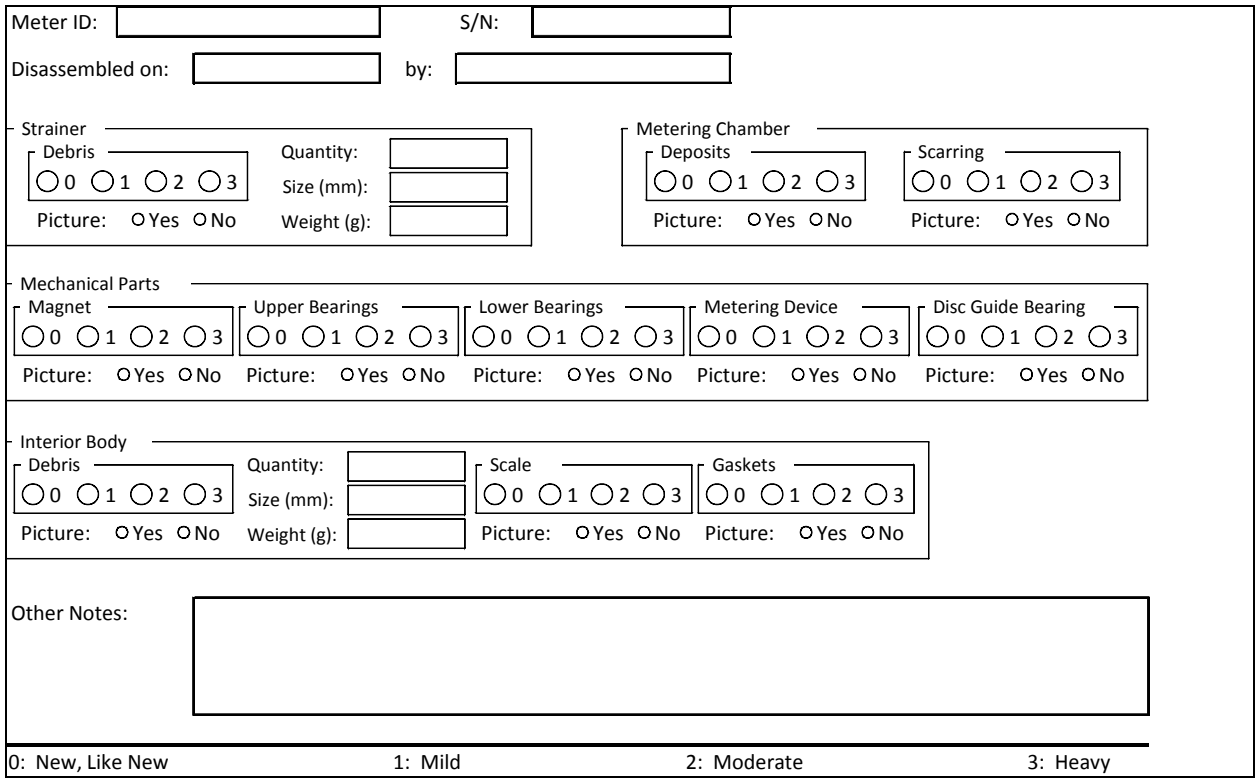
Meter ID: S/N:

Disassembled on: by:

Strainer
Debris ○0 ○1 ○2 ○3 Quantity: Size (mm): Weight (g):
Picture: ○Yes ○No

Metering Chamber
Deposits ○0 ○1 ○2 ○3 Picture: ○Yes ○No
Scarring ○0 ○1 ○2 ○3 Picture: ○Yes ○No

Mechanical Parts
Magnet ○0 ○1 ○2 ○3 Picture: ○Yes ○No
Upper Bearings ○0 ○1 ○2 ○3 Picture: ○Yes ○No
Lower Bearings ○0 ○1 ○2 ○3 Picture: ○Yes ○No
Metering Device ○0 ○1 ○2 ○3 Picture: ○Yes ○No
Disc Guide Bearing ○0 ○1 ○2 ○3 Picture: ○Yes ○No

Interior Body
Debris ○0 ○1 ○2 ○3 Quantity: Size (mm): Weight (g):
Picture: ○Yes ○No
Scale ○0 ○1 ○2 ○3 Picture: ○Yes ○No
Gaskets ○0 ○1 ○2 ○3 Picture: ○Yes ○No

Other Notes:

0: New, Like New 1: Mild 2: Moderate 3: Heavy

Figure 2.21 Disassembly data sheet

Meter Disassembly and Analysis

Following the accuracy testing of each pulled meter, the meters were disassembled and carefully examined for particulates, deposits, lime scale, and wear. Any particulates captured or lodged in the meter were photographed, removed, and weighed. Any heavily worn components of the meters were also photographed, and notes describing any peculiar findings during disassembly were taken. This data was recorded so that applicable trends and conclusions regarding meter wear could be made.

An objective and unbiased investigation of each pulled meter was necessary to aid in the understanding of meter performance versus life. To facilitate an objective inspection, a data sheet was prepared that was used to rate the various components of each pulled meter. The inspection categories of interest included; measurable accumulations of scale, metering chamber deposits, condition of interior gaskets, captured strainer and interior body debris, bearing conditions, metering chamber and device condition, and magnet condition. Each of these meter components was inspected and numerically rated from 0 to 3 with 0 being new or near new and 3 being very heavy wear or failure. Although the ratings were subjective, the intent of this process was to document correlations between certain wear patterns and meter accuracy.

PHASE III: PARTICULATE TESTING

Although potable water has limits on its turbidity, suspended solids are occasionally found in distribution systems after lines are flushed, after fire flows, following pipe segment

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replacements, or when corrosion or scale breaks off from the pipe wall and enters the flow stream. In some cases, wells may produce sand or sediment that is pumped directly into the distribution system (NHDES 1998). Particles may also come from the source water, the treatment plant, or household plumbing (Booth 2005). Particulates can become lodged in the flow meter, often causing the meter to fail or to lose accuracy. Furthermore, turbidity and other larger particles may result in excessive meter wear that effectively shortens the life of the meter. The intent was to prepare a test program that would simulate in a laboratory setting, some of the possible scenarios described above and the associated impact particulates have on meter accuracy.

The test program included testing the same 75 meters that were tested during Phase II in sets of three), but the second series of tests would include the introduction of particulates into the water so that they traveled through the meter being tested. By repeating tests on the same meter set that was tested in Phase II and Phase III/Component 1, additional data for each of those meters became available in both new and aged conditions. Since the project team received a significantly larger number of 5/8-inch sized meters compared to 3/4-inch for the pulled meter testing, it was apparent that the 5/8-inch size meters would be most appropriate to use for the Phase III/Component 3 particulate tests.

It was originally proposed that each set of meters would be tested with one of four different particulates commonly found in the municipal systems. However, after disassembling 175 meters during Phase III/Component 2 testing (pulled meter tests), only 37 had any measureable particulates inside the body of the meter, and of the 37 only four of the meters contained particles other than sand or small rocks. To provide maximum effectiveness for the project, it was determined that the use of one particulate (quartzite sand) would represent the majority of particulate problems and allow the research team to place greater focus on test variables rather than the particulate type itself. Additionally, quartzite sand is common and could be used by any lab to repeat these tests if necessary. It would be difficult, for instance, to use tuberculation particulates as a particulate type for the project since tuberculation is often different depending on factors like pipe material and water quality.

During the particulate portion of the study, it was anticipated that the following questions could be answered:

- How is meter accuracy affected by particulates?
- Does accuracy improve over time (after damage has occurred to the meter as a result of the particulate introduction) as clean water runs through the meter?
- Do meters “heal” from internal chamber scarring?
- What meter types are most/least sensitive to particulates?
- How does meter chamber scarring affect accuracy?

Preliminary Testing

Preliminary tests were performed in test bench #4 to establish appropriate types, amounts, and rates of particulates to be injected upstream of utility flow meters in order to better understand the effect of particulates on meter accuracy. These preliminary tests were performed in preparation for the Phase III/Component 3 particulate tests. Two different types of sand were used in these preliminary qualitative tests. The first was course quartzite sand and the second was

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much finer sand. A complete sieve analysis for the quartzite sand is shown in Table 2.10 and for the fine sand in Table 2.11.

Table 2.10
Sieve analysis for the course quartzite sand used in the preliminary testing

Sieve number	Opening size (mm)	Soil retained (g)	%finer
16	1.180	0.181	99.93%
20	0.850	3.916	98.34%
30	0.600	12.052	93.47%
40	0.425	55.409	71.05%
50	0.300	77.914	39.53%
60	0.250	34.697	25.49%
80	0.180	33.192	12.07%
100	0.150	13.464	6.62%
140	0.106	10.503	2.37%
200	0.075	4.537	0.53%
< 200	< 0.075	1.321	0.00%

Table 2.11
Sieve analysis for the fine sand used in the preliminary testing

Sieve number	Opening size (mm)	Soil retained (g)	%finer
30	0.600	2.139	99.08%
40	0.425	4.490	97.14%
50	0.300	18.015	89.36%
60	0.250	31.690	75.68%
80	0.180	67.442	46.56%
100	0.150	47.762	25.94%
140	0.106	38.789	9.20%
200	0.075	12.466	3.82%
< 200	< 0.075	8.840	0.00%

Fifty-gram samples of each kind of sand were introduced into the test bench with no meter in-line to find what flow rate would be needed to wash the sand through the line with no sand settling at the bottom of the pipe. A bag filter was installed at the end of the line to catch all of the sand that came through. The difference from the initial 50 g and what was caught in the bag filter was determined to be in the pipeline. Different flow rates were tested, and a minimum flow rate of 10 gpm was found to be necessary to wash all of the sand through the line. Three different meter types were then used for the preliminary testing. These included a multi-jet, a piston, and a nutating disc. Sand particles were introduced at varying volumes into the pipe line upstream of the meter starting at 10 grams and moving up in 10 gram increments up to 40 gram

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loadings. Four individual meters of each of the three different types of meters were tested at each increment sample size.

The 12 preliminary test meters were then taken apart and examined to determine how much sand was captured inside of the meter and what damage had occurred (if any). An examination of all of the meters revealed that the nutating disc meter mechanisms were deeply scarred. Similarly, the piston meters were scratched, but they did not have deep grooves like the nutating disc. On the other hand, the multi-jet meters showed no scarring or damage to any mechanical parts. Figure 2.22 shows a sample of the damage that was done to one of the nutating disc meters after 10 grams of sand was introduced.

Figure 2.22 Sand particle damage to nutating disc meter

Figure 2.23 illustrates the damage to a piston type meter after 20 grams of sand was introduced. Since the damage to the nutating disc type meters was most obvious to see, they were solely used during subsequent preliminary testing. Because ten grams of sand caused more damage than expected to the meters, smaller sample sizes of 2.5 grams, 5 grams, and 7.5 grams were then attempted.

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Figure 2.23 Sand particle damage to piston meter

These preliminary tests were performed using only nutating disc meters to determine the extent of damage occurring with smaller amounts of sand. It was found that the damage caused by the sand particles was very similar in all of the slug sample sizes between 2.5 and 10 grams, although it is expected that more sand would mean more chances for sand to damage or stall the meter. Therefore, it was decided that a 2.5-gram sample would be used for subsequent particulate testing during this study, since a 2.5-gram sample would have a greater probability of getting into a meter than the large introduction samples.

For reference, a 2.5-gram sample of sand is approximately twice the amount a person can pinch between their thumb and forefinger. There was no noticeable difference in scarring patterns to the meters between the two sand types. It was also decided that the coarser quartzite sand would be used for subsequent testing because it had been washed, and it appeared to be closer to the sand particles that were found inside the pulled meters during the time of the preliminary testing.

During preliminary testing, the rate that the sand sample was introduced upstream of the meter was also varied, and it was determined that smaller introduction rates generally equated to less damage to the meter. This was surmised to occur because a slug of sand is less easily washed through the meter than extremely small amounts over time. Since the sand would be introduced upstream of over 70 individual meters, it was determined that the 2.5-gram sample

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should be introduced at a fairly rapid but repeatable rate because the faster rate is much easier than a very slow and deliberate rate to repeat consistently over and over again.

Also, since the primary objective of this portion of the study was to show how meter accuracy might be affected when meter mechanisms become damaged by particulates, the method and the rate at which the particles enter the meter were determined to be secondary issues. In other words, how the sand gets into the meter was deemed to be less important than what the sand does to the meter once it finds its way into the metering chamber.

Test Procedures

The following is the procedure that was used for injecting and passing the particulates through the meters during the Phase III/Component 3 testing as determined during the preliminary testing:

1. Each particulate meter was first tested in its new condition at each of the four AWWA flow rates and two repeat accuracy tests for three tests total at each flow rate. These initial tests were necessary to determine an accuracy baseline, so that changes in meter accuracy after the meter was subjected to particulates could be determined.
2. The subject meter was installed into the particulate injection bench for testing (see Figure 2.16**)**
3. The flow rate was set to 10 gpm using a magnetic flow meter (with pipe end level with meter). The furthest upstream valve (valve #1) was used as an isolation valve (either on or off). Valve #2 was used to set the proper flow rate.
4. After the flow rate was set by adjusting the position of the valve #2, valve #1 was turned off.
5. The downstream end of the pipe was elevated slightly so that the entire pipe and meter remained full of water when no water was flowing.
6. The vertical tee, as illustrated in Figure 2.16, was used to introduce 2.5 grams of sand (with pipe end elevated). The valve on the tee was opened and the 2.5 grams of sand was placed into the riser of the tee. A funnel was used to ensure that the entire sample of sand made it into the pipe. After the sand was injected into the pipe, the funnel and interior of the tee were rinsed with a cup of water, and the valve on the tee was closed.
7. Valve #1 was then slowly opened over a 3 second interval (from closed to open). At the same time, the end of the pipe was lowered so that it was level with the meter.
8. After running water for five minutes at 10gpm, the flow rate was increased to 15gpm to help remove any loose sand from the meter. The meter was flushed at 15gpm for approximately 5 minutes.
9. After the sand slug had been introduced into each of the meters as described above, each meter was again accuracy tested at the same four AWWA calibration flows as they were before the particulates were introduced. The meters were accuracy tested at 25%, 50%, 75%, and 100% of their expected life of 2 million gallons. This type of testing was performed to determine if the meter accuracy recovers after the slug of sand had been put through it or if the accuracy worsened.
10. Following the endurance testing phase, each of the meters was disassembled as originally proposed to look at scarring patterns. The procedure for disassembly was

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similar to that done for Phase III/Component 2 (pulled meter testing). This portion of the phase was to determine if meter scarring and wear correlate with meter accuracy.

Data Collection

As previously mentioned, each particulate meter was tested in its new condition before the particulate was introduced. To be sure of the condition of the new meter and to avoid false conclusions caused by the particulates, each meter was initially tested three times, and an average of the three tests was used as the new meter accuracy.

Even though the same set of 5/8x3/4-inch meters were used for the particulate testing as were used in the new meter testing, only the minimum, intermediate, and maximum AWWA flow rates were tested for the particulate meters. Since there was a different intermediate flow rate for the displacement meters than for the multi-jet meters, four flow rates were tested for each meter. These flow rates can be seen in Table 2.12.

Table 2.12
AWWA test flow rates for 5/8x3/4-inch meters

Minimum	Intermediate 1	Intermediate 2	Maximum
1/4 gpm	1 gpm	2 gpm	15 gpm

Source: Data from AWWA M6 manual

Similarly to the other tests performed during this project, the researchers collected the meter data by hand. An initial reading was taken after the meters were flushed to insure that no air was trapped in the line. After the flow was started through the meters, the temperature was recorded. After at least ten gallons of water went through the meter (ten gallons is the amount needed for 5/8x3/4-inch meters for testing), the water was stopped and the weight of water was recorded, and then the final meter readings were recorded. Immediately following the data collection for each test, the data were entered into a computer and evaluated to find obvious typing or reading errors. When errors were found, the final readings on the meters were re-read.

After the initial testing, the particulate was injected as described earlier. The meters were then installed into an endurance bench where they were tested to full life. After each 500,000 gallons of throughput, the meters were tested as they were initially tested at the four AWWA flow rates shown in Table 2.12. This continued until the final testing occurred after 2,000,000 gallons of throughput.

Meter Disassembly and Analysis

After the meters had been tested at full life, they were then disassembled. The disassembly of the particulate meters followed the procedures of the pulled meters.

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PROJECT LIMITATIONS

Meter Sample Size

For this project, a sample size of six identical meters was used for the 5/8 x 3/4-inch, 3/4-inch, and 1-inch sizes. A larger sample size was desired, however, it was not economically feasible for this project to test larger sample sizes. While six identical meters would typically not be a sufficiently large statistical sample, the results from these tests clearly provide valuable and significant information. For the 1 1/2-inch and 2-inch meters, only one meter of each kind was tested. The authors recognize that a single meter sample is insufficient to draw any solid statistical conclusions; however, the authors believe that the information presented for those meters is still of some benefit to the reader, and was therefore included in the project results.

Meter Donations

Some utilities who originally agreed to participate in this project did not donate any pulled meters, even though the utilities were contacted continually and consistently to solicit donations. For the utilities that did participate, the degree of participation varied. Some utilities did not pull meters during the winter, and sometimes they were too busy to follow the pull procedure during the summer months. Also, several utilities either changed management or, because of economic struggles, had to be more frugal in replacing existing meters after agreeing to participate. Another obvious limitation was that not all of the same meter offerings tested during the new and endurance portions of the study were represented within the pulled meters. As a matter of fact, meters from a few manufacturers that are no longer in business were donated.

Meter Service Times

Most of the participating utilities were able to provide the project team with all of the needed data on each meter, such as installation dates and pulled dates, which were necessary to find the service time; however, there were some that did not.

The research team had no control over the precision of the data that was provided by the participating utilities. It was apparent that some utilities had more accurate records than others and could therefore give precise installation and pull dates. The research team was required to utilize only the information that was provided to them even though a specific list of information was requested for each meter.

Utility Consistency

The research team did not know and could not control the consistency of sample collection between each of the participating utilities. For instance, although pull procedures were sent asking the utilities to follow a specific procedure, it was up to the utilities to follow them.

Another inconsistency between utilities was water quality. Although two identical meters may have been in service for the same period of time, if one utility had sand in their system

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while another utility had pristine water, it would be hard to relate the effects of time on the meter.

Each utility also had different meter replacement programs. Since the meters had been in service for a variety of times and had various throughputs, some meters still functioned very well, while others did not.

Water Quality

While the laboratory tests had a very tight control on parameters such as water quality, the water quality for the pulled meters was not quantified. Without a clear understanding of the particulate loading and chemical composition of field flows, only generalized correlations were possible for the pulled meters. Having said this, the research team still believes that the pulled meter data is informative and valuable to the overall outcome of the study since the data indicates the "operational" accuracy of meters in the U.S. A large number of the pulled meters that were tested did not meet AWWA registry requirements.

Particulate Testing

Only one particulate type and size of particulate was tested during this project. It is understood that each utility may have different types and different amounts of particulates in their system, so the particulate meter test results may not show exactly what each utility would experience. Quartzite sand was selected because it is commonly found throughout the United States and is readily available if repeated testing or continued laboratory tested is desired.

The sample size for the particulate tests was also limited. Even with the relatively small sample size (meters), the research team determined that the test results effectively show problem areas and highlight concerns with particulates.

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CHAPTER 3 – RESULTS AND DISCUSSION

PHASE I: LITERATURE REVIEW

The significant findings of the Phase I, Literature Review portion of the study are contained in subsequent paragraphs.

Previous Papers and Research

Many public water utilities have testing programs where meter accuracy is tested before and/or after the meter is placed in service. This meter data is very valuable to each individual utility. These testing programs, along with meter accuracy data collected from the meter manufacturer usually involve flow rates consistent with the AWWA standard, but these data are not published. In fact, few studies on water meter accuracy have been published. Examples of these published studies are discussed in the following paragraphs.

AWWARF Study (1991)

Noteworthy is an in-depth study of residential water meter accuracy published by the AWWA Research Foundation (AWWARF, currently known as Water Research Foundation) in 1991 (AWWARF 1991). The Evaluating Residential Water Meter Performance study included information on residential water meter accuracy and head loss. The study included the testing of two hundred 5/8 x 3/4-inch displacement type meters (both nutating disc, and oscillating piston). Valuable information on head loss and accuracy were determined from this research. For instance, it was noted in the study that a larger number of nutating disc meters registered closer to 100 percent for flow rates of 1/2 gpm and below; however, a greater percentage of the oscillating piston meters registered the same or closer to 100 percent accuracy for flow rates greater than 1/2 gpm (AWWARF, 1991).

Connecticut Study

A more recent report was prepared by Brian Lakin, P.E., for the South Central Connecticut Regional Water Authority called Report on Low and Ultra Low Flow Meter Accuracy of Various Types of Residential Meters (2003). This preliminary study also included meter accuracy tests, specifically at flows 1/4 gpm and lower, which is the Minimum Flow Accuracy Standard flow rate set by the AWWA for 5/8-inch meters (Lakin, 2003). In this research, twelve different 5/8-inch meters were tested (two each of six different models). The models that were tested represented two different brands of nutating disc type meters, two different brands of oscillating piston type meters, one fluidic oscillator type, and one single-jet type meter. This preliminary work showed a need for an even more detailed study.

AWWA Standards

Current standards for water meters have been in place for many years, but in recent years many new manufacturers and new flow measurement technologies have joined the marketplace.

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This suggests a need for additional in-service water meter performance data. Revisions should occur periodically, focusing on new technologies and studies as they become available, such as the recent 2005 addition of the fluidic oscillator meter standard (C713) or the in-progress update for the 2002 single-jet standard (C712).

Although the meter testing results from this study were compared to existing AWWA standards, it is important to note historical changes within the standards. By analyzing the trends of these historical standards, it was possible to develop an appropriate testing program for this project to help in preparing the way for future standards.

The first meter standard, published in 1921, was titled "Standard Specifications for Cold Water Meters: Disc Type." Two years later, additions were made to attach assessments for current, compound, and fire-service type meters. Twenty-five years later, the standard received its first update. A second standard, developed for turbine type meters was published in 1947, followed by a third standard in 1949 for propeller meters. A standard for multi-jet meters was published in 1976, for plastic-bodied displacement meters in 1988, for single-jet meters in 2002 (as previously mentioned), and for fluidic oscillators in 2005. Today, meter standards are published for seven meter technologies (nine if the remote access standards are included). The historical meter standard data is presented in Table 3.1 through Table 3.7). Each of these seven meter standards is compared over its revision history. Of interest in each comparison are the flow and registry figures.

Each standard has been catalogued and compared to its predecessor. The comparisons are made for the five project meter sizes in the following tables. Each table is divided by revision and is labeled with the standard number and year of the revision. For example C700-02 indicates the standard number (C700) and the year of the revision (-02). At the time of this study, only those standards which existed were used for flow rate determination therefore some of the flow rates tested are different from AWWA standards published since 2006.

Positive Displacement, Bronze Casing (C700)

The C700 standard has been revised seven times from its original publication in 1921. Of concern, the changes (highlighted yellow), shown in Table 3.1, were made between the revisions:

Table 3.1
C700 revision summary

Meter size (in)	Minimum test flow (gpm)	Normal test flow limits (gpm)	Registration accuracy at < 80°F: Normal flow rate Max (%)	Normal flow rate Min (%)	Min flow rate Max (%)	Min flow rate Min (%)
		C700-02*				
5/8 x 3/4	0.25	1-20	101.5	98.5	101	95
3/4	0.5	2-30	101.5	98.5	101	95
1	0.75	3-50	101.5	98.5	101	95
1 1/2	1.5	5-100	101.5	98.5	101	95
2	2	8-160	101.5	98.5	101	95

(continued)

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Table 3.1 (Continued)

Meter size (in)	Minimum test flow (gpm)	Normal test flow limits (gpm)	Registration accuracy at < 80°F At normal flow rate Max (%)	At normal flow rate Min (%)	At min flow rate Max (%)	At min flow rate Min (%)
			C700-95			
5/8 x 3/4	0.25	1-20	101.5	98.5	101	95
3/4	0.5	2-30	101.5	98.5	101	95
1	0.75	3-50	101.5	98.5	101	95
1 1/2	1.5	5-100	101.5	98.5	101	95
2	2	8-160	101.5	98.5	101	95
			C700-90			
5/8 x 3/4	0.25	1-20	101.5	98.5	101	95
3/4	0.5	2-30	101.5	98.5	101	95
1	0.75	3-50	101.5	98.5	101	95
1 1/2	1.5	5-100	101.5	98.5	101	95
2	2	8-160	101.5	98.5	101	95
			C700-77			
5/8 x 3/4	0.25	1-20	101.5	98.5	101	95
3/4	0.5	2-30	101.5	98.5	101	95
1	0.75	3-50	101.5	98.5	101	95
1 1/2	1.5	5-100	101.5	98.5	101	95
2	2	8-160	101.5	98.5	101	95
			C700-46			
5/8	0.25	1-20	101.5	98.5		95
3/4	0.5	2-30	101.5	98.5		95
1	0.75	3-50	101.5	98.5		95
1 1/2	1.5	5-100	101.5	98.5		95
2	2	8-160	101.5	98.5		95
			C700-21			
5/8	0.25	1-20	102	98		90
3/4	0.5	2-34	102	98		90
1	0.75	3-53	102	98		90
1 1/2	1.5	5-100	102	98		90
2	2	8-160	102	98		90

Source: Data from AWWA C700-02, C700-95, C700-90, C700-77, C700-46, C700-21
*Only current standard listed in References

Missing from Table 3.1 because they were not located during the project's literature review, are revisions dated 1964 and 1971. The largest changes occur between the 1921 and 1946 updates where the registration accuracy was raised. The 5/8 x 3/4-inch standard was added in the 1964 or 1971 edition, and the maximum registry for the minimum flow rate was increased in the 1977 edition.

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Turbine (C701)

The C701 standard has been updated four times from its 1947 publication date. Changes between standards are documented in Table 3.2. Changes from one standard to the next are highlighted yellow.

Table 3.2
C701 revision summary

Type	Meter size (in)	Normal test flow limits (gpm)	Minimum test flow (gpm)	Registration accuracy at < 80°F: At normal flow rate Max (%)	At normal flow rate Min (%)	At min flow (%)
			C701-07*			
	3/4	1.5-30		102	98	
CLASS I	1	2-50		102	98	
Vertical shaft	1 1/2	3-100		102	98	
	2	4-160		102	98	
Horizontal shaft	2	16-120				
CLASS II	1 1/2	4-120		101.5	98.5	
	2	4-190		101.5	98.5	
			C701-02			
CLASS I						
Vertical shaft	3/4	1.5-30		102	98	
	1	2-50		102	98	
	1 1/2	3-100		102	98	
CLASS II	2	4-160		102	98	
Horizontal shaft	2	1-120				
			C701-88			
CLASS I	1 1/2	12-80		102	98	
	2	16-120		102	98	
CLASS II	2	4-160		101.5	98.5	
			C701-47			
CLASS I	1 1/2	12-100	7	103	97	95
	2	16-160	10	103	97	95

Source: Data from AWWA C701-07, C701-02, C701-88, C701-47
*Only current standard listed in References

Revisions for 1970 and 1978 are missing from Table 3.2. In one of these two revisions, the 'Class II' turbine (high-velocity type) meter was added. The 2002 update added standards for the 3/4- and 1-inch sizes for Class I, a standard for 2-inch Class I Horizontal-Shaft meters, and a standard for 1-1/2-inch Class II meters. Registration accuracy and test flow limits were also updated for the 1-1/2 - and 2-inch Class I meters in either 1970 or 1978.

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Propeller (C704)

The propeller meter standard was introduced in 1949 and has been revised five times. Table 3.3 summarizes flow and registration changes over three of these standards.

Table 3.3
C704 revision summary

Meter size (in)	Normal test flow limits (gpm)	Minimum test flow (gpm)	Registration accuracy at < 100°F At normal flow rate Max (%)	Min (%)	At min flow (%)
		C704-02*			
2	35-100		102	98	
		C704-92			
2	35-100		102	98	
		C704-70			
2	35-100	30	102	98	95
		C704-49			
2	15-80		102	98	

*Data from AWWA C704-02, C704-92, C704-70, C704-49
*Only current standard listed in References

Accuracy requirements at minimum test flows were added with the 1970 update. Normal test flow limits were raised this same year. One of the missing revisions (1975 or 1984) removed the minimum test flow rates and accuracy and raised the temperature from 80 to 100 degrees Fahrenheit.

Multi-Jet (C708))

The multi-jet standard was originally approved in 1976 and has received four revisions since. The highlighted values in Table 3.4 show the changes that have occurred between these revisions.

Table 3.4
C708 revision summary

Meter size (in)	Minimum test flow (gpm)	Normal test flow limits (gpm)	Registration accuracy at < 80°F At normal flow rate Max (%)	Min (%)	At min flow Max (%)	Min (%)
		C-708-05*				
5/8	0.25	1-20	101.5	98.5	103	97
5/8 x 3/4	0.25	1-20	101.5	98.5	103	97
3/4	0.5	2-30	101.5	98.5	103	97
1	0.75	3-50	101.5	98.5	103	97

(continued)

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Table 3.4 (Continued)

Meter size (in)	Minimum test flow (gpm)	Normal test flow limits (gpm)	Registration accuracy at < 80°F At normal flow rate Max (%)	At normal flow rate Min (%)	At min flow Max (%)	At min flow Min (%)
1 1/2	1.5	5-100	101.5	98.5	103	97
2	2	8-160	101.5	98.5	103	97
		C-708-96				
5/8	0.25	1-20	101.5	98.5	103	97
5/8 x 3/4	0.25	1-20	101.5	98.5	103	97
3/4	0.5	2-30	101.5	98.5	103	97
1	0.75	3-50	101.5	98.5	103	97
1 1/2	1.5	5-100	101.5	98.5	103	97
2	2	8-160	101.5	98.5	103	97
		C-708-91				
5/8	0.25	1-20	101.5	98.5	103	97
5/8 x 3/4	0.25	1-20	101.5	98.5	103	97
3/4	0.5	2-30	101.5	98.5	103	97
1	0.75	3-50	101.5	98.5	103	97
1 1/2	1.5	5-100	101.5	98.5	103	97
2	2	8-130	101.5	98.5	103	97
		C-708-82				
5/8	0.25	1-20	101.5	98.5	103	97
5/8 x 3/4	0.25	1-20	101.5	98.5	103	97
3/4	0.5	2-30	101.5	98.5	103	97
1	0.75	3-50	101.5	98.5	103	97
1 1/2	1.5	5-100	101.5	98.5	103	97
2	2	8-160	101.5	98.5	103	97
		C-708-76				
5/8	0.25	1-20	101.5	98.5	103	97
5/8 x 3/4	0.25	1-20	101.5	98.5	103	97
3/4	0.5	2-30	101.5	98.5	103	97
1	0.75	3-50	101.5	98.5	103	97
1 1/2	1.5	5-90	101.5	98.5	103	97
2	2	8-130	101.5	98.5	103	97

Source: Data from AWWA C708-05, C708-96, C708-91, C708-82, C708-76
*Only current standard listed in References

Relatively few changes have occurred in the multi-jet standard. In the 1982 revision, the normal test flow limits were raised for the 1-1/2- and 2-inch sizes. In 1991, the 2-inch normal test flow limit was reduced before it was again raised in 1996.

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Positive Displacement, Plastic Casing (C710)

The C710 standard is a branch of the C700. It was first published in 1988 and has been revised three times. As shown in Table 3.5, no changes have occurred over the tested sizes.

Table 3.5
C710 revision summary

Meter size (in)	Minimum test flow (gpm)	Normal test flow limits (gpm)	Registration accuracy at < 80°F At normal flow rate Max (%)	At normal flow rate Min (%)	At min flow Max (%)	At min flow Min (%)
		C710-02*				
5/8	0.25	1-20	101.5	98.5	101	95
5/8 x 3/4	0.25	1-20	101.5	98.5	101	95
3/4	0.5	2-30	101.5	98.5	101	95
1	0.75	3-50	101.5	98.5	101	95
		C710-95				
5/8	0.25	1-20	101.5	98.5	101	95
5/8 x 3/4	0.25	1-20	101.5	98.5	101	95
3/4	0.5	2-30	101.5	98.5	101	95
1	0.75	3-50	101.5	98.5	101	95
		C710-90				
5/8	0.25	1-20	101.5	98.5	101	95
5/8 x 3/4	0.25	1-20	101.5	98.5	101	95
3/4	0.5	2-30	101.5	98.5	101	95
1	0.75	3-50	101.5	98.5	101	95
		C710-88				
5/8	0.25	1-20	101.5	98.5	101	95
5/8 x 3/4	0.25	1-20	101.5	98.5	101	95
3/4	0.5	2-30	101.5	98.5	101	95
1	0.75	3-50	101.5	98.5	101	95

Source: Data from AWWA C710-02, C710-95, C710-90, C710-88
*Only current standard listed in References

In 1990, standards were set for 1/2-inch and 1/2 x 3/4-inch sizes. As neither of these sizes was tested in this study they have been omitted from the table.

Single-Jet (C712)

The single-jet standard was introduced in 2002. It was revised in June 2010, which was near the end of this project. Table 3.6 summarizes the registration accuracy and normal test flow limits for this meter. It should be noted that at the time of testing there were no standards for meter sizes smaller than the 1 1/2-inch size.

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Table 3.6
C712 revision summary

Meter size (in)	Normal test flow limits (gpm)	Minimum Test flow (gpm)	Registration accuracy at < 80°F At normal flow rate Max (%)	At normal flow rate Min (%)	At min flow Max (%)	At min flow Min (%)
			C712-10*			
5/8	1.0-20	0.25	101.5	98.5	101.5	95
5/8 X 3/4	1.0-20	0.25	101.5	98.5	101.5	95
3/4	2.0-30	0.5	101.5	98.5	101.5	95
1	3.0-50	0.75	101.5	98.5	101.5	95
1 1/2	1.5-100	0.5	101.5	98.5	101.5	95
2	2.0-160	0.5	101.5	98.5	101.5	95
			C712-02			
1 1/2	1.5-100		101.5	98.5	101.5	95
2	2.0-160		101.5	98.5	101.5	95

Source: Data from AWWA C712-10, C712-02
*Only current standard listed in References

Fluidic Oscillator (C713)

The first publication of the C713 standard was in 2005, shown in Table 3.7. Like the single-jet standard, it has not been revised since it was developed.

Table 3.7
C713 revision summary

Meter size (in)	Normal test flow limits (gpm)	Minimum test flow (gpm)	Registration accuracy at < 80°F At normal flow rate Max (%)	At normal flow rate Min (%)	At min flow Max (%)	At min flow Min (%)
			C713-05			
1/2	1-15	0.25	101.5	98.5	101	95
5/8	1-20	0.25	101.5	98.5	101	95
5/8 x 3/4	1-20	0.25	101.5	98.5	101	95
3/4	2-30	0.5	101.5	98.5	101	95
1	3-50	0.75	101.5	98.5	101	95
1 1/2	5-100	1.5	101.5	98.5	101	95
2	8-160	2	101.5	98.5	101	95

Source: Data from AWWA C713-05

Summary of AWWA Standards

Accuracy data for this research was compared to the most current AWWA Standards. Table 3.8 shows a summary of the upper and lower registration boundaries for the minimum flow rates of the meter sizes included in this study. Table 3.9 shows a summary for the normal

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flow rates for all the sizes. Most values given in Tables 3.8 and 3.9 are referenced from "Water Meters-Selection, Installation, Testing, and Maintenance: M6", published by the AWWA (1999). For values that were not found in the M6 manual, the individual Cold-Water Meter AWWA Standard was referenced (AWWA 2002a, AWWA 2002b, AWWA 2005a, AWWA 2005b, and AWWA 2007). As indicated in the tables with an asterisk (*), there are some values given that were determined by the authors that are not published in any AWWA standard; however, the authors believe the values are representative. It should be noted that there is no lower flow rate in Table 3.9 for the turbine and propeller meters. This is because there is no intermediate flow rate given in the standards and the lower normal flow rate is given as the minimum flow rate in Table 3.8.

Table 3.8
AWWA accuracy standards for minimum flow rates

	Flow rate where standard applies (gpm)					Accuracy range (%)	
Type	5/8" x 3/4"	3/4"	1"	1 1/2"	2"	Lower	Upper
DP	0.25	0.5	0.75	1.5	2	95	101
ND	0.25	0.5	0.75	1.5	2	95	101
FO	0.25	0.5	N/A	N/A	N/A	95	101
T1	N/A	1	1.5	12	16	98	102
T2	N/A	N/A	N/A	4	4	98.5	101.5
PR	N/A	N/A	N/A	N/A	35	98	102
SJ	0.25	0.5	0.75	0.5	0.5	95	101.5
MJ	0.25	0.5	0.75	1.5	2	97	103

Source: Adapted from AWWA 1999, AWWA 2002b, AWWA 2005b

Table 3.9
AWWA accuracy standards for normal flow rates

	Flow rate where standard applies (gpm)					Accuracy range (%)	
Type	5/8" x 3/4"	3/4"	1"	1 1/2"	2"	Lower	Upper
DP	2-15	3-25	4-40	8-50	15-100	98.5	101.5
ND	2-15	3-25	4-40	8-50	15-100	98.5	101.5
FO	2*-15*	3*-20*	N/A	N/A	N/A	98.5	101.5
T1	N/A	30	50	100	160	98	102
T2	N/A	N/A	N/A	120	160	98.5	101.5
PR	N/A	N/A	N/A	N/A	100	98	102
SJ	1-20	2-30	3-50	1.5-100	2-160	98.5	101.5
MJ	1-15	2-25	3-35	5-70	8-100	98.5	101.5

Source: Adapted from AWWA 1999, AWWA 2002b, AWWA 2005b
*Not published by AWWA

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Identification of Existing Meter Types and Specifications

By performing a comprehensive literature review of meter manufacturer's brochures, datasheets, specifications, and websites, those meter types that are available, that are currently in use, and that comply to the AWWA standards have been thoroughly documented. These meter types include positive displacement (both nutating disc and oscillating piston types), multi-jet, single-jet, rotor, propeller, turbine, fluidic oscillator, and electromagnetic. Several other meter types have been documented but were not selected for this project, either because they did not comply with AWWA standards or they are not widely used.

During the literature review, upon encountering unknown manufacturers or unclear specifications, phone calls were made to verify the manufacturer's compliance to AWWA standards and to confirm understanding about the product. It was found that a number of meters currently in use were manufactured by companies that have been bought by another manufacturer, that have sold their meter designs to another company, or that cease to exist. The history of various manufacturers that resulted from company buyouts and mergers was also documented to provide limited information about meters that were manufactured under new names or are no longer in production. In some cases, meters were found that are still in use, but they are no longer manufactured. Information compiled during the literature review has been printed and organized by manufacturer.

PHASE II/III: NEW METER AND LABORATORY ENDURANCE TESTS

Presenting the quantity of data collected during the course of this study in such a manner that it is relatively easy to understand is challenging at best. For this component of testing, three hundred and seventy-five (375) different new meters were tested over several different flow rates to establish the performance of each meter size and type. The authors carefully considered the most effective presentation of data and concluded that a graphical presentation would be more easily understood and interpreted than providing tabular flow data for each meter; however, the tabular data are included in Appendix A. The figures that follow show the average of all meters and data points for individual meters. For the 5/8x3/4-inch, 3/4- inch, and 1-inch meters, six identical meters of each design were tested. The 1 1/2-inch and 2-inch meters, a single type of each design was tested.

5/8x3/4-inch Meters

Figures 3.1 through 3.30 show the results for the 5/8x3/4-inch meters tested in the new condition and their registry at various levels of throughput.

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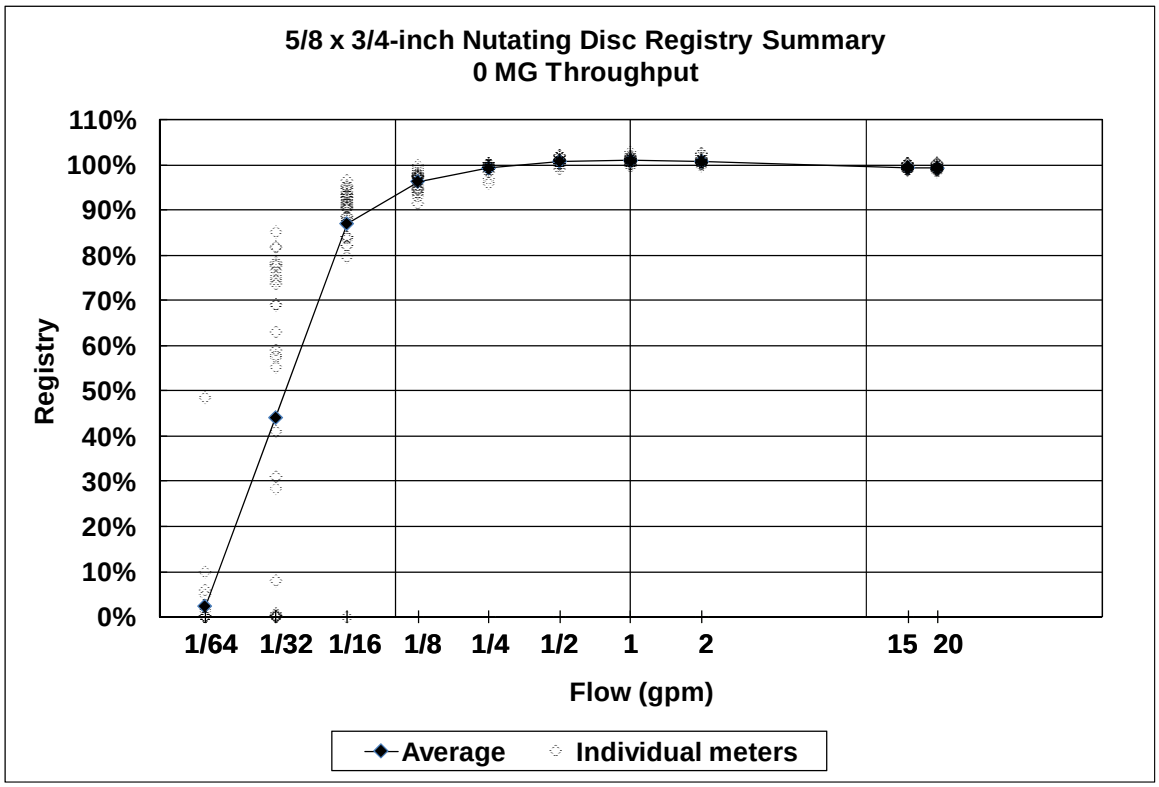

Figure 3.1 5/8x3/4–inch nutating disc 0 MG throughput

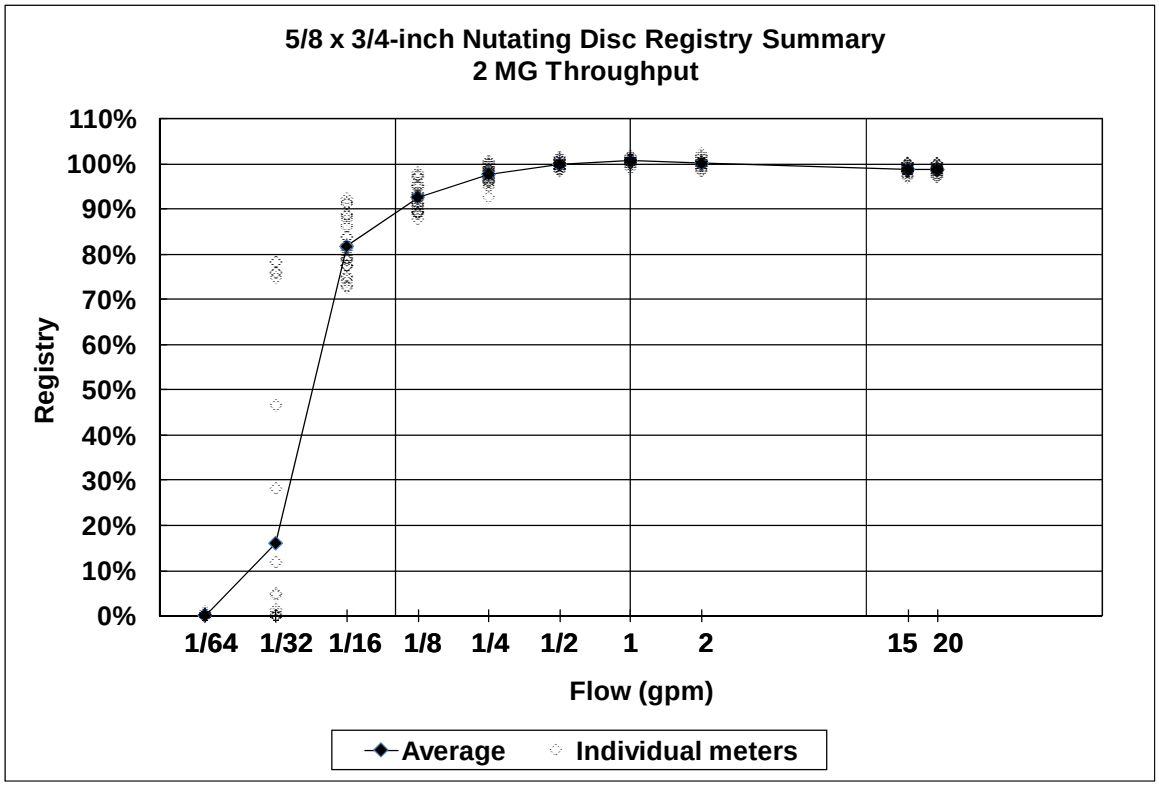

Figure 3.2 5/8x3/4-inch nutating disc 2 MG throughput

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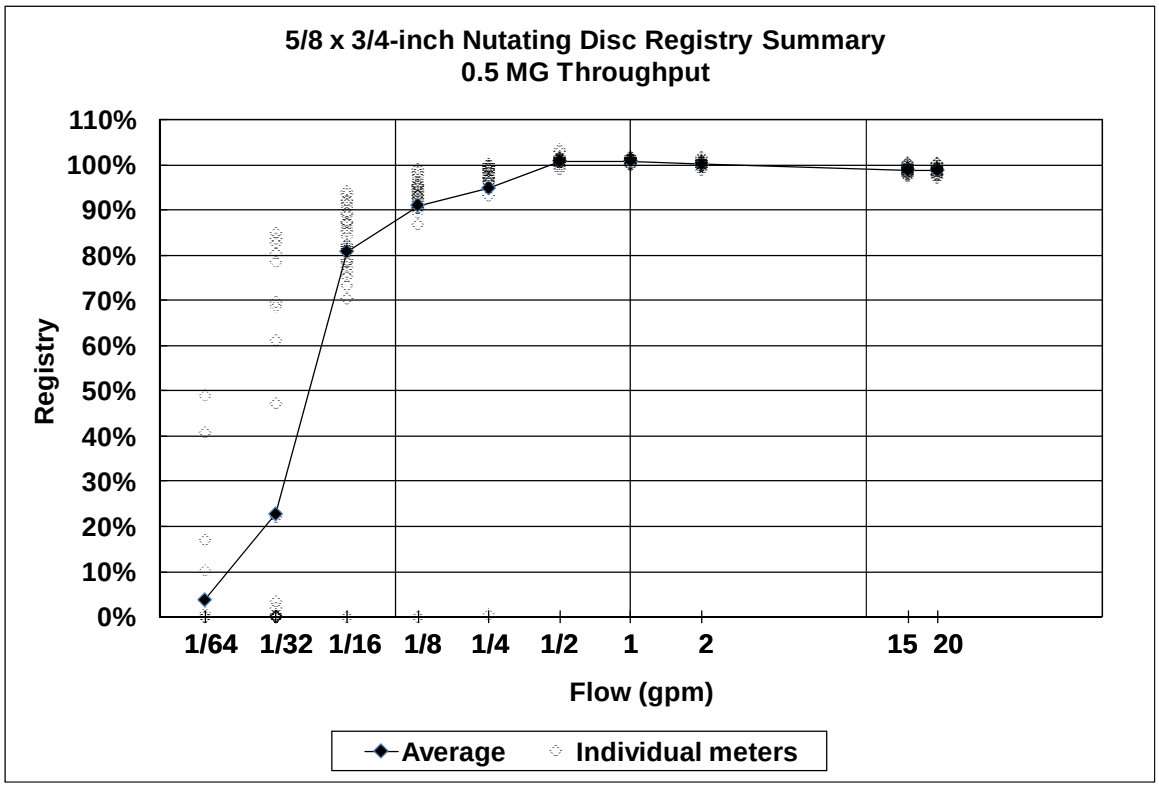

Figure 3.3 5/8x3/4–inch nutating disc 0.5 MG throughput

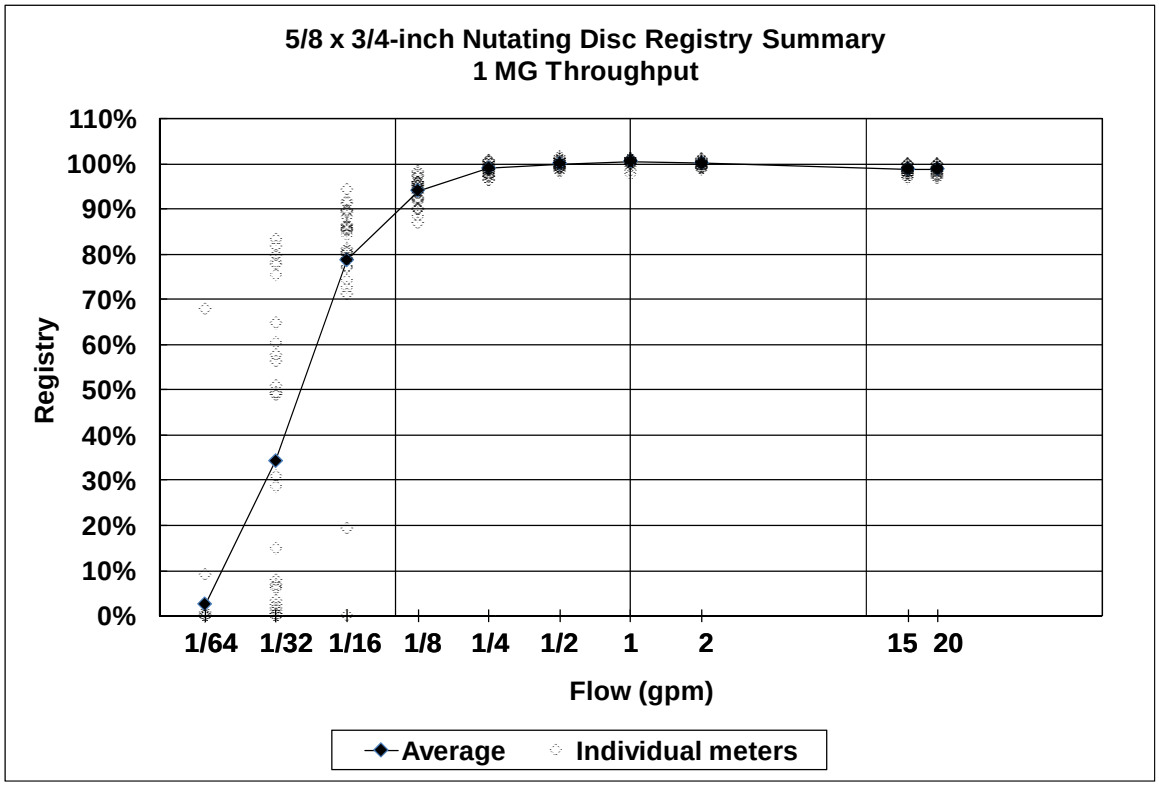

Figure 3.4 5/8x3/4–inch nutating disc 1 MG throughput

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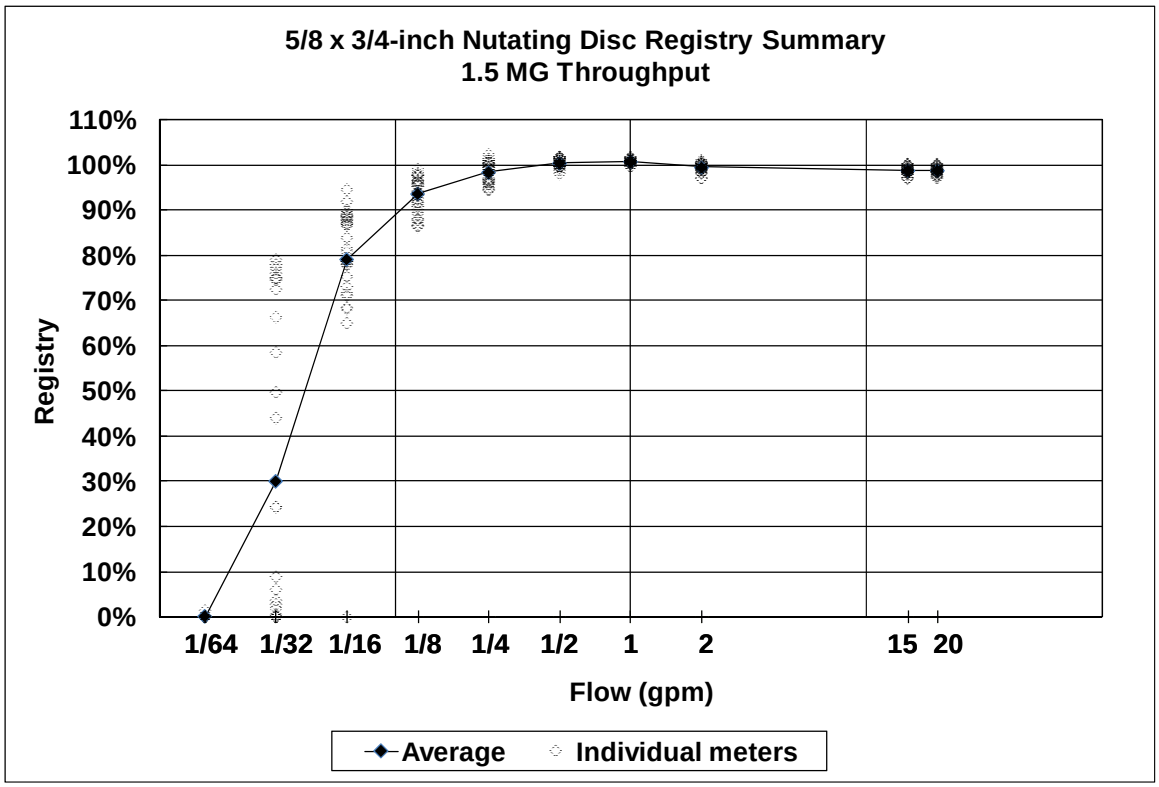

Figure 3.5 5/8x3/4–inch nutating disc 1.5 MG throughput

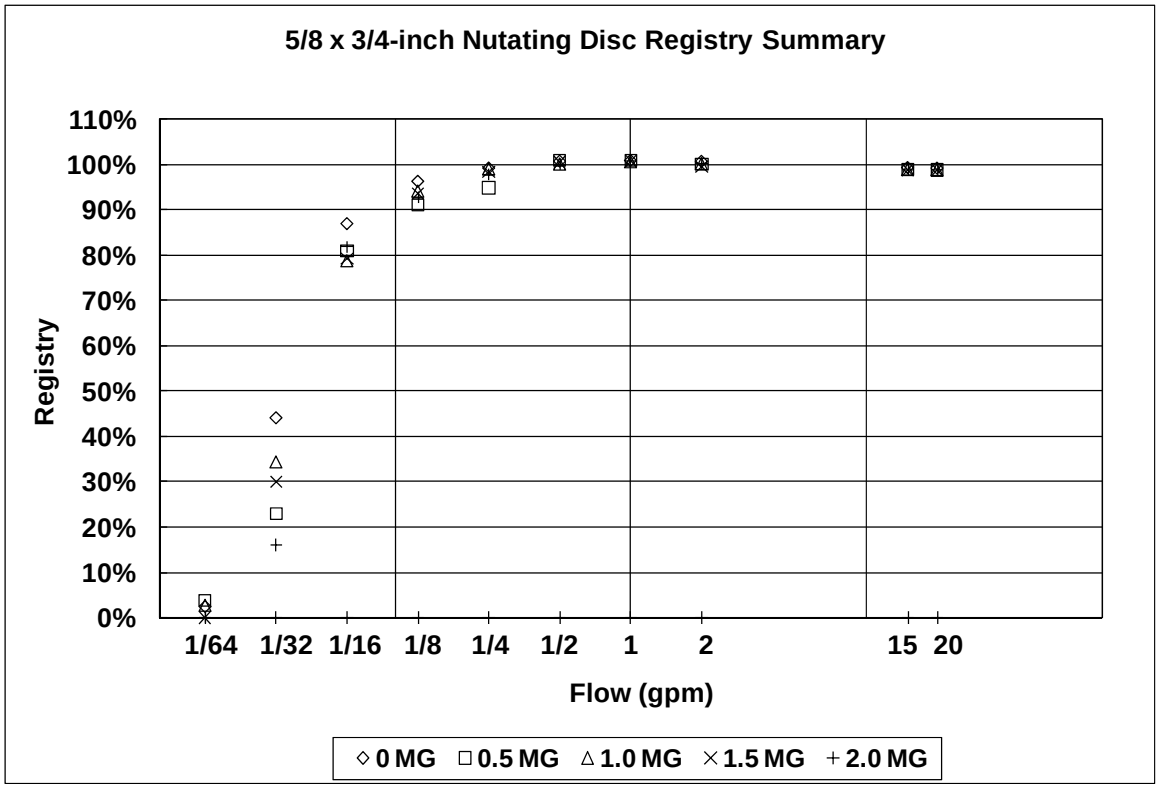

Figure 3.6 5/8x3/4-inch nutating disc registry summary

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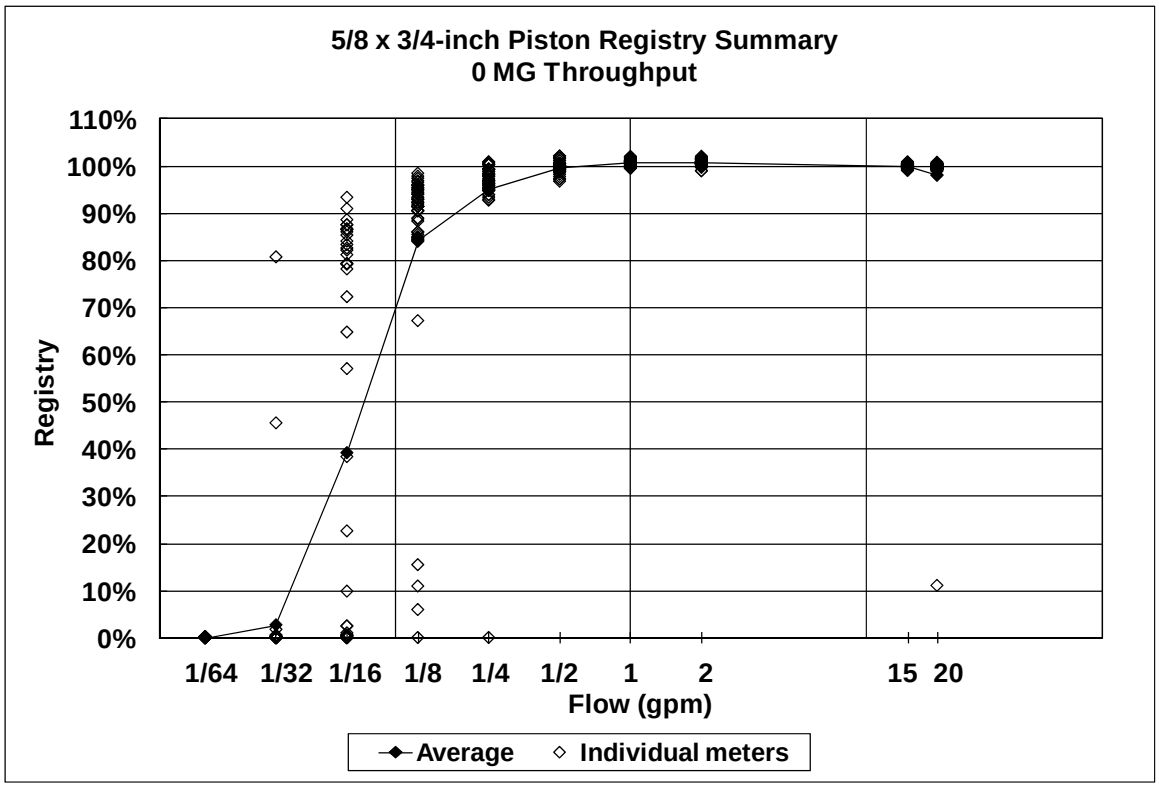

Figure 3.7 5/8x3/4-inch piston 0 MG throughput

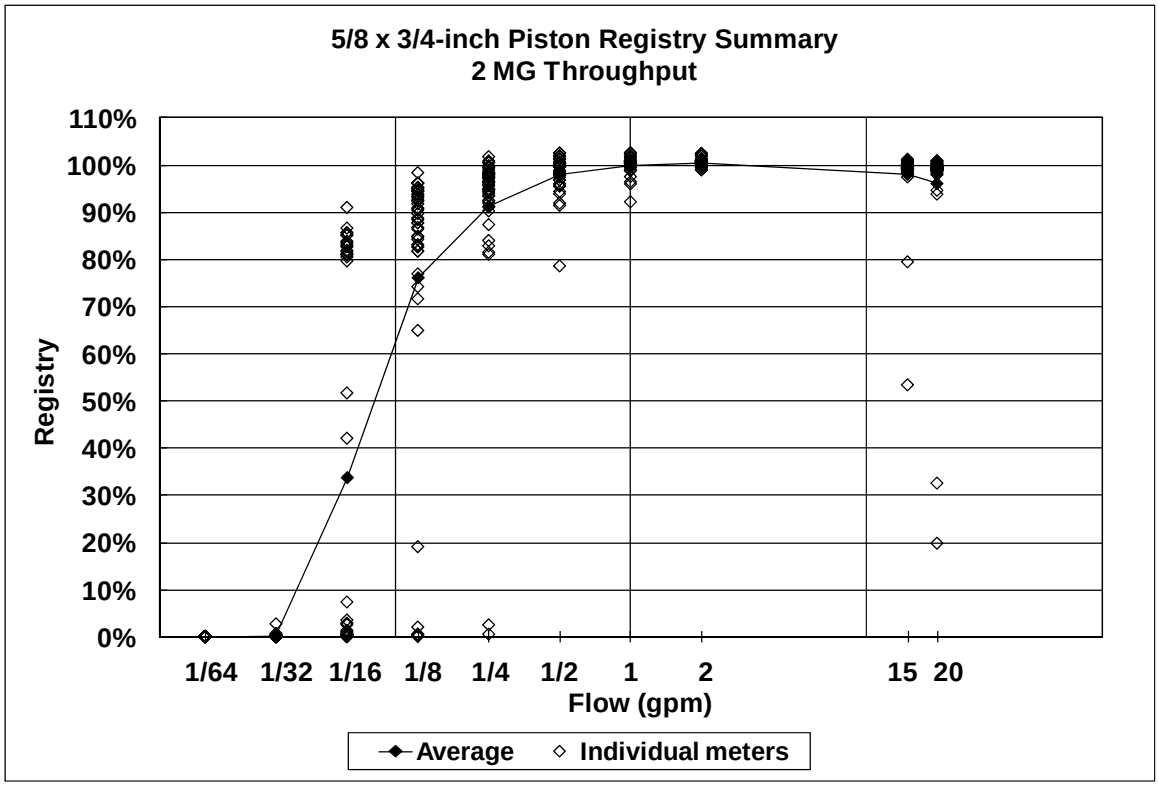

Figure 3.8 5/8x3/4-inch piston 2 MG throughput

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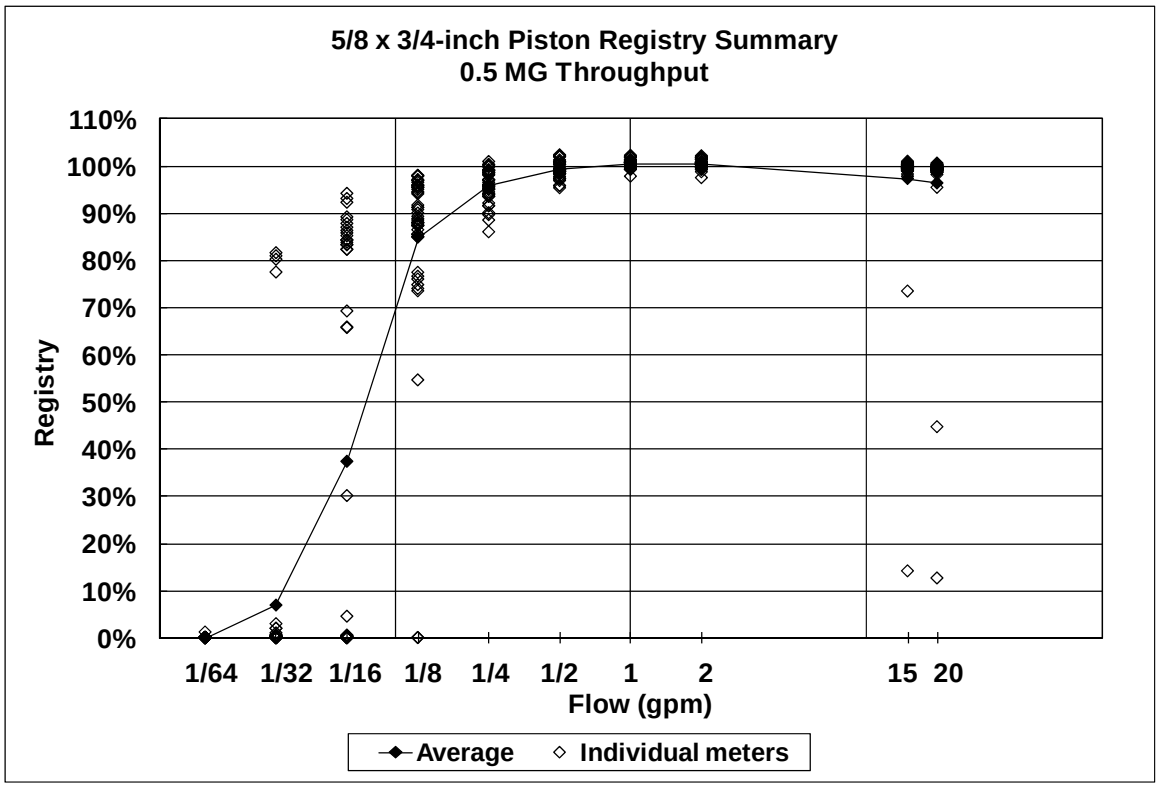

Figure 3.9 5/8x3/4-inch piston 0.5 MG throughput

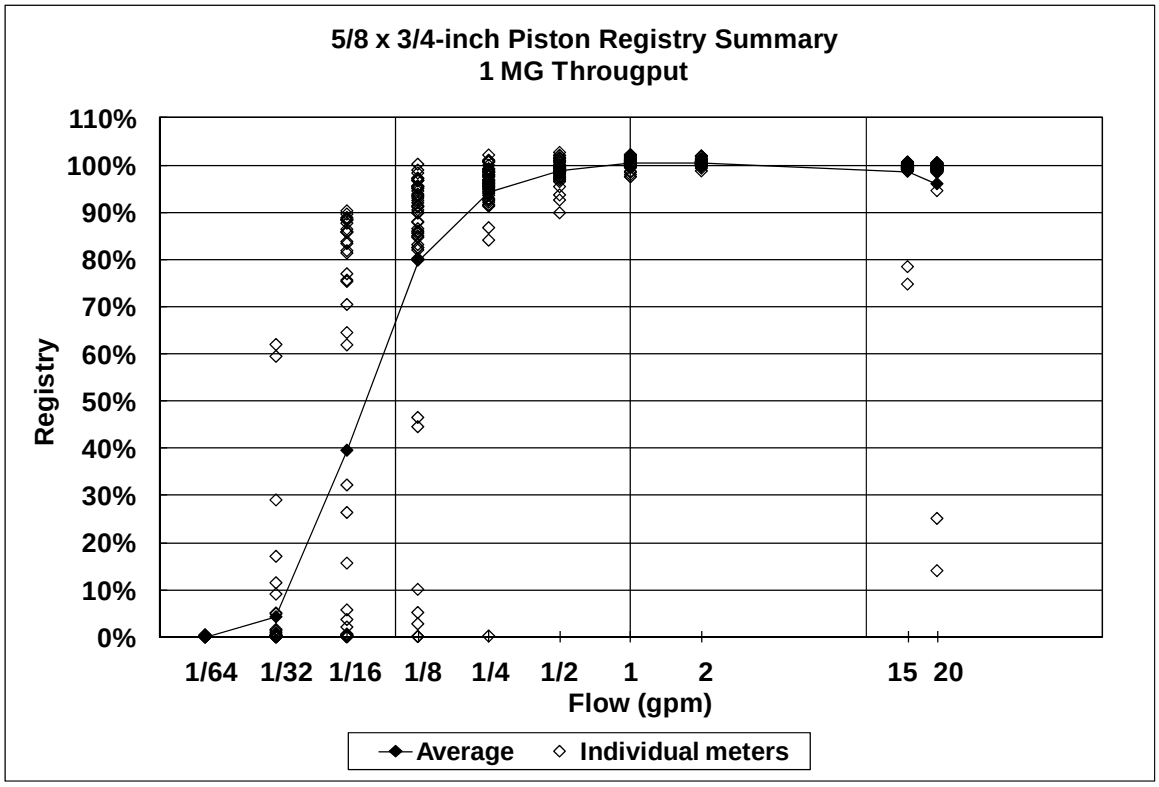

Figure 3.10 5/8x3/4-inch piston 1 MG throughput

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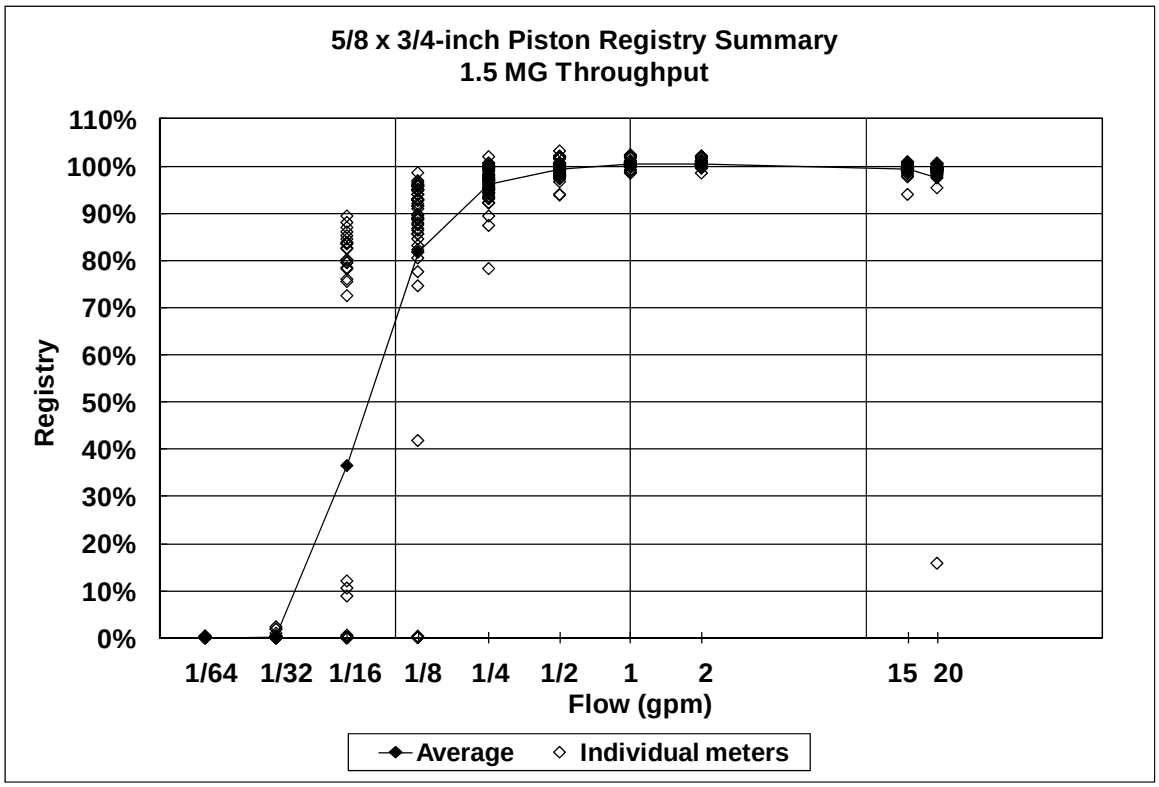

Figure 3.11 5/8x3/4-inch piston 1.5 MG throughput

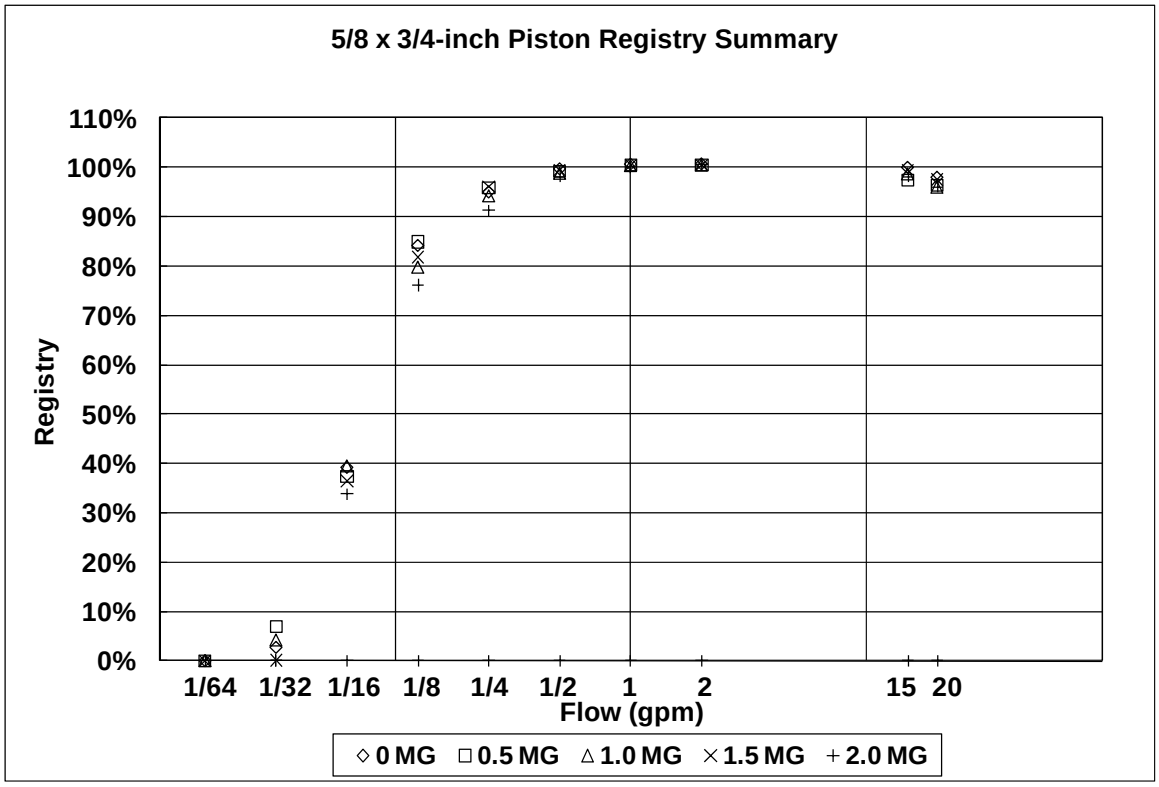

Figure 3.12 5/8x3/4-inch piston registry summary

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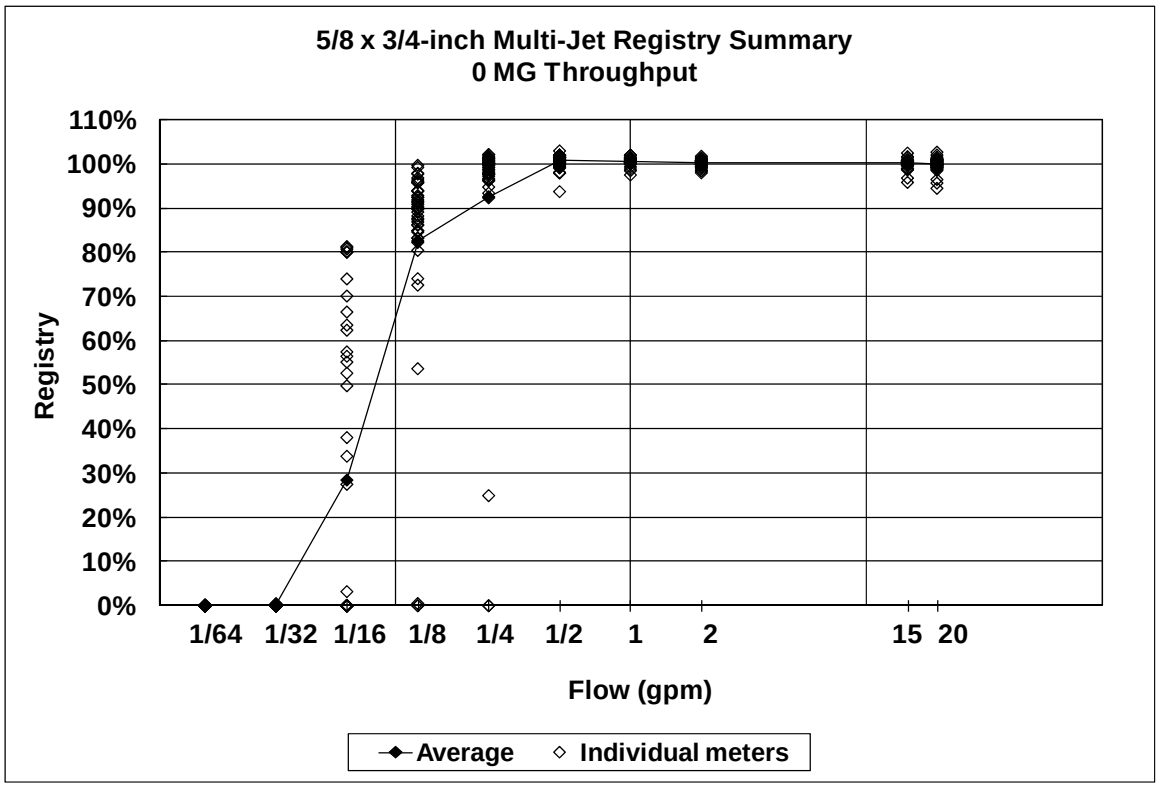

Figure 3.13 5/8x3/4-inch multi-jet 0 MG throughput

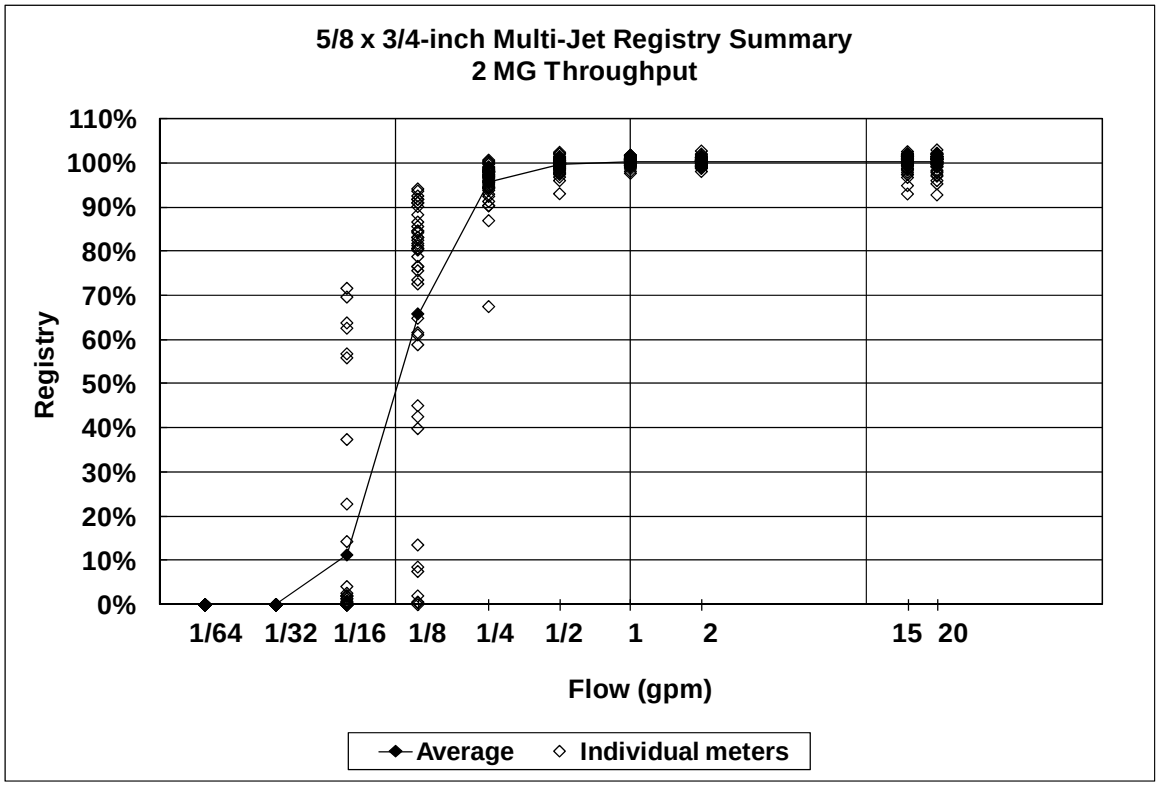

Figure 3.14 5/8x3/4-inch multi-jet 2 MG throughput

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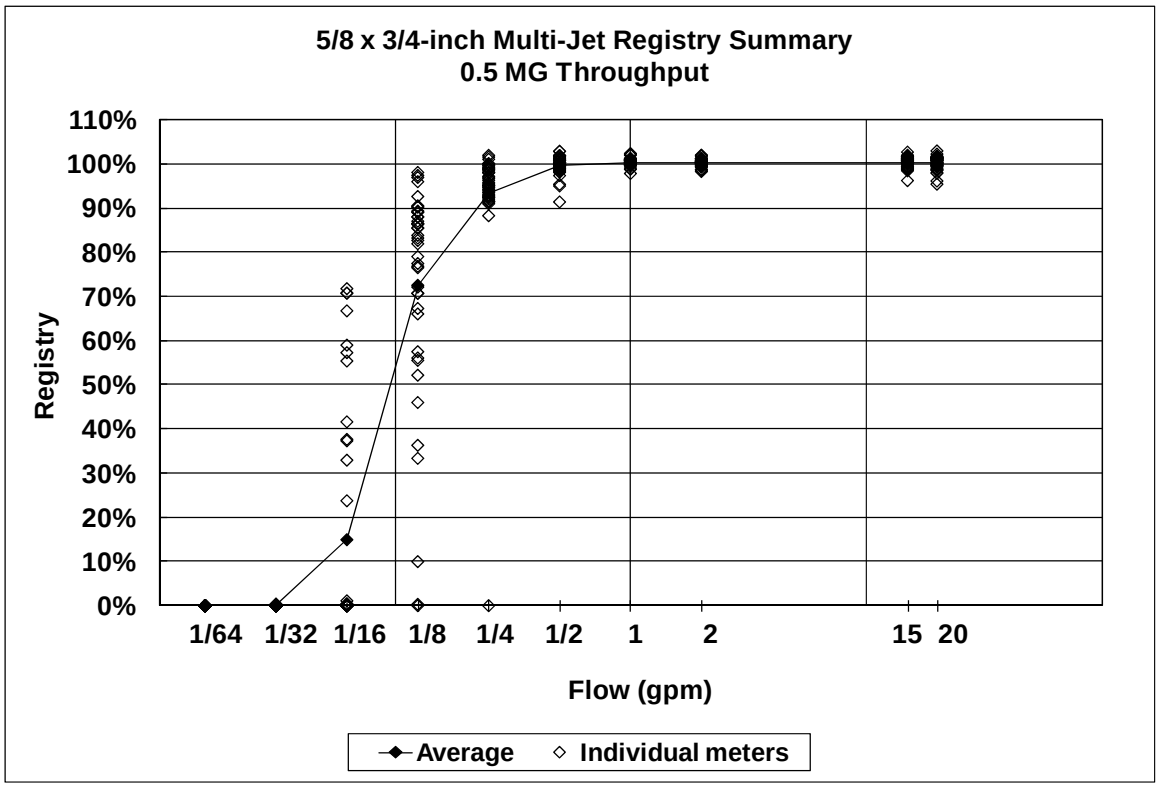

Figure 3.15 5/8x3/4-inch multi-jet 0.5 MG throughput

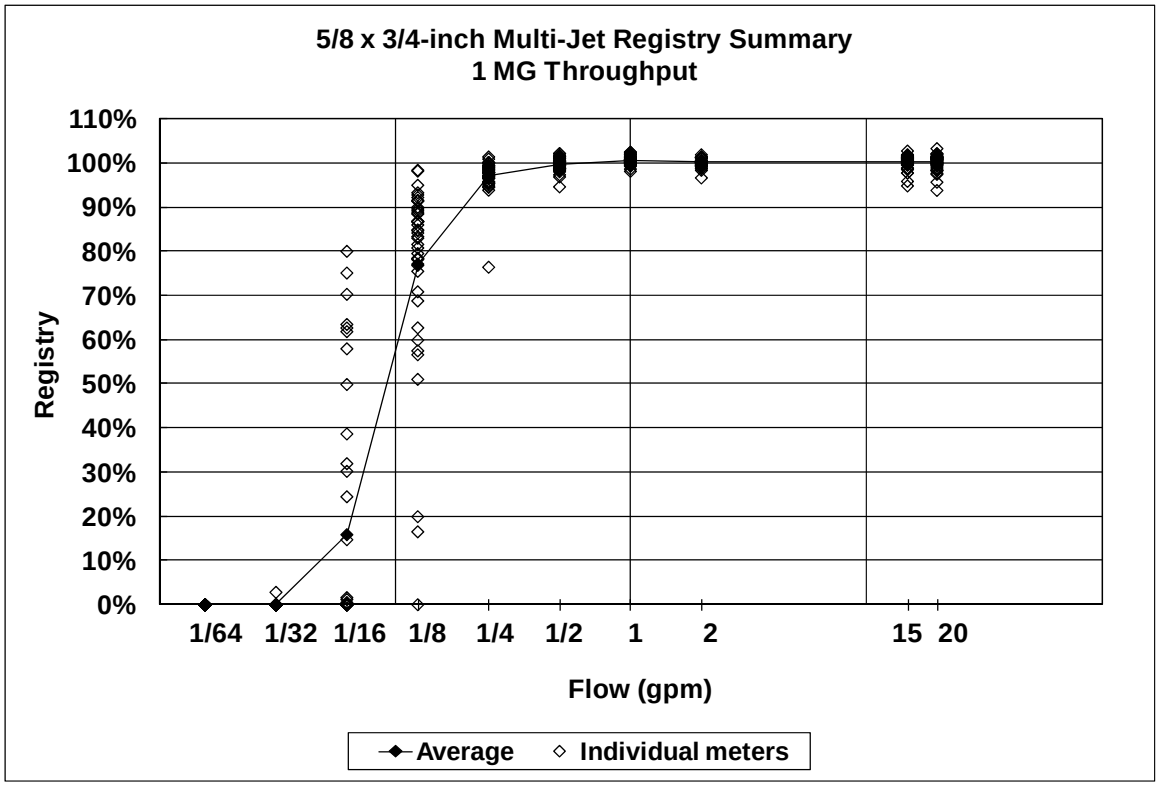

Figure 3.16 5/8x3/4-inch multi-jet 1 MG throughput

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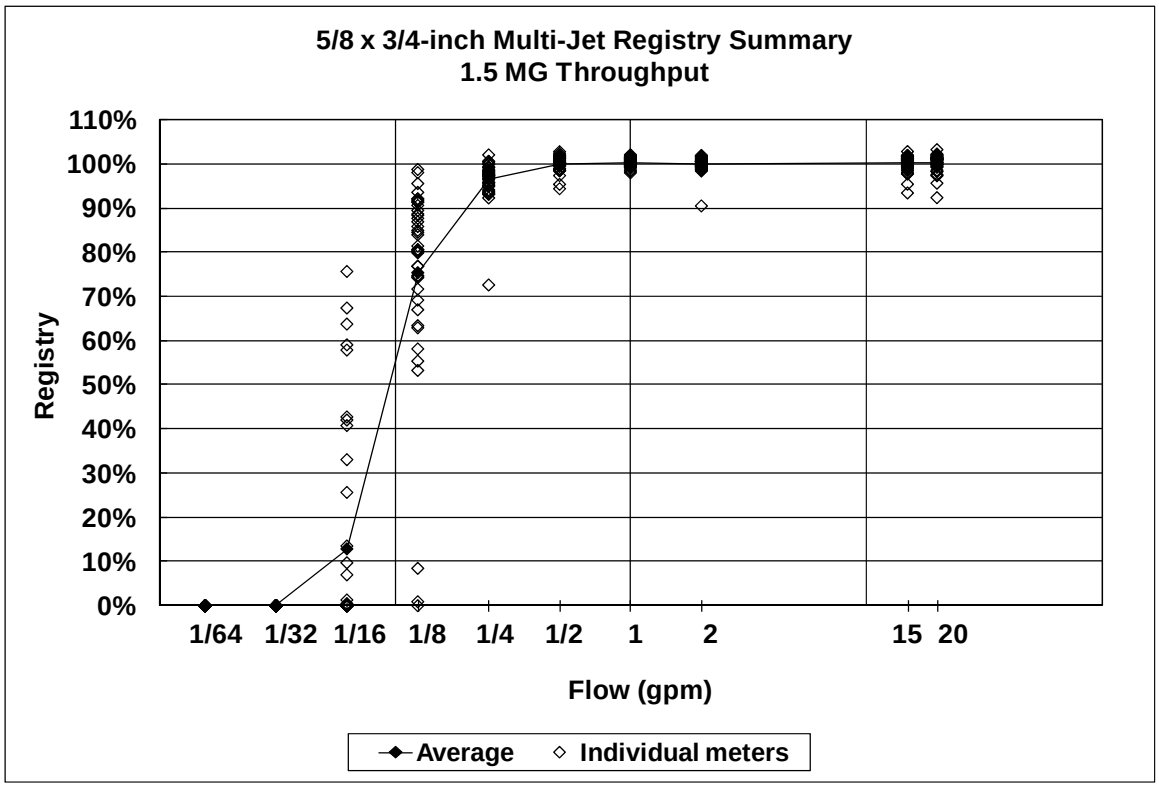

Figure 3.17 5/8x3/4-inch multi-jet 1.5 MG throughput

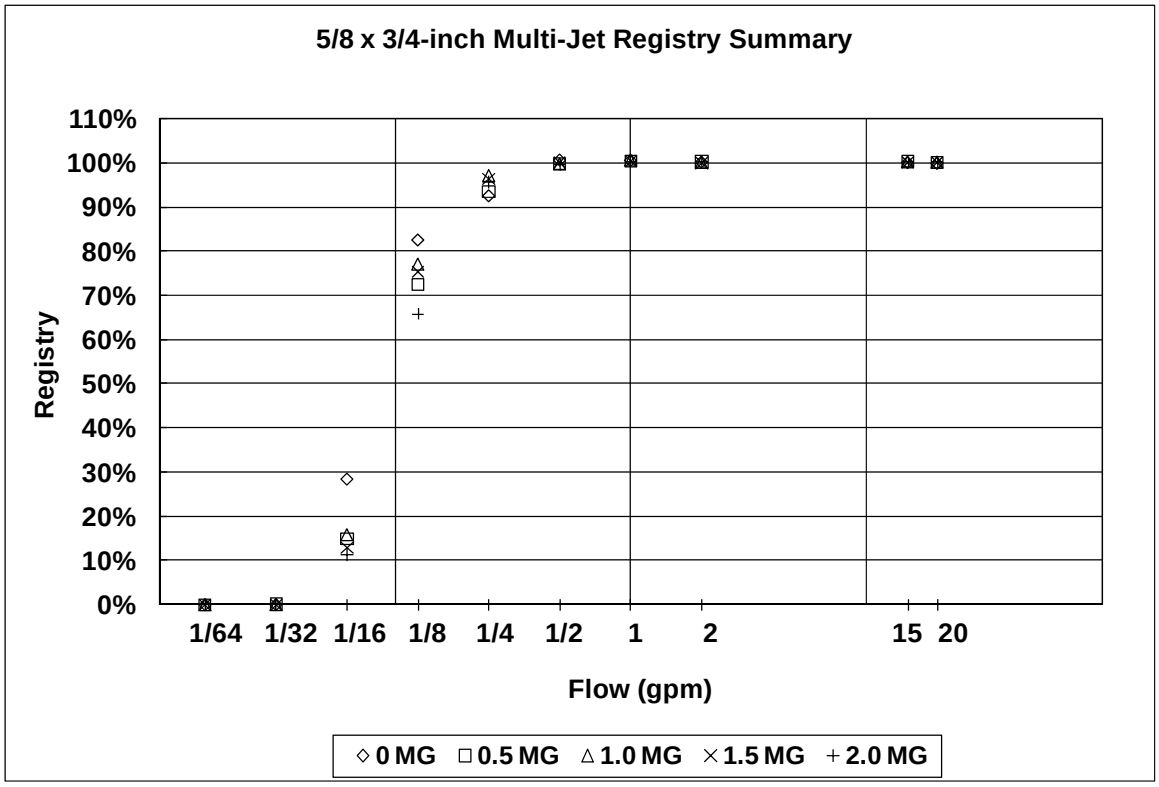

Figure 3.18 5/8x3/4-inch multi-jet registry summary

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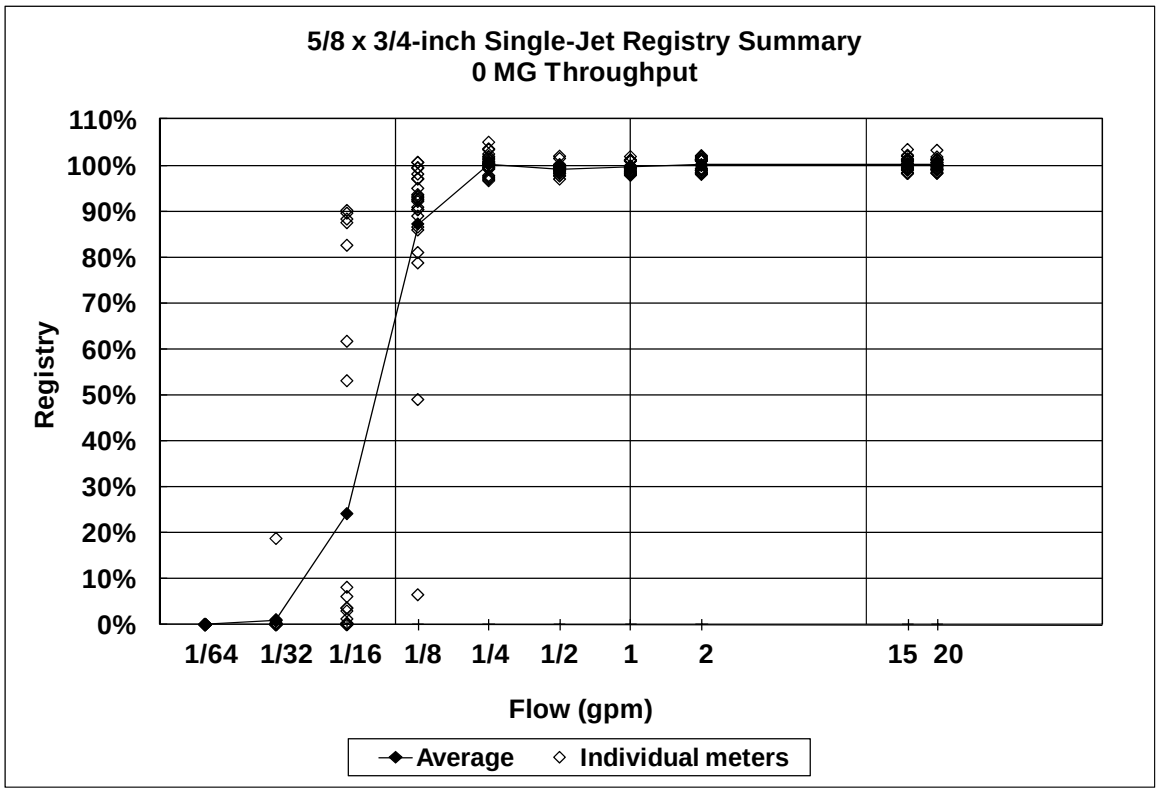

Figure 3.19 5/8x3/4-inch single-jet 0 MG throughput

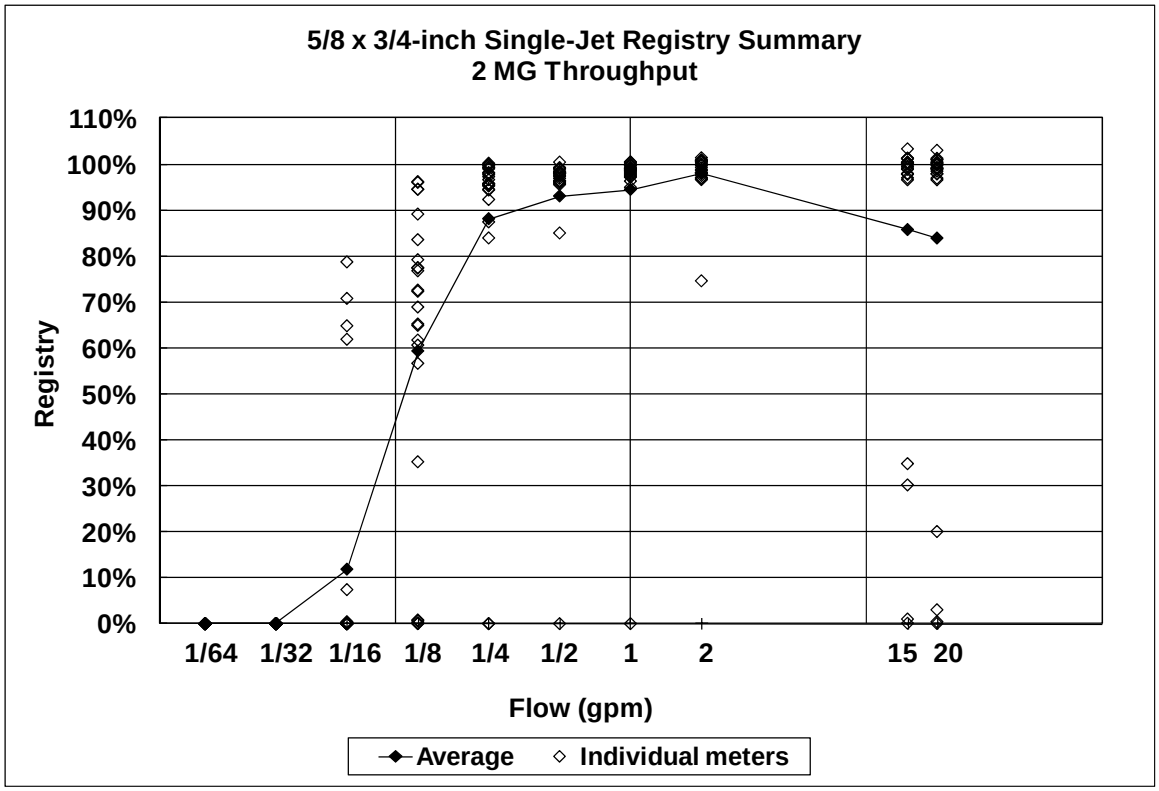

Figure 3.20 5/8x3/4-inch single-jet 2 MG throughput

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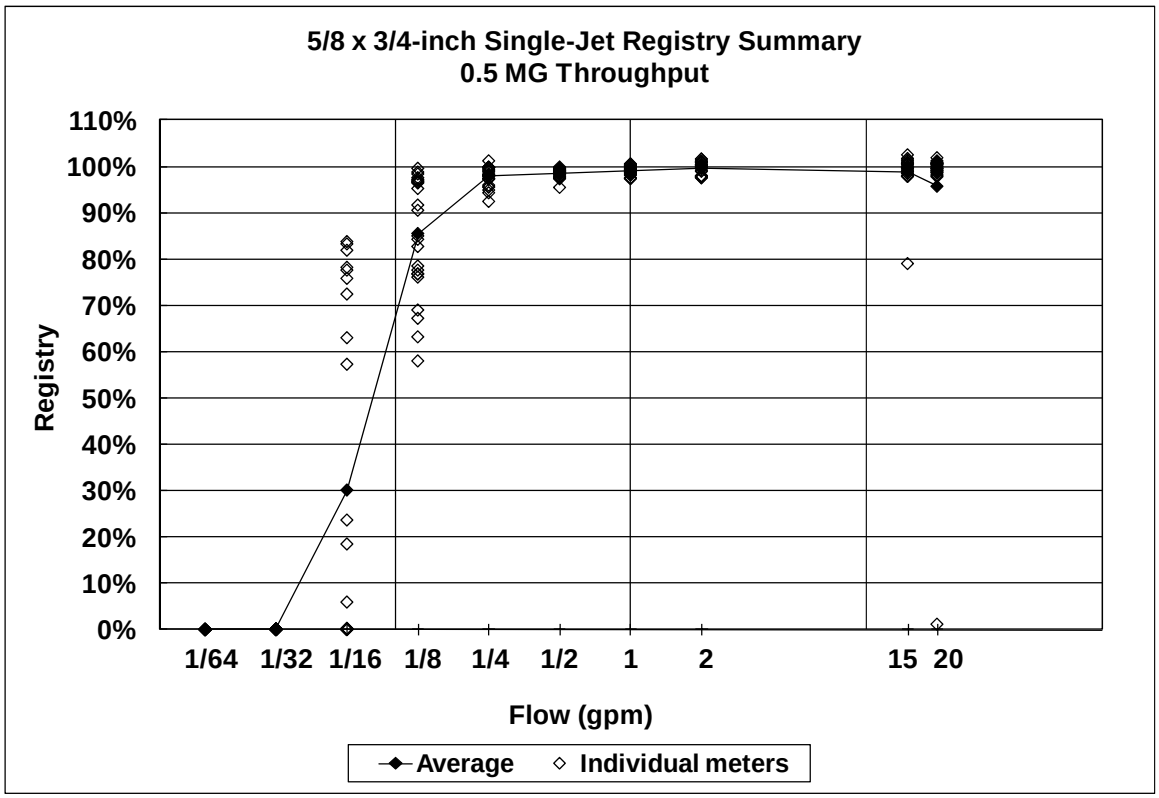

Figure 3.21 5/8x3/4-inch single-jet 0.5 MG throughput

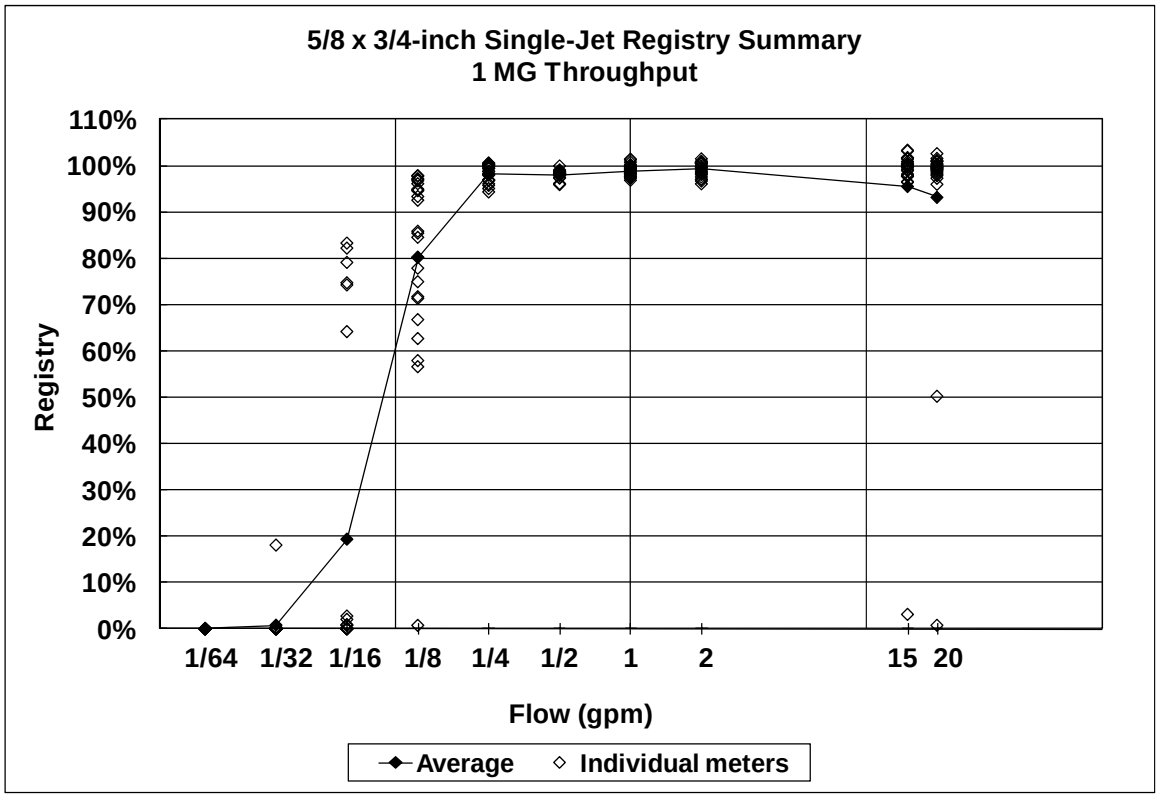

Figure 3.22 5/8x3/4-inch single-jet 1 MG throughput

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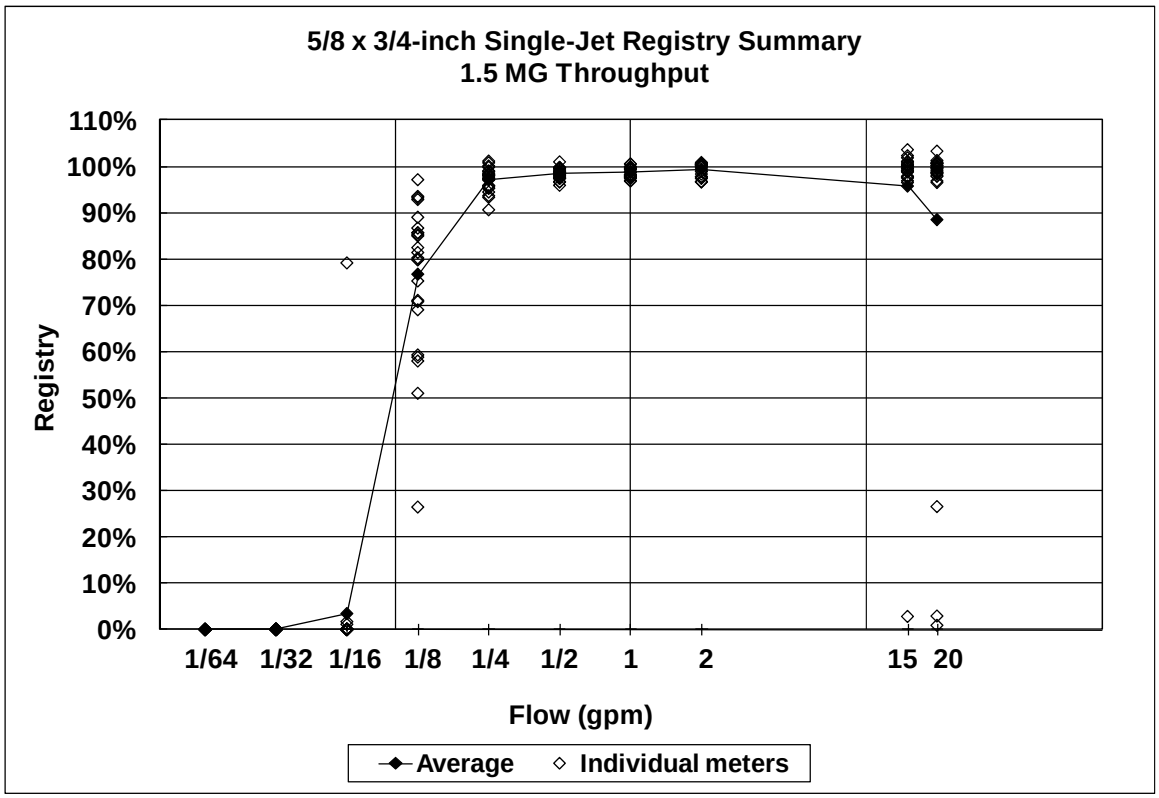

Figure 3.23 5/8x3/4-inch single-jet 1.5 MG throughput

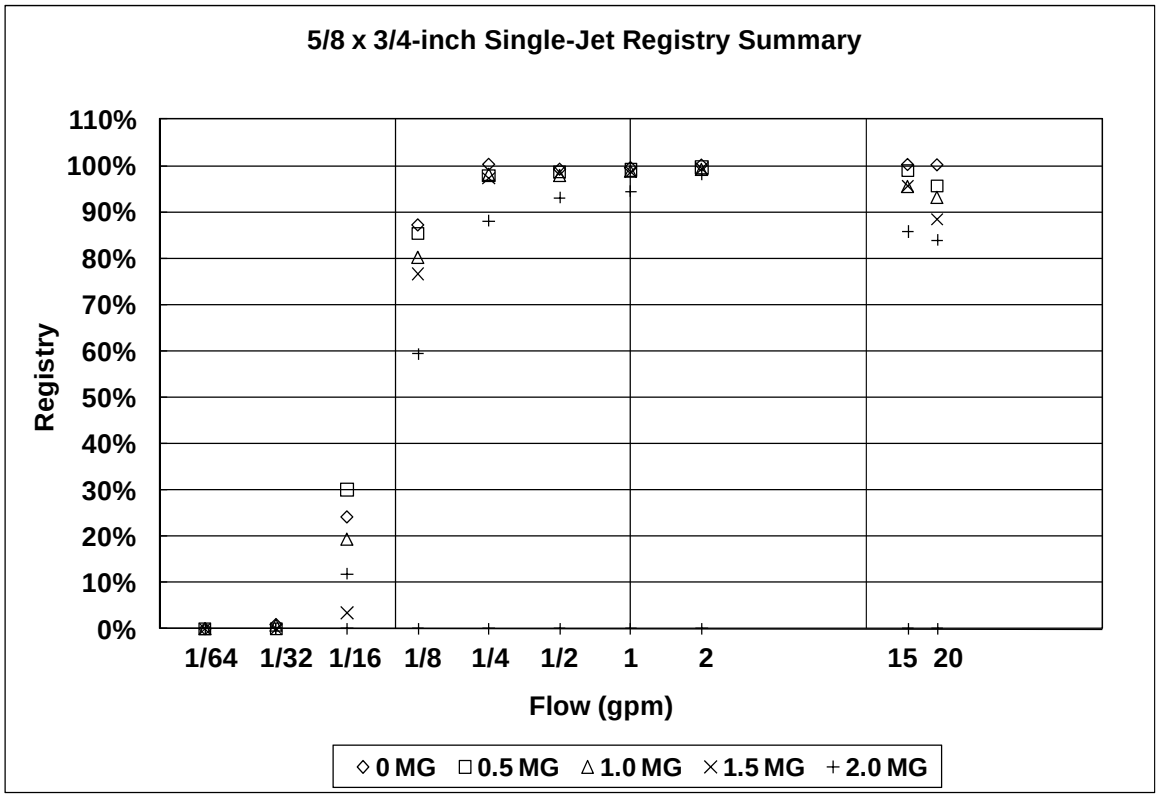

Figure 3.24 5/8x3/4-inch single-jet registry summary

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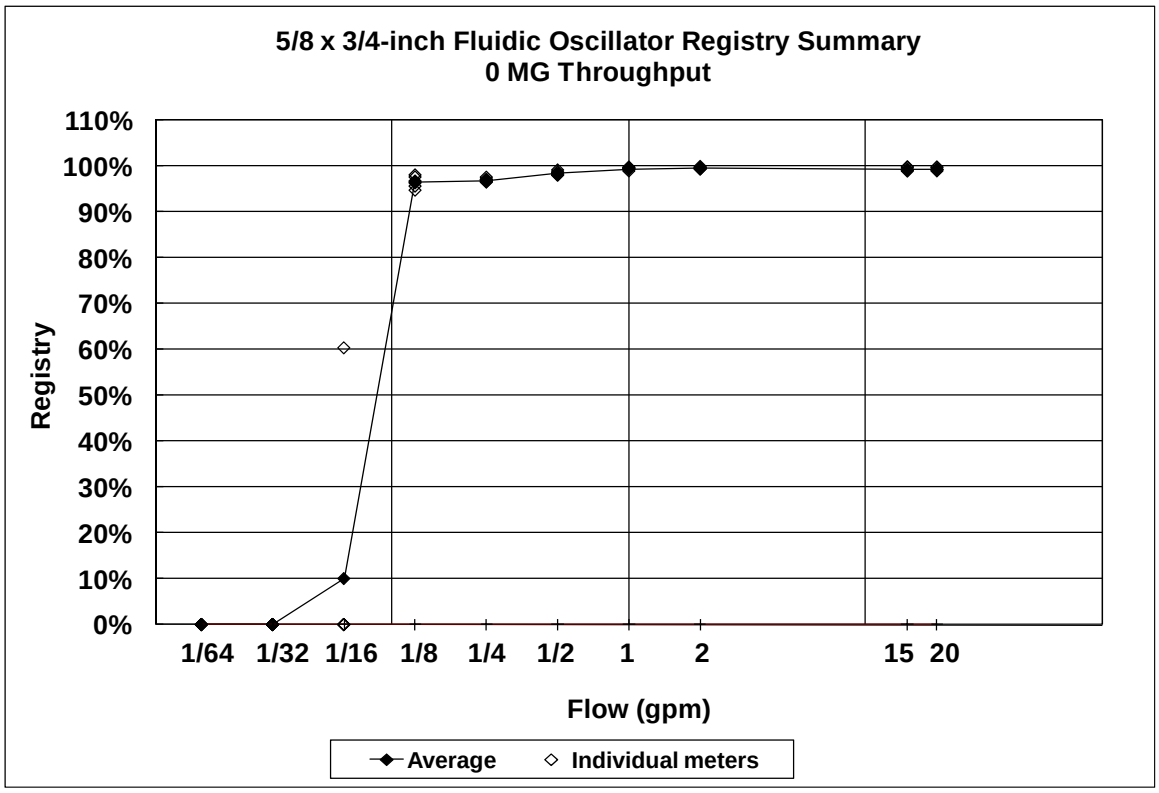

Figure 3.25 5/8x3/4-inch fluidic oscillator 0 MG throughput

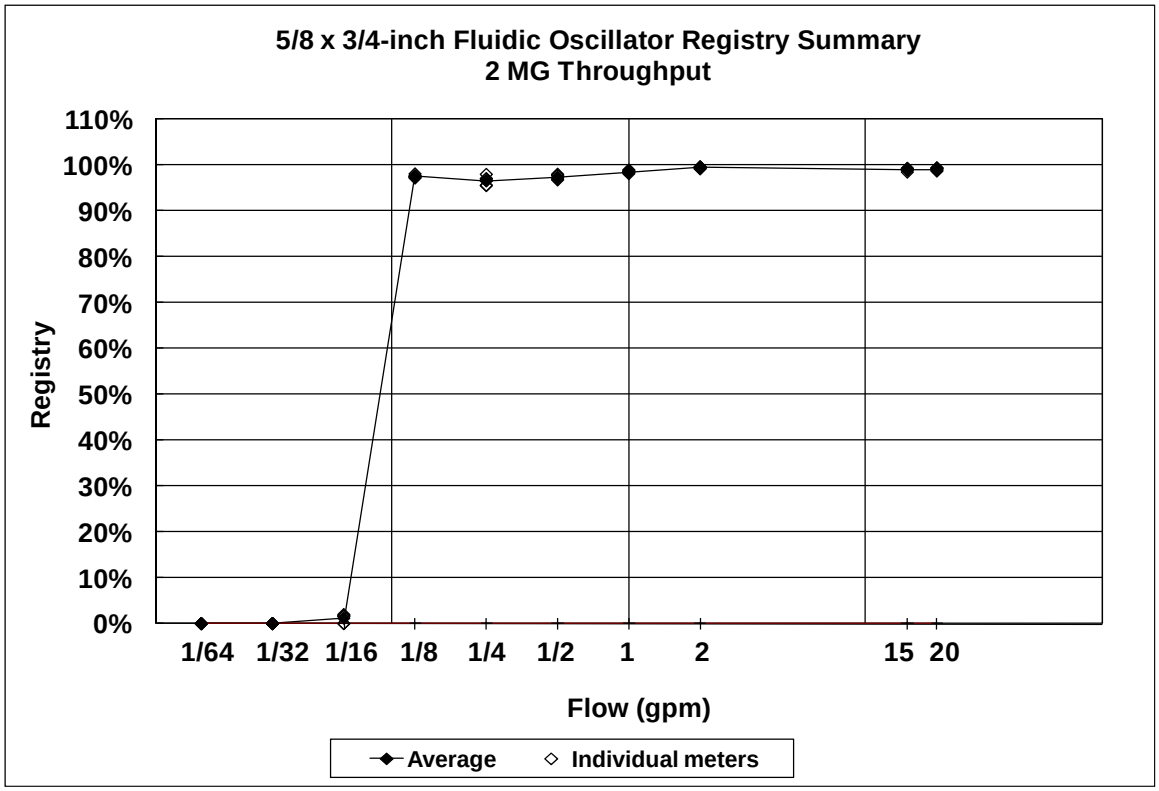

Figure 3.26 5/8x3/4-inch fluidic oscillator 2 MG throughput

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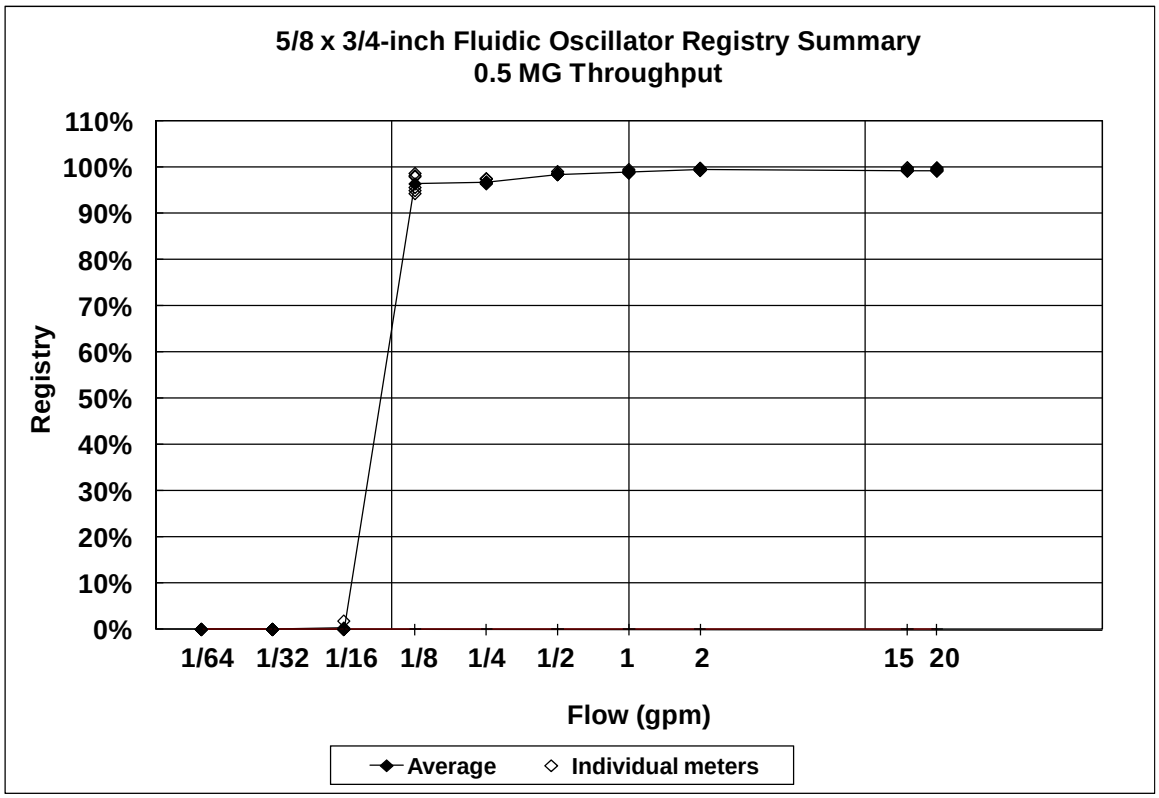

Figure 3.27 5/8x3/4-inch fluidic oscillator 0.5 MG throughput

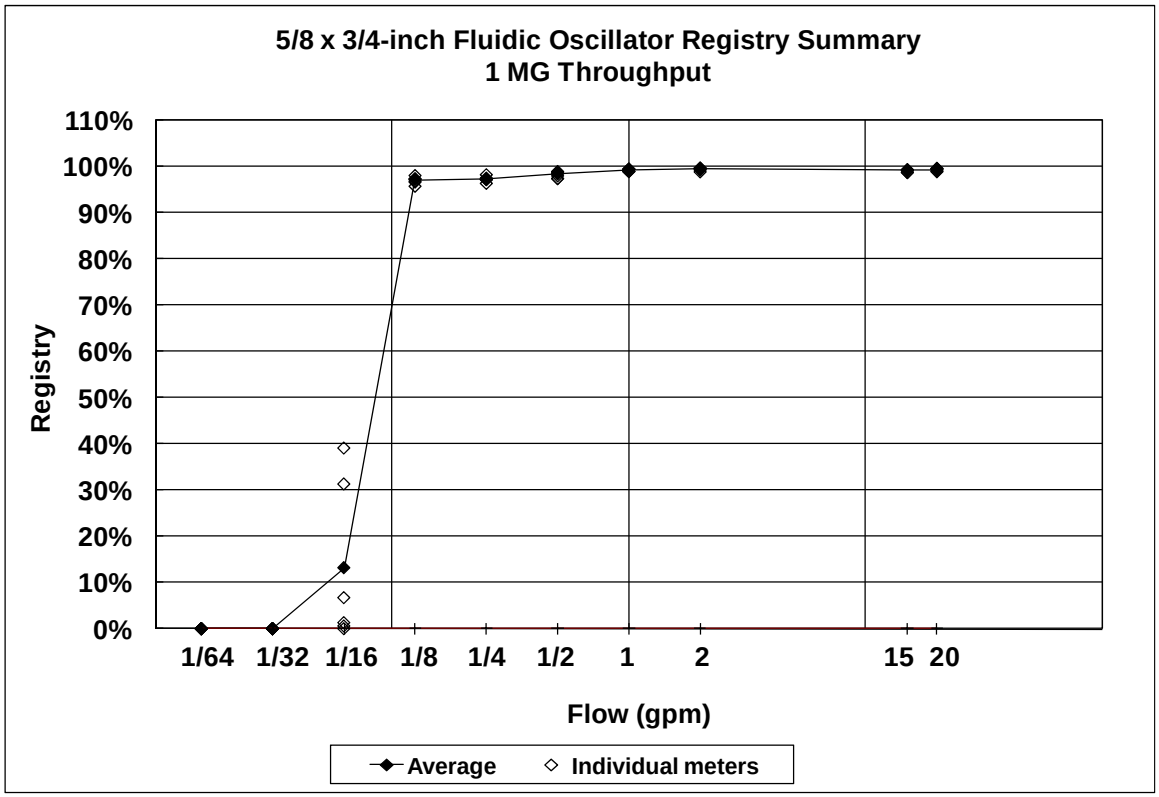

Figure 3.28 5/8x3/4-inch fluidic oscillator 1 MG throughput

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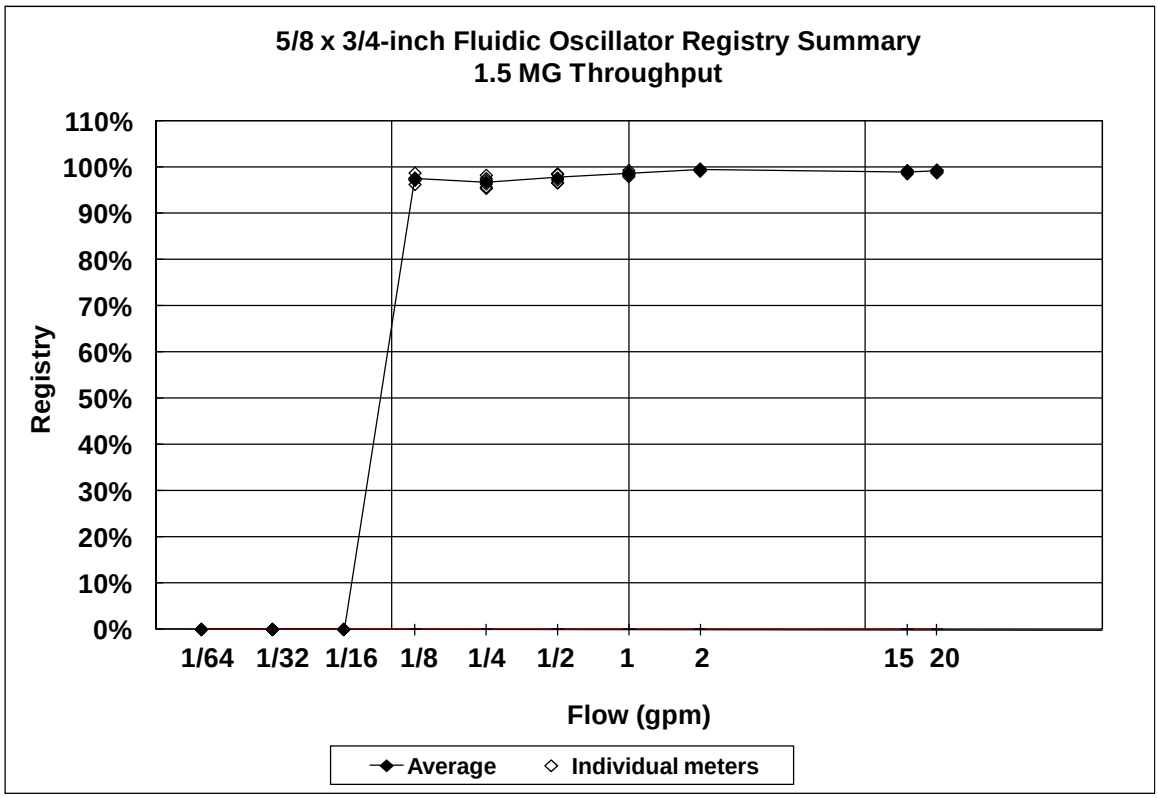

Figure 3.29 5/8x3/4-inch fluidic oscillator 1.5 MG throughput

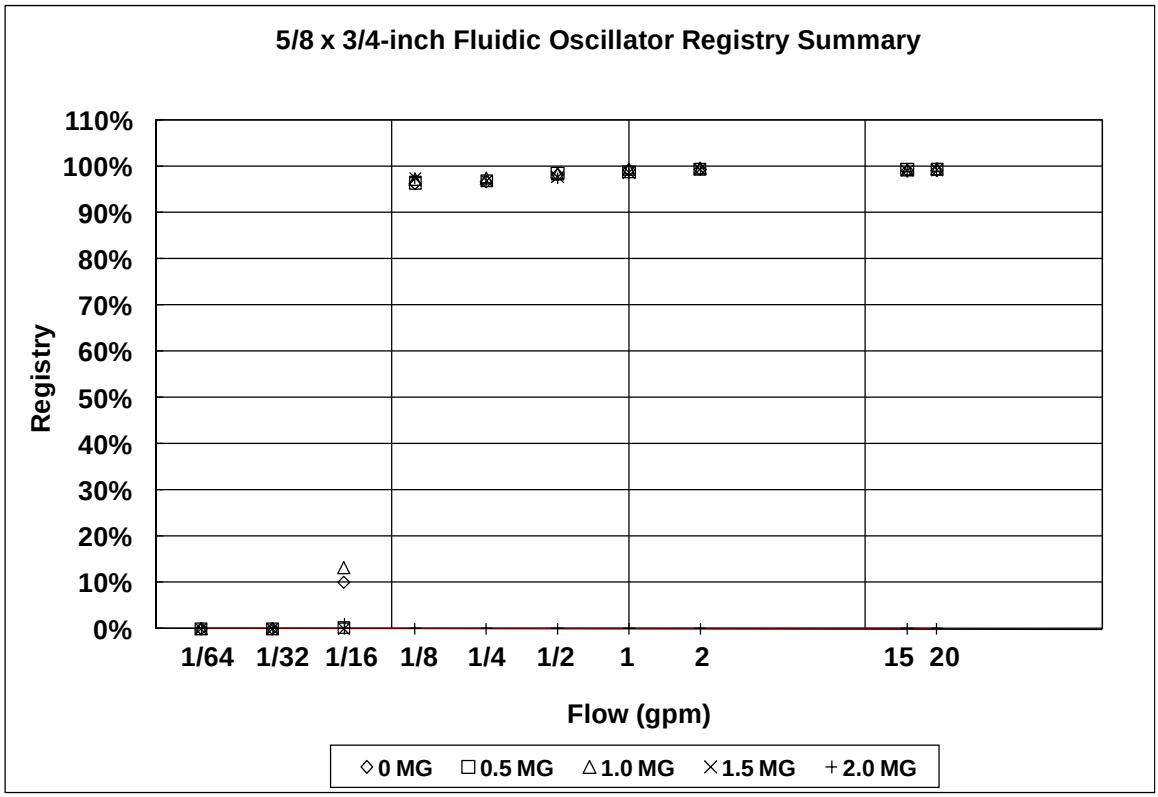

Figure 3.30 5/8x3/4-inch fluidic oscillator registry summary

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3/4-inch Meters

Figures 3.31 through 3.66 show the results for the 3/4-inch meters tested in the new condition and their registry at various levels of throughput.

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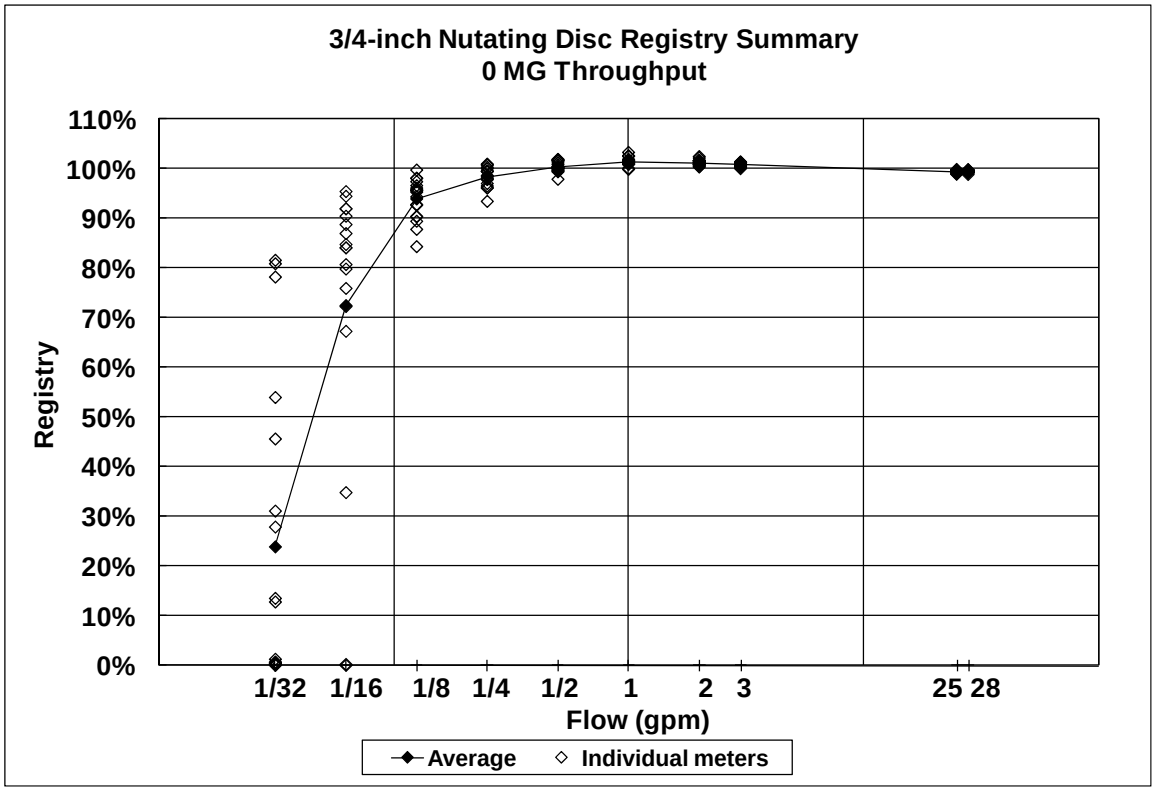

Figure 3.31 3/4–inch nutating disc 0 MG throughput

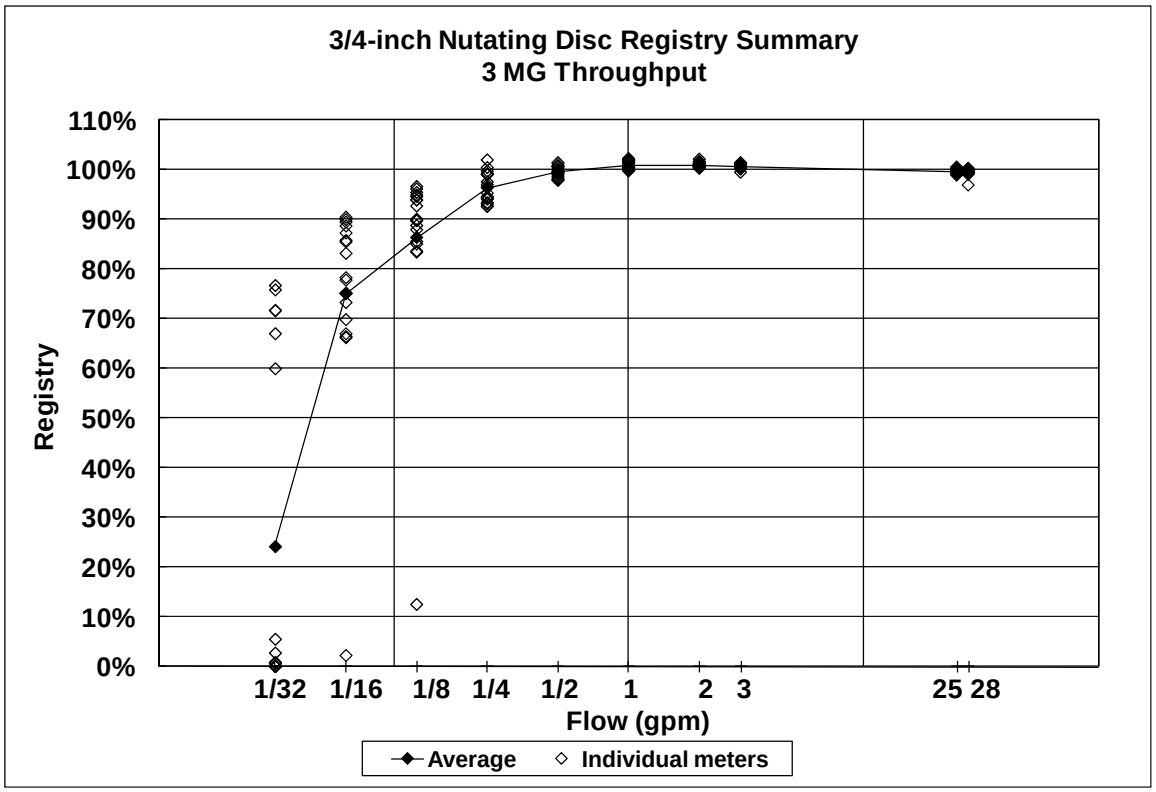

Figure 3.32 3/4-inch nutating disc 3 MG throughput

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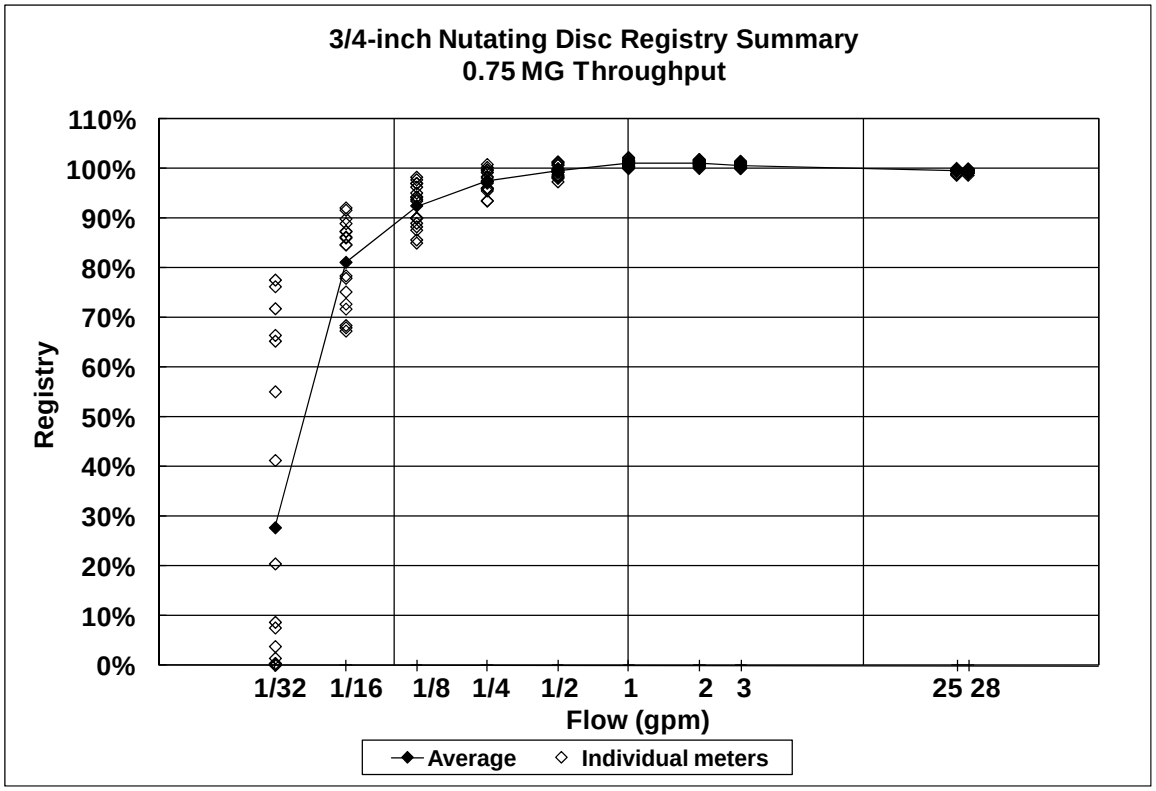

Figure 3.33 3/4–inch nutating disc 0.75 MG throughput

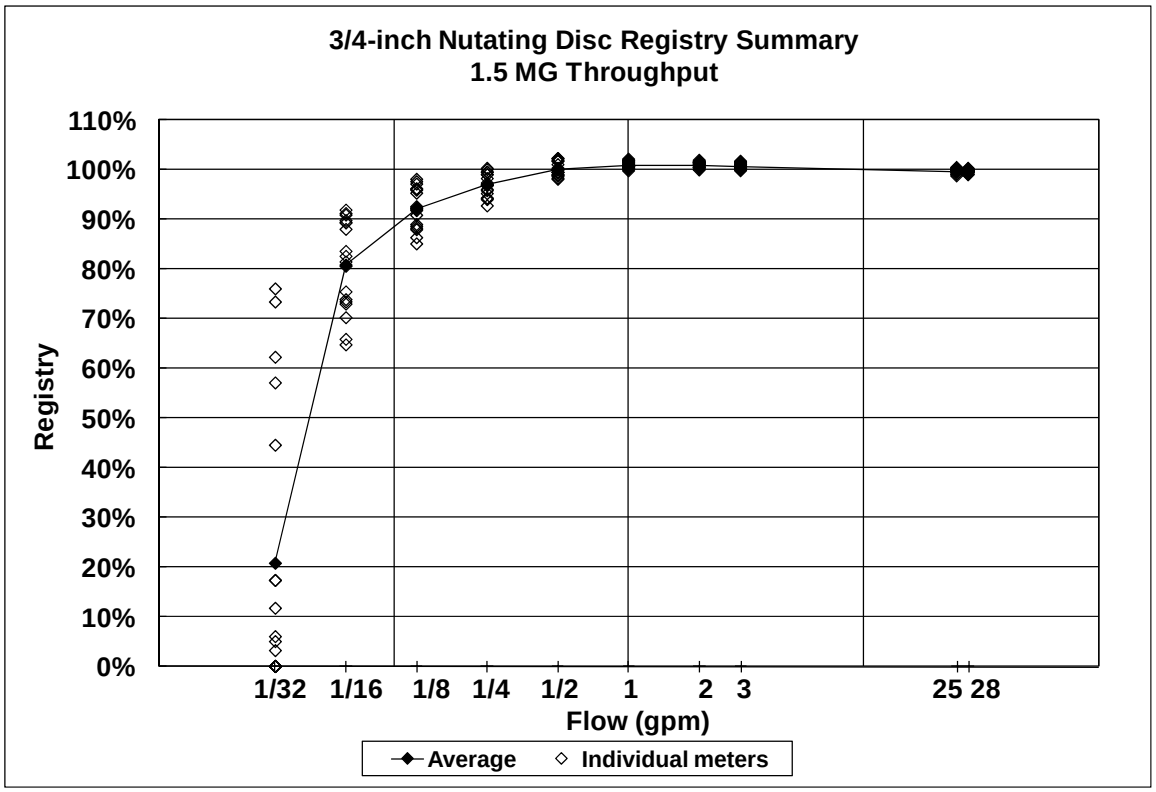

Figure 3.34 3/4–inch nutating disc 1.5 MG throughput

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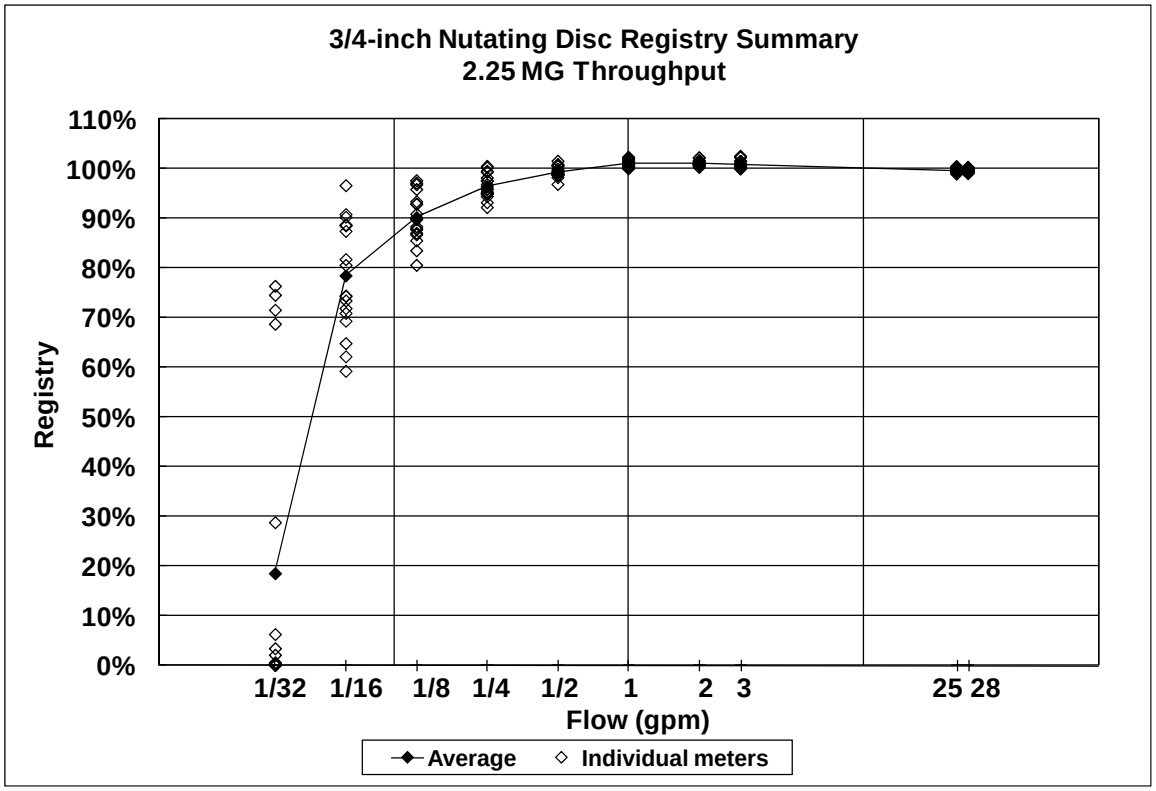

Figure 3.35 3/4–inch nutating disc 2.25 MG throughput

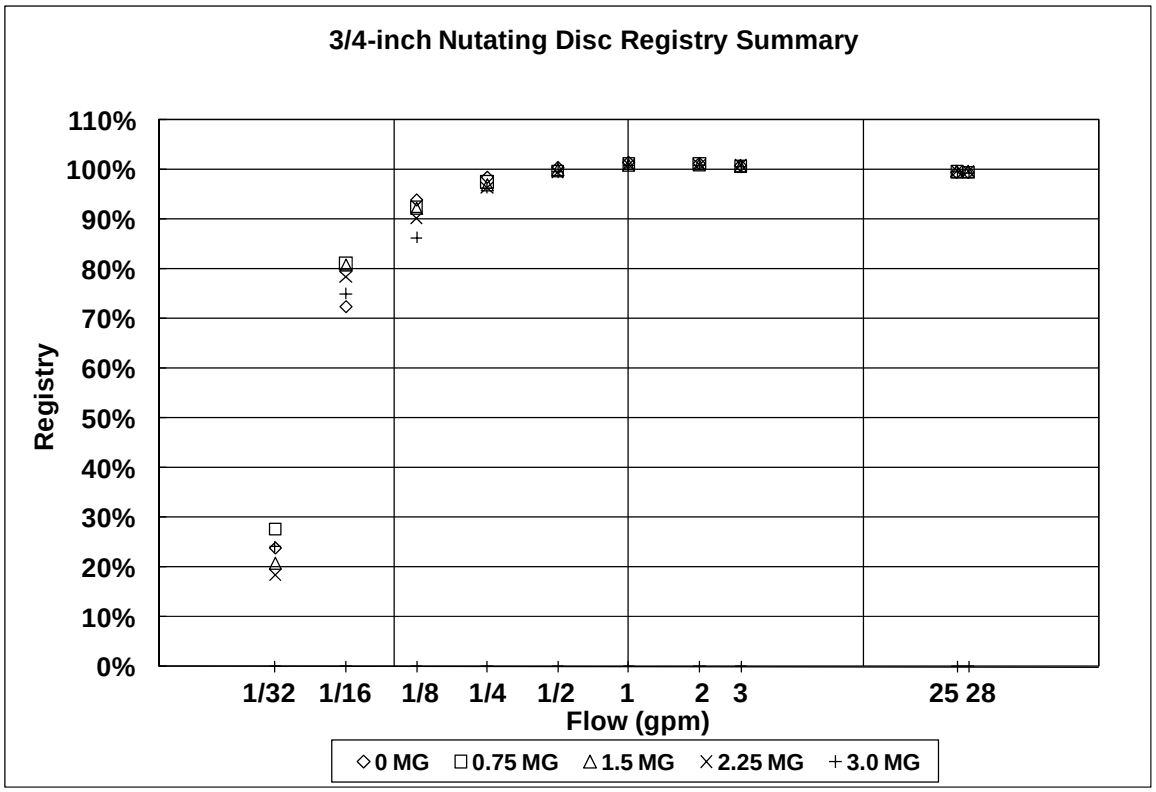

Figure 3.36 3/4-inch nutating disc registry summary

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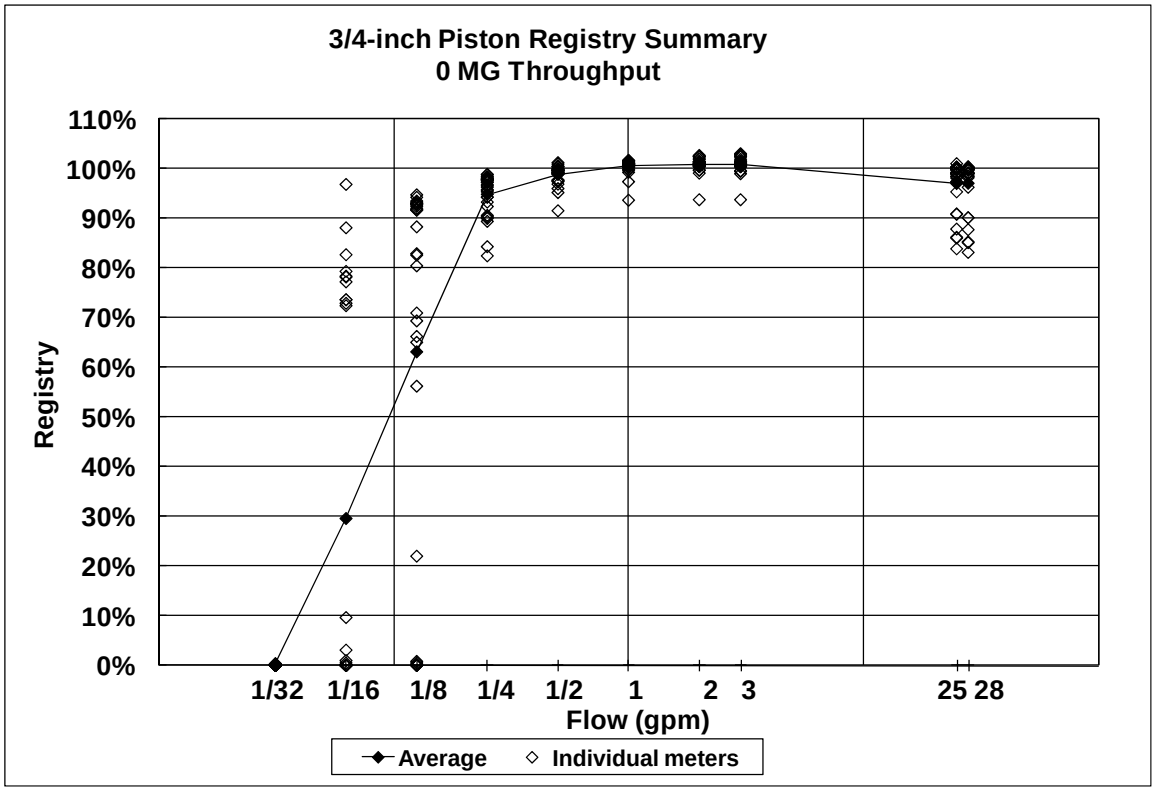

Figure 3.37 3/4-inch piston 0 MG throughput

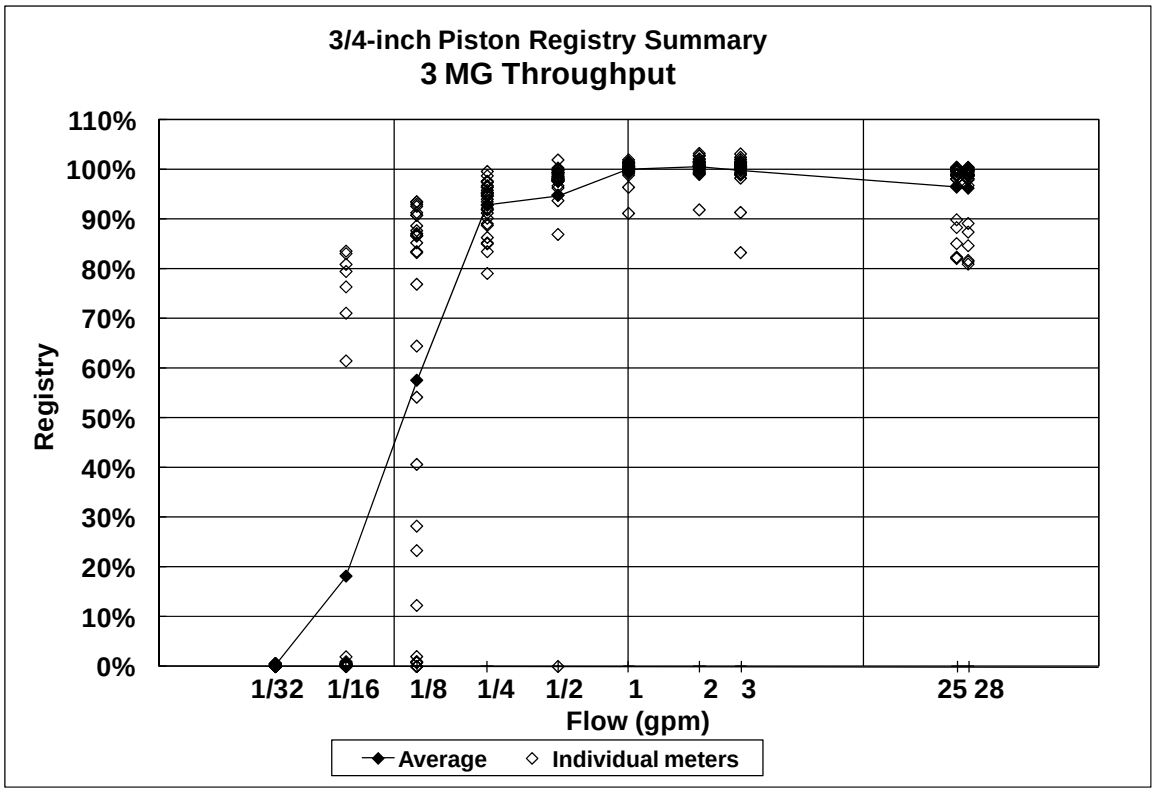

Figure 3.38 3/4-inch piston 3 MG throughput

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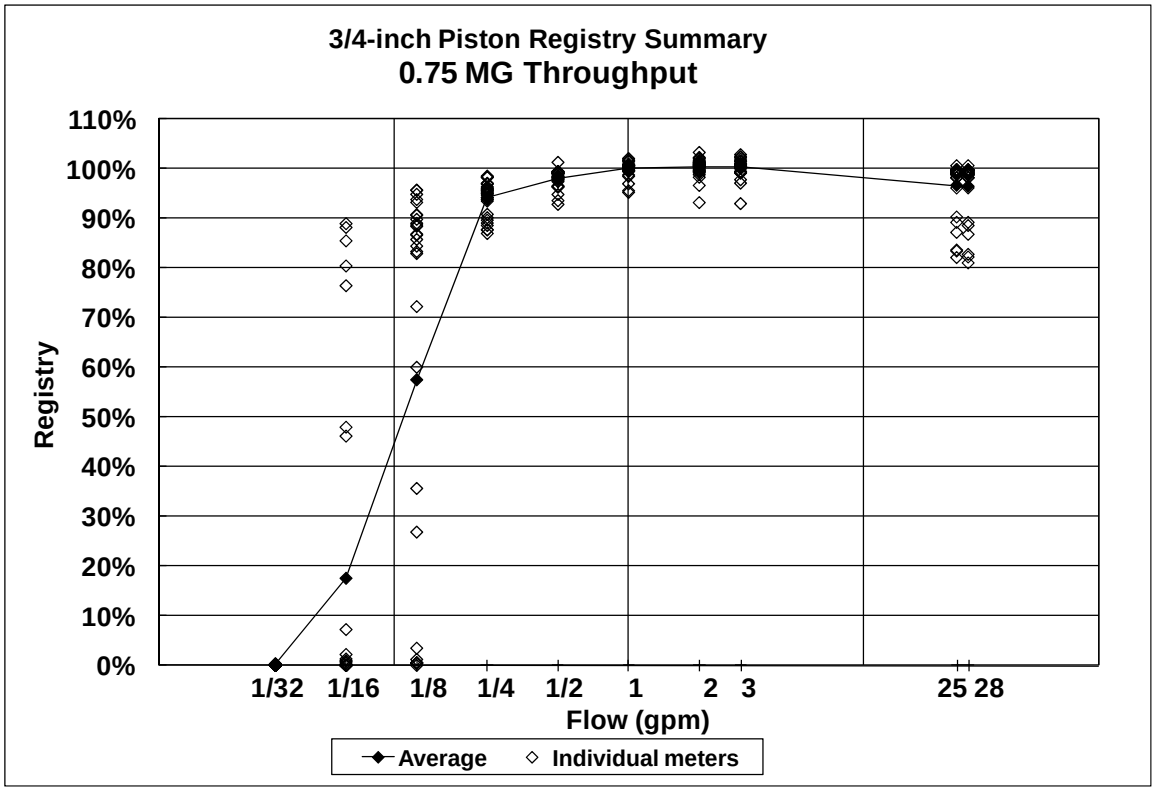

Figure 3.39 3/4-inch piston 0.75 MG throughput

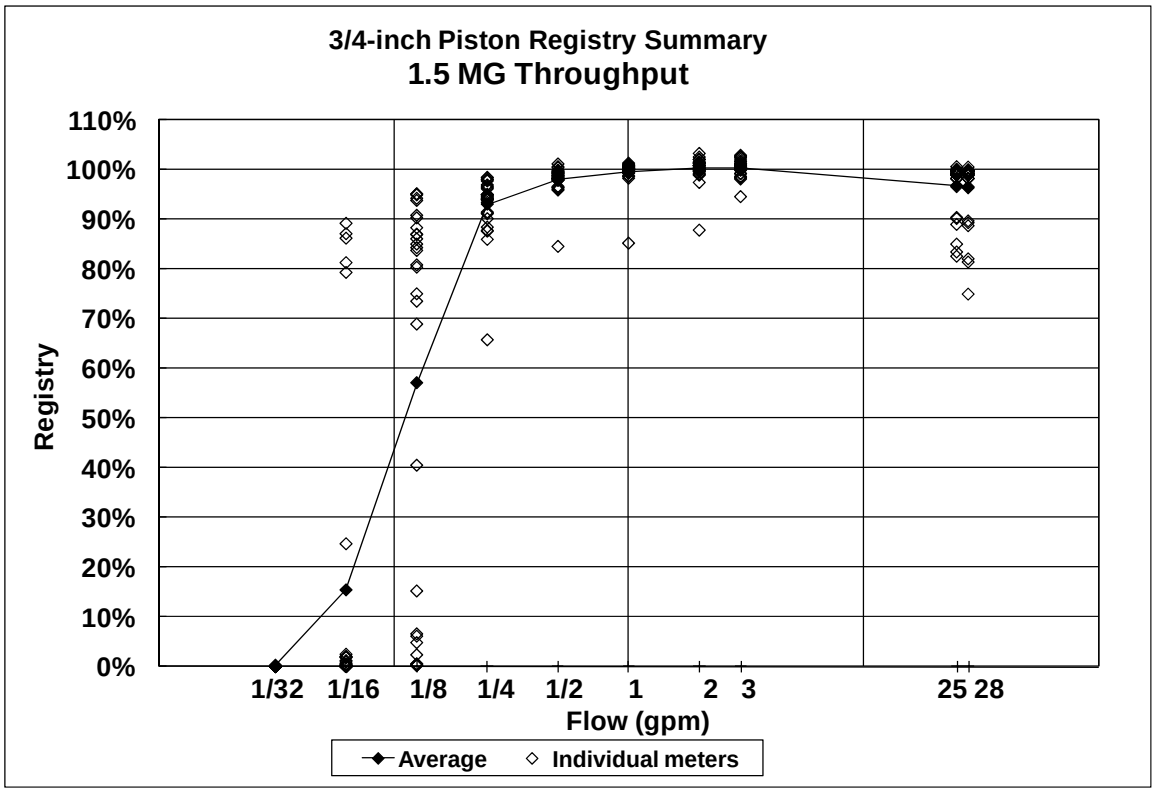

Figure 3.40 3/4-inch piston 1.5 MG throughput

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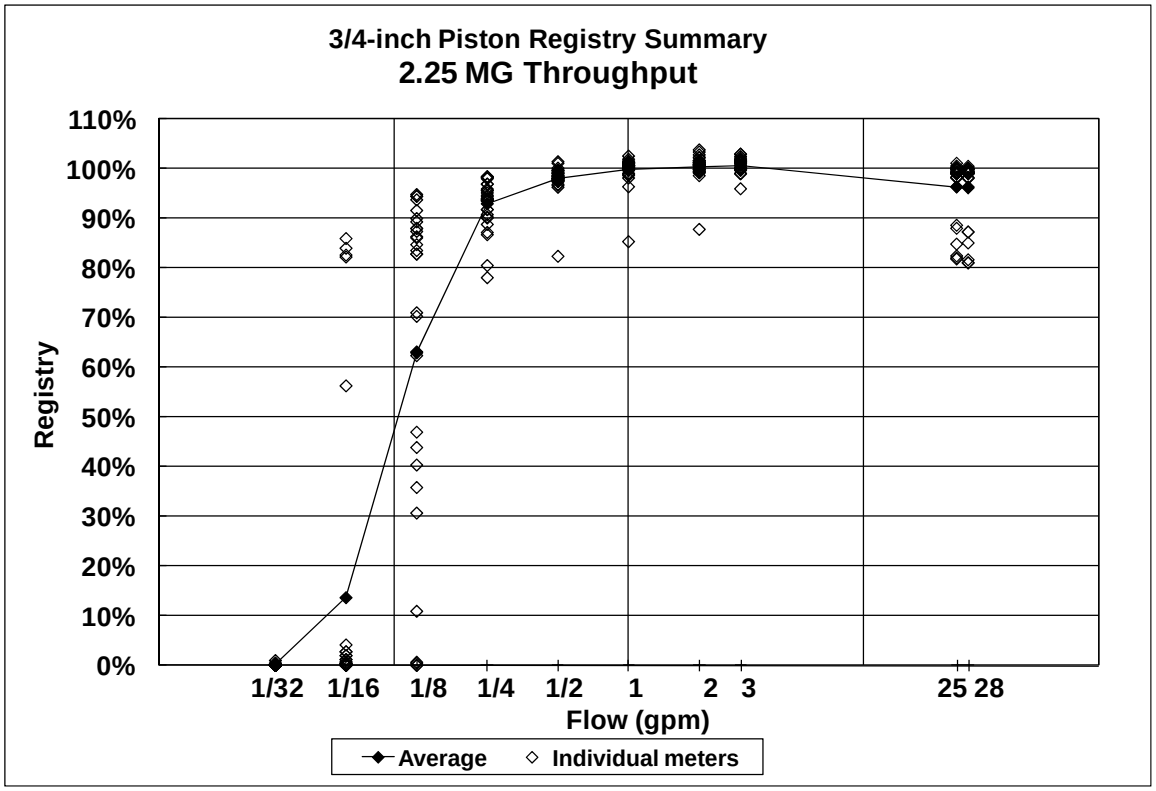

Figure 3.41 3/4-inch piston 2.25 MG throughput

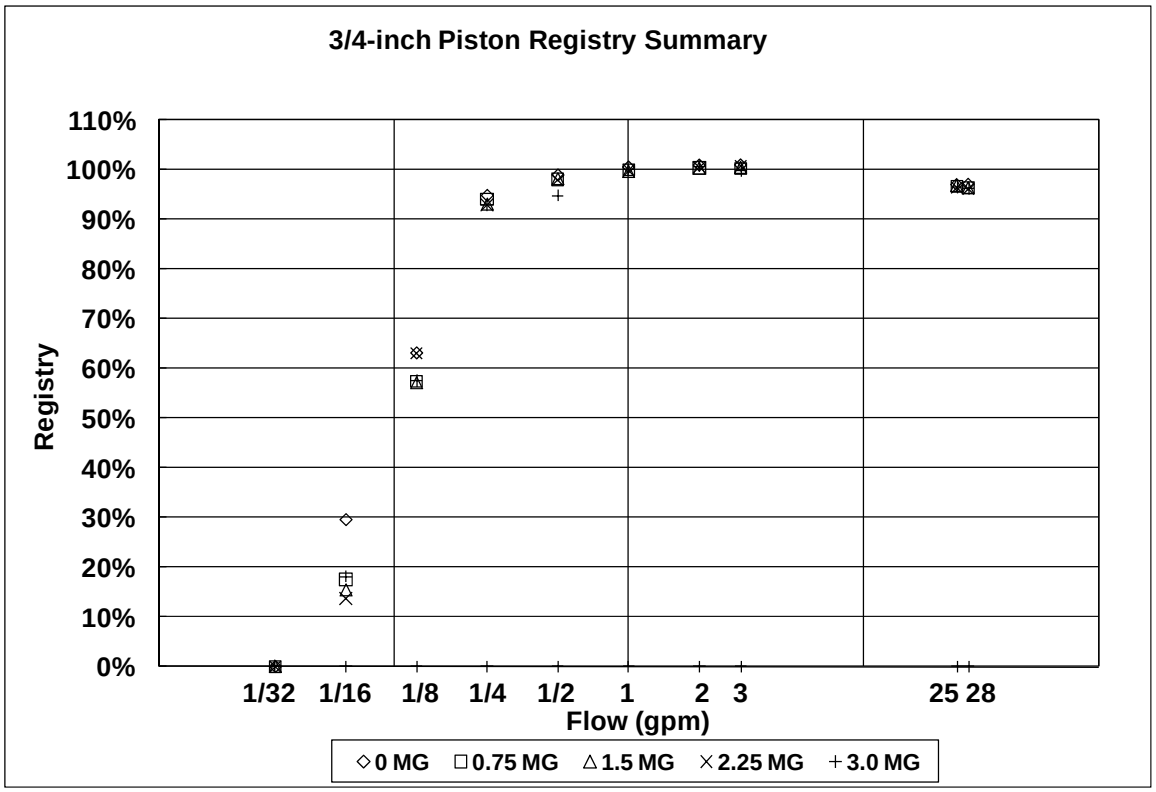

Figure 3.42 3/4-inch piston registry summary

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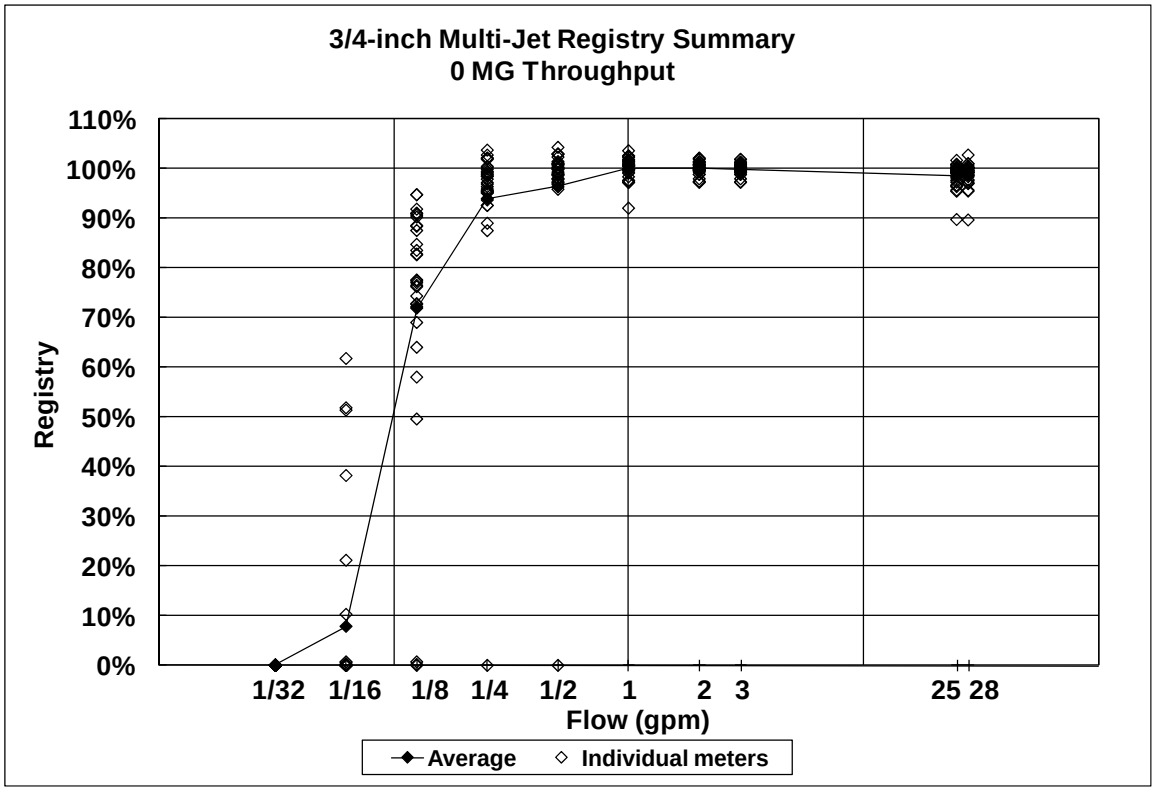

Figure 3.43 3/4-inch multi-jet 0 MG throughput

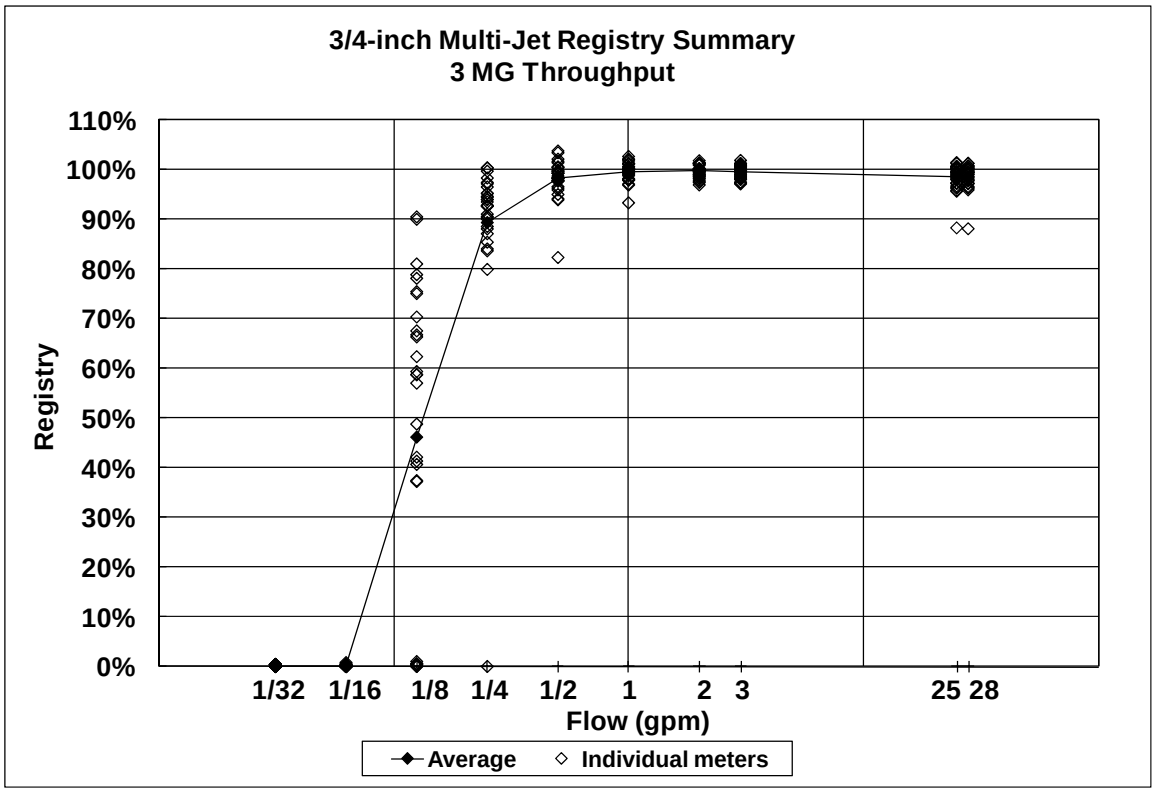

Figure 3.44 3/4-inch multi-jet 3 MG throughput

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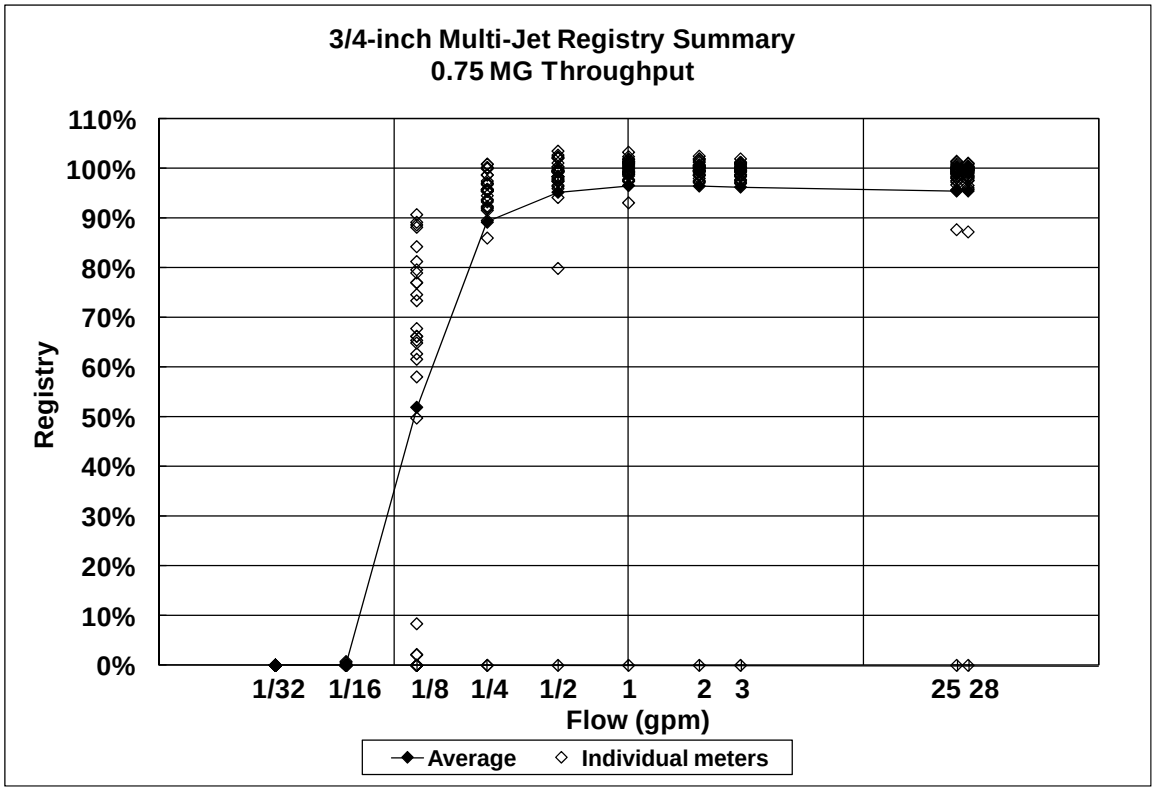

Figure 3.45 3/4-inch multi-jet 0.75 MG throughput

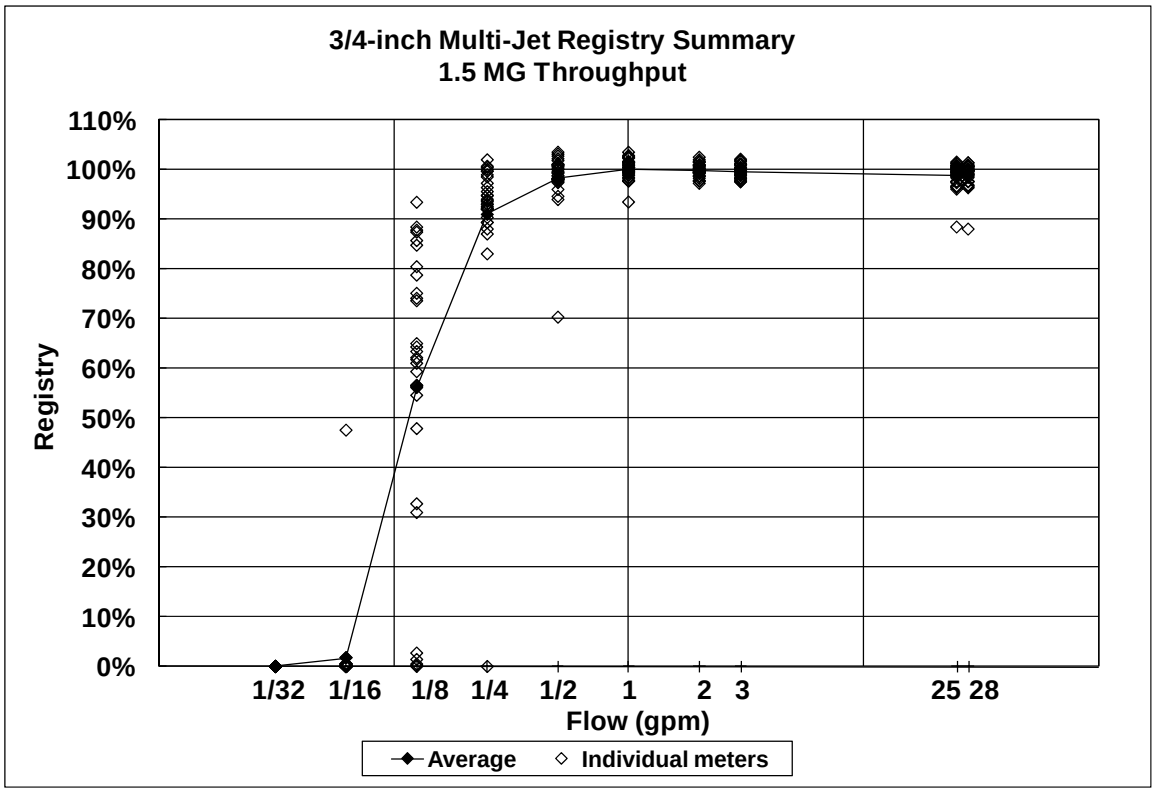

Figure 3.46 3/4-inch multi-jet 1.5 MG throughput

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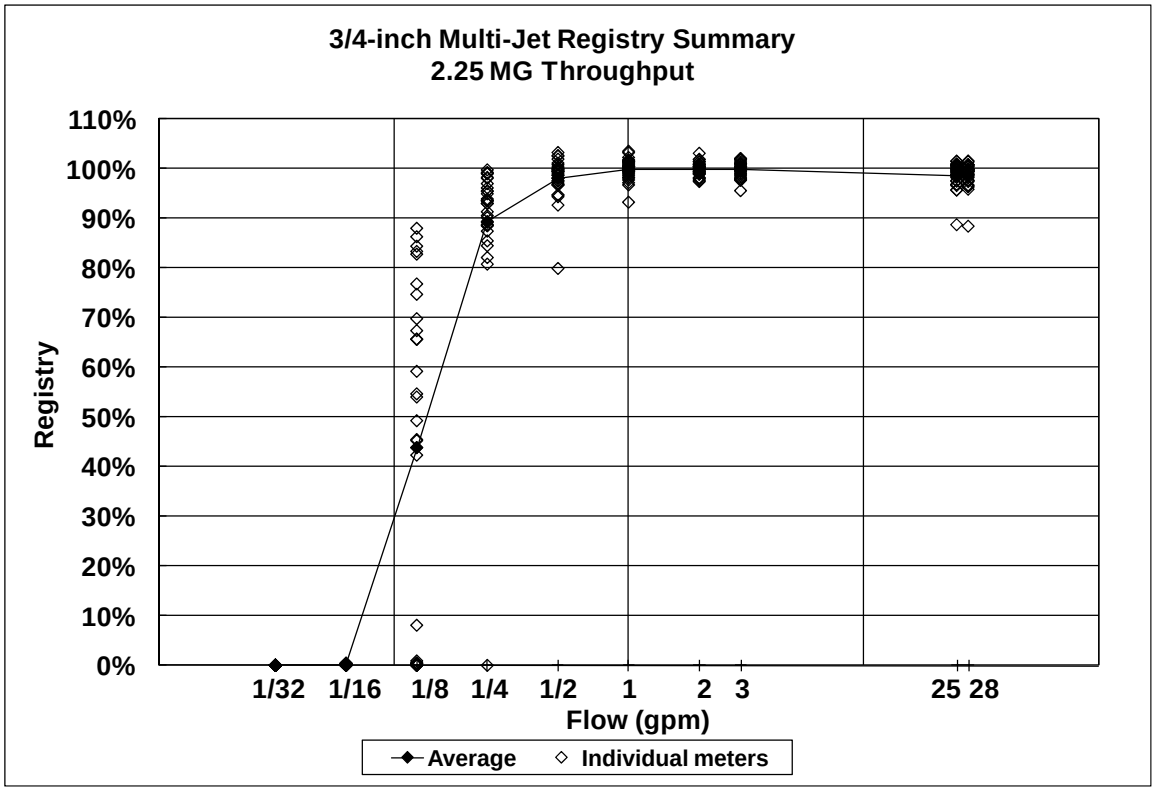

Figure 3.47 3/4-inch multi-jet 2.25 MG throughput

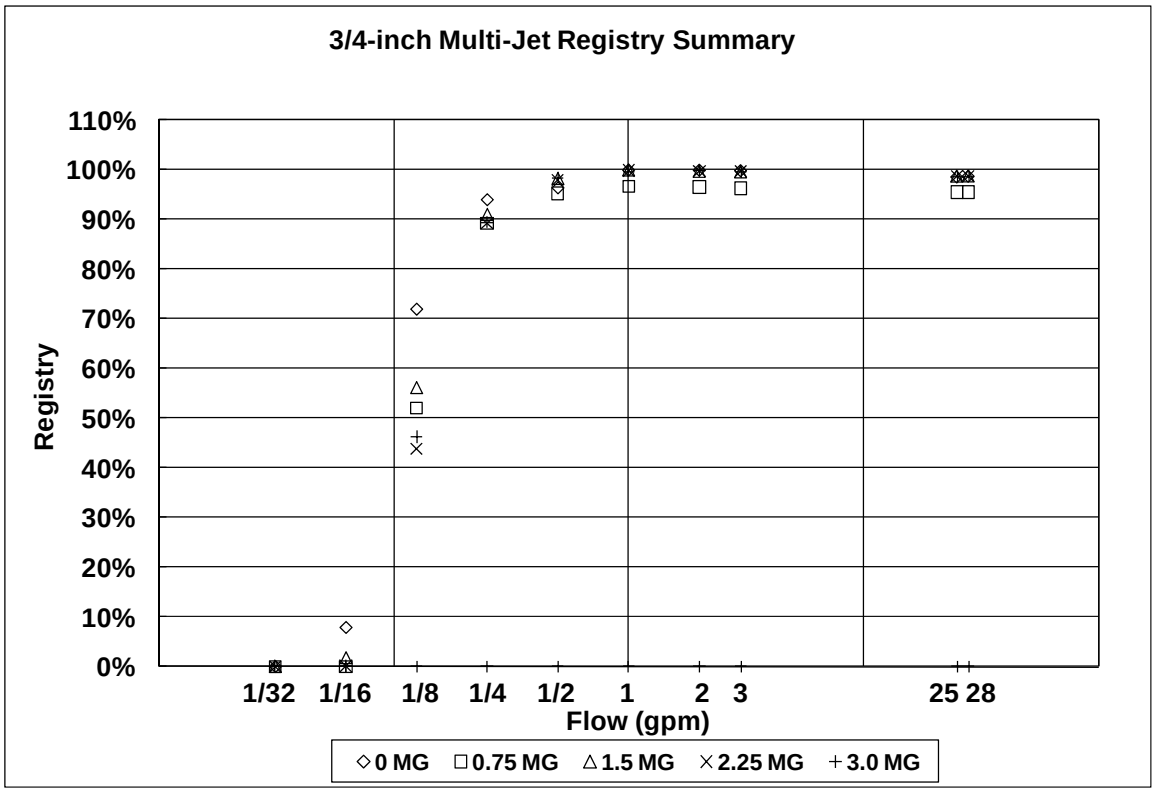

Figure 3.48 3/4-inch multi-jet registry summary

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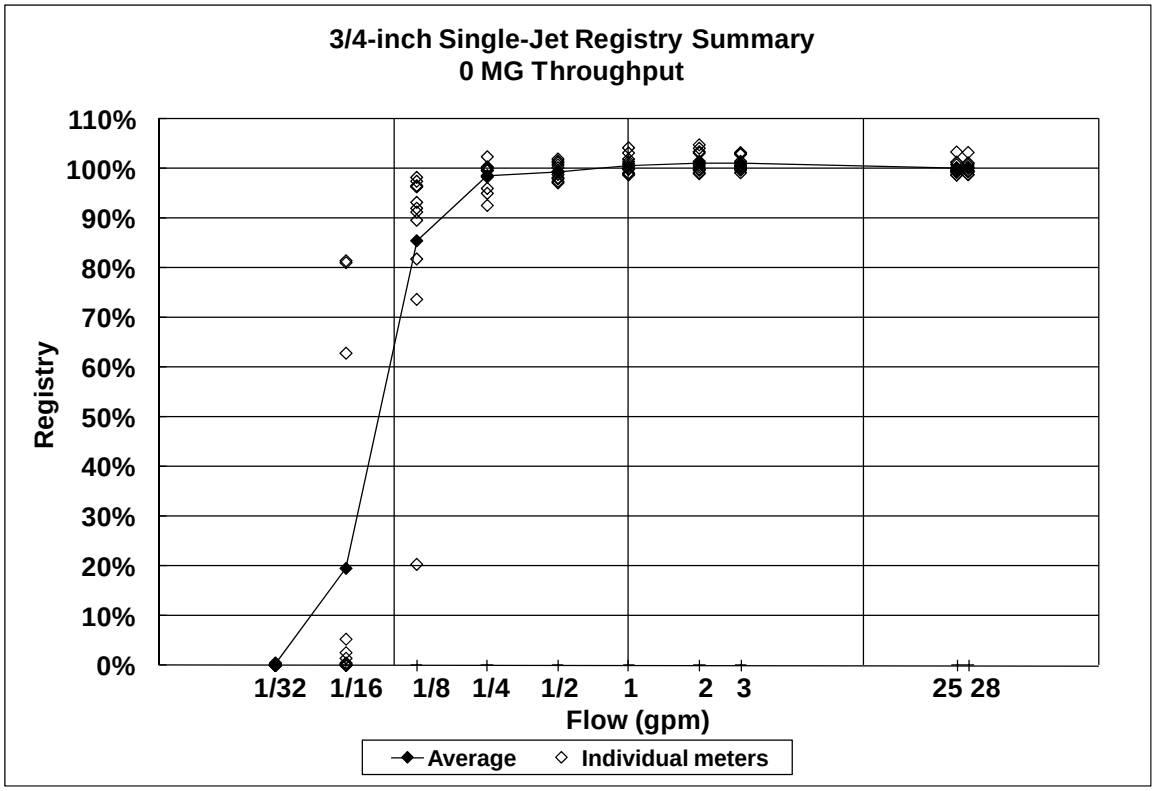

Figure 3.49 3/4-inch single-jet 0 MG throughput

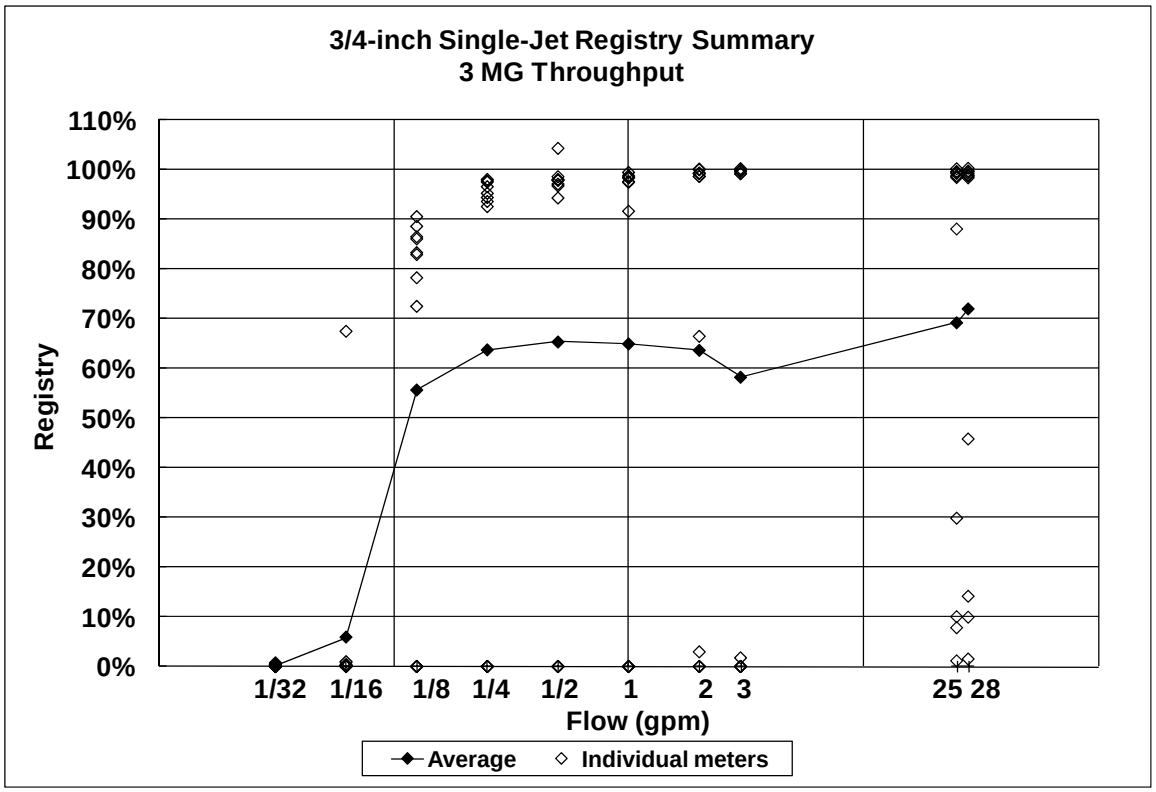

Figure 3.50 3/4-inch single-jet 3 MG throughput

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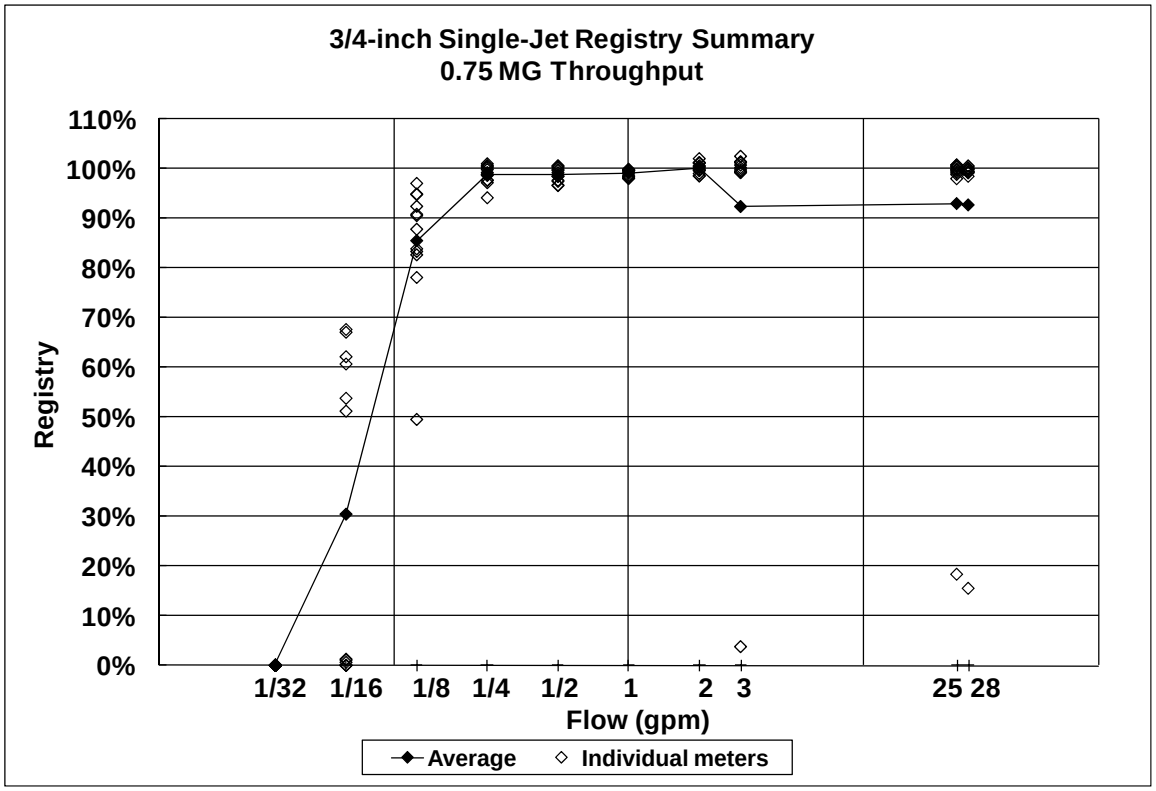

Figure 3.51 3/4-inch single-jet 0.75 MG throughput

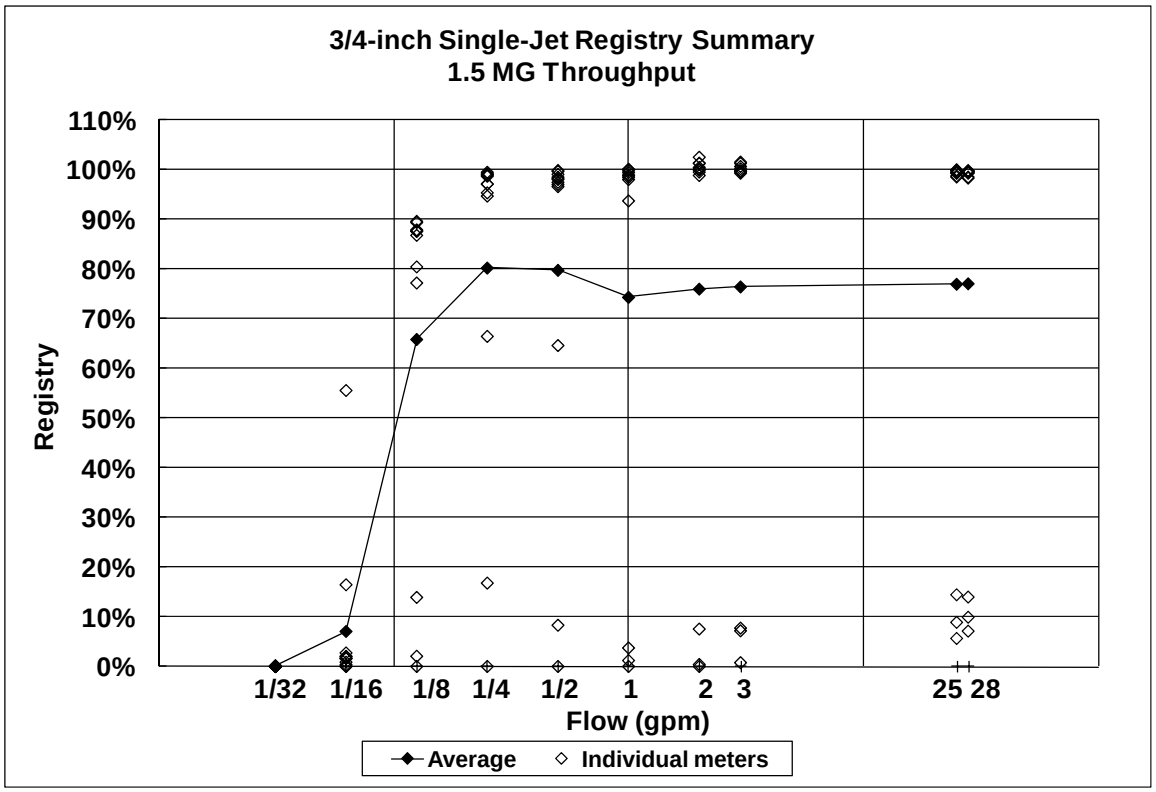

Figure 3.52 3/4-inch single-jet 1.5 MG throughput

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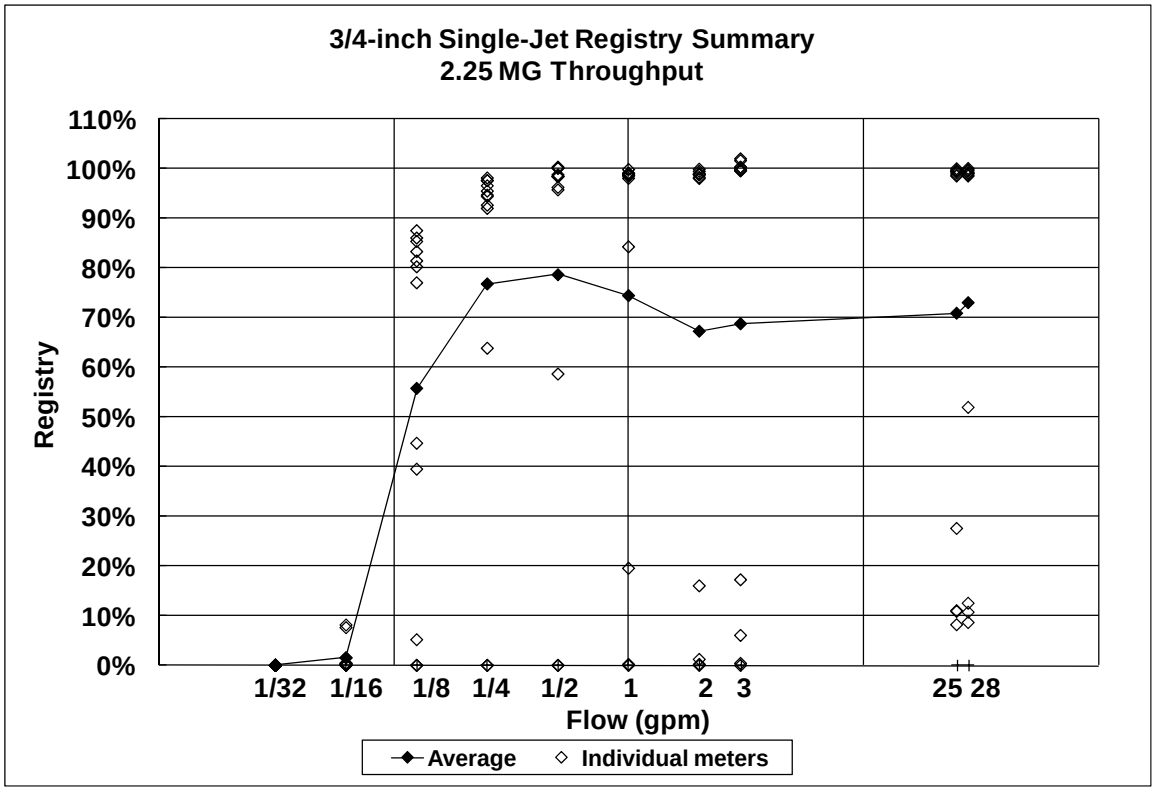

Figure 3.53 3/4-inch single-jet 2.25 MG throughput

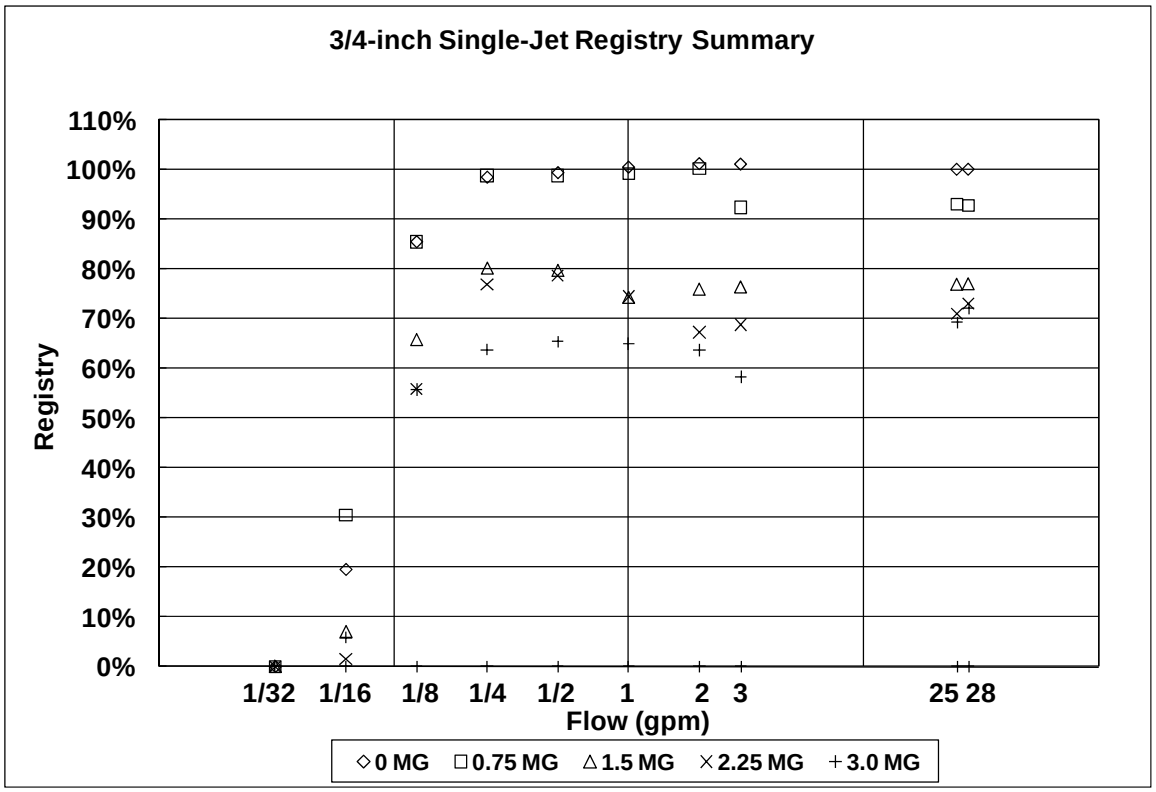

Figure 3.54 3/4-inch single-jet registry summary

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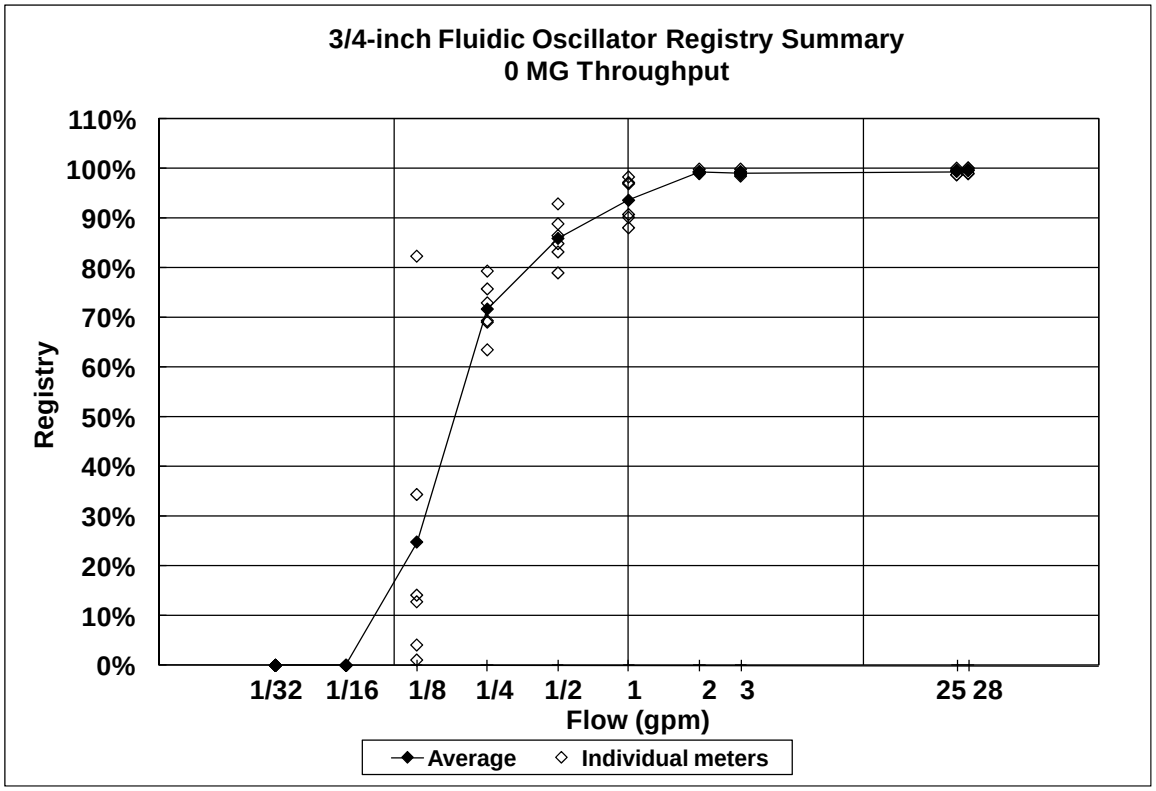

Figure 3.55 3/4-inch fluidic oscillator 0 MG throughput

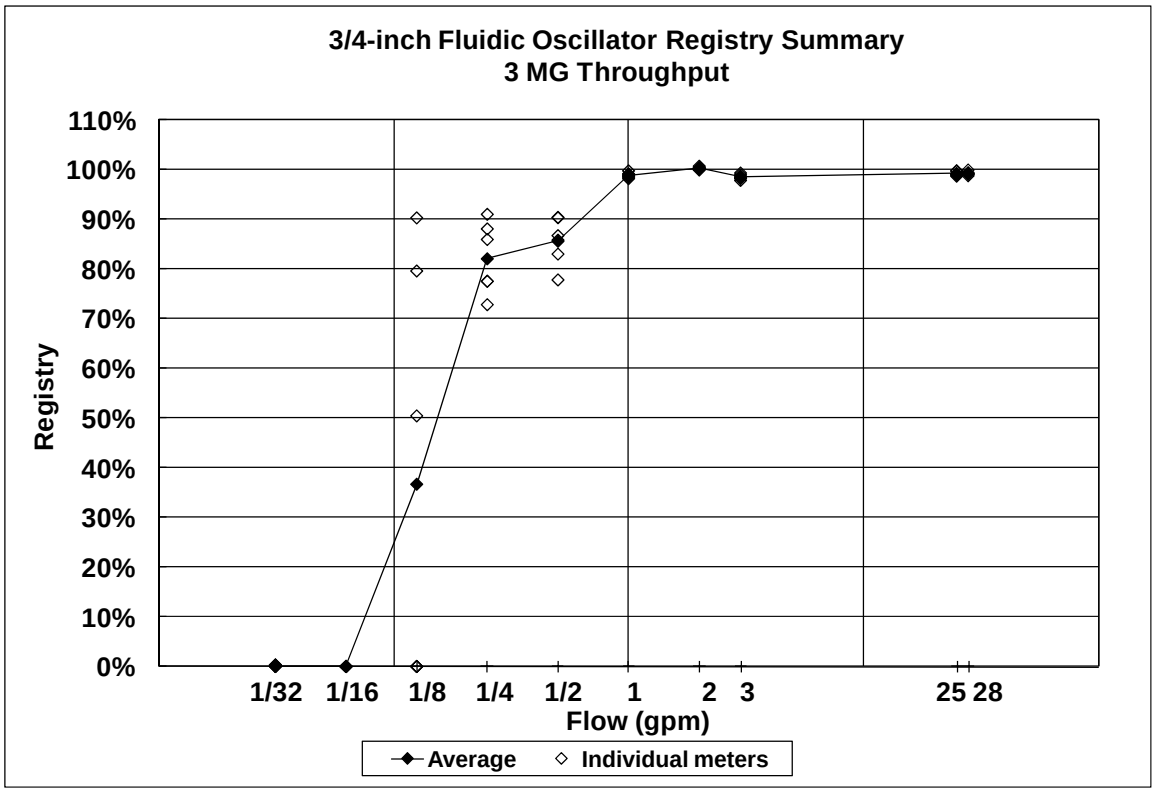

Figure 3.56 3/4-inch fluidic oscillator 3 MG throughput

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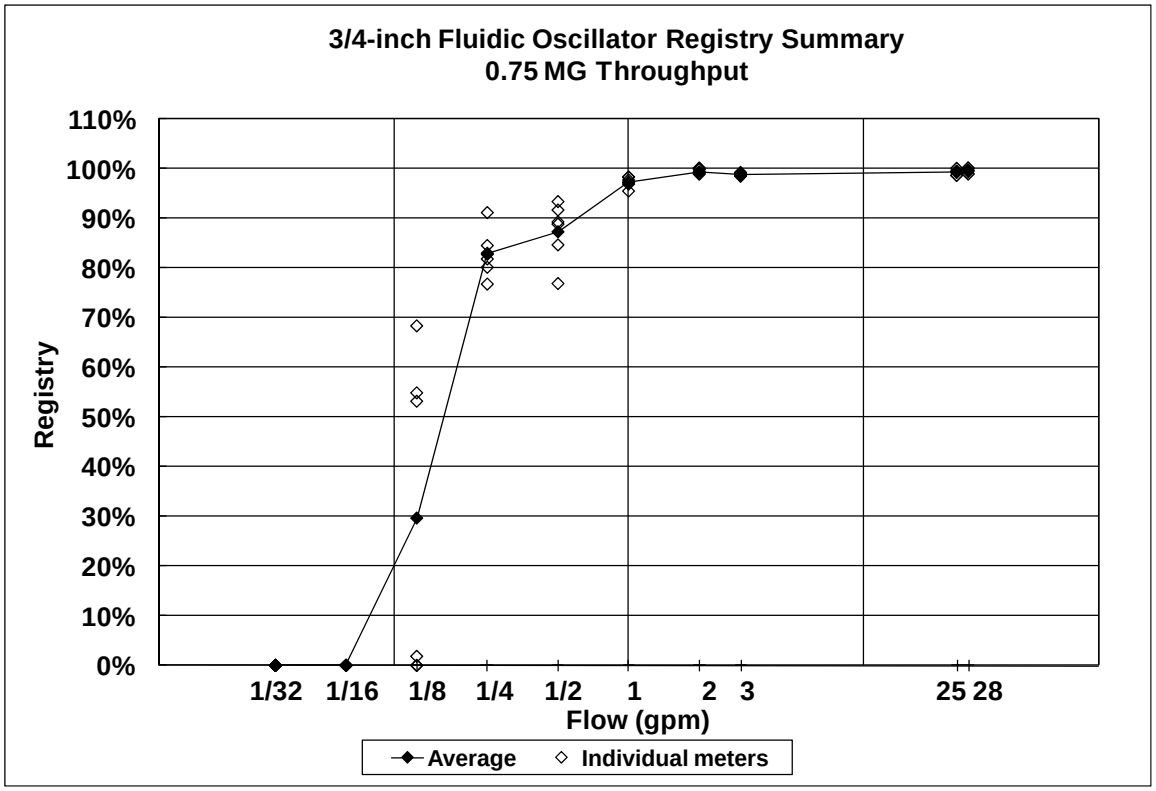

Figure 3.57 3/4-inch fluidic oscillator 0.75 MG throughput

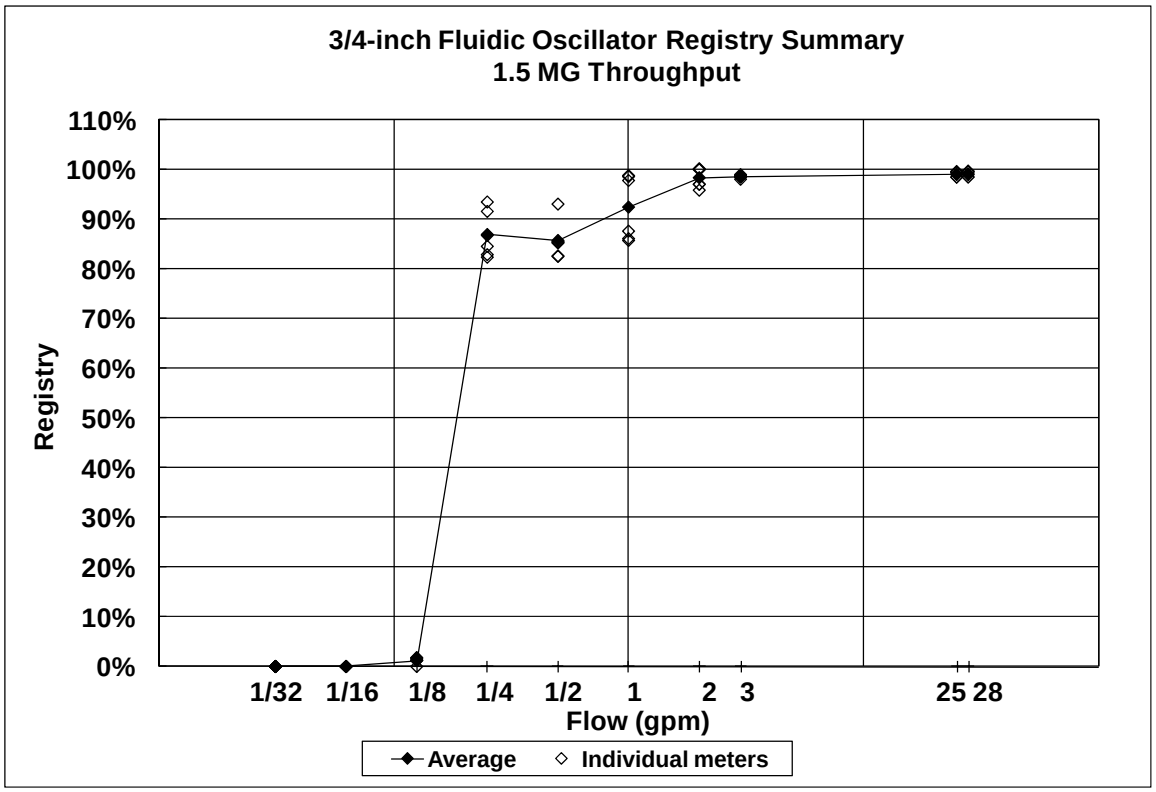

Figure 3.58 3/4-inch fluidic oscillator 1.5 MG throughput

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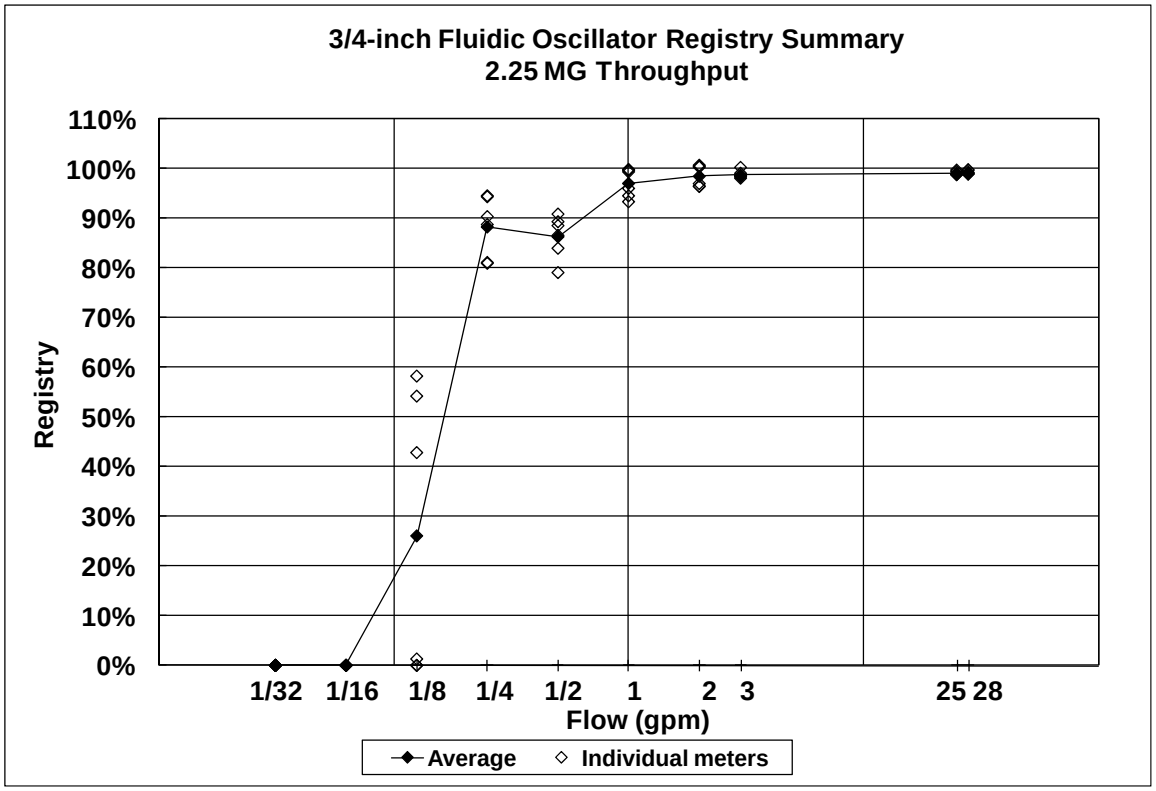

Figure 3.59 3/4-inch fluidic oscillator 2.25 MG throughput

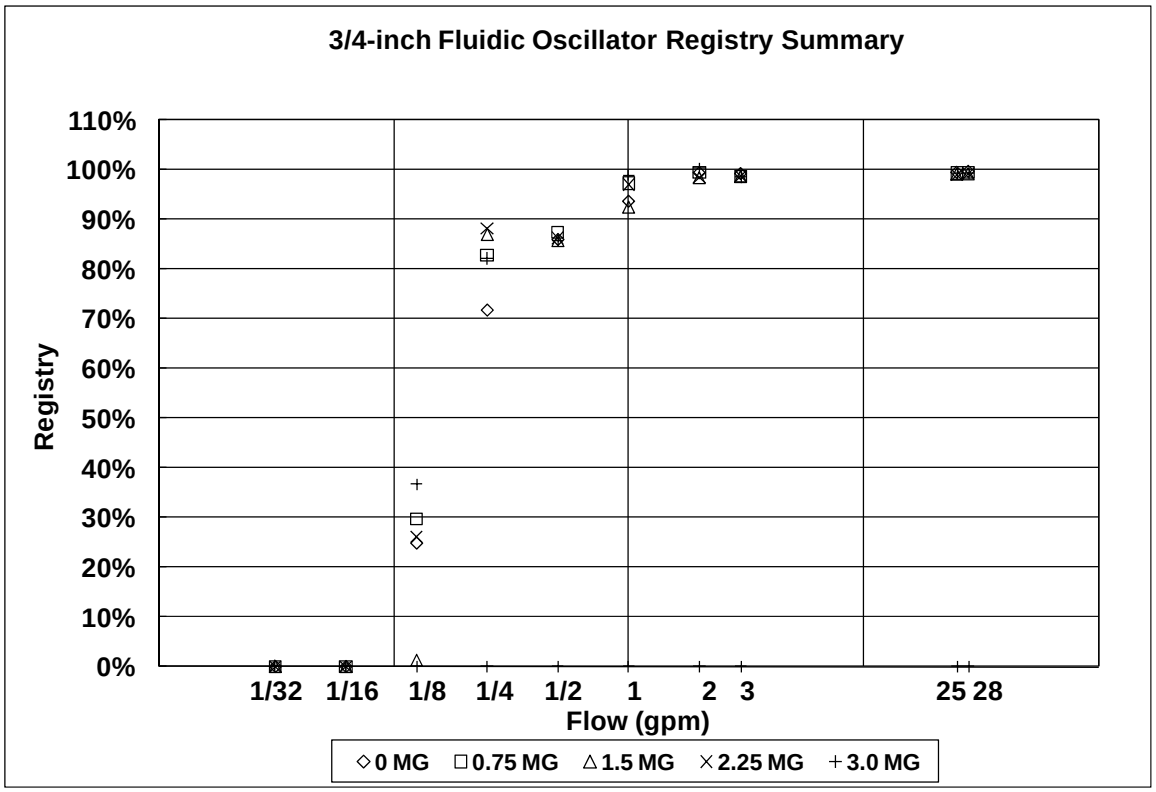

Figure 3.60 3/4-inch fluidic oscillator registry summary

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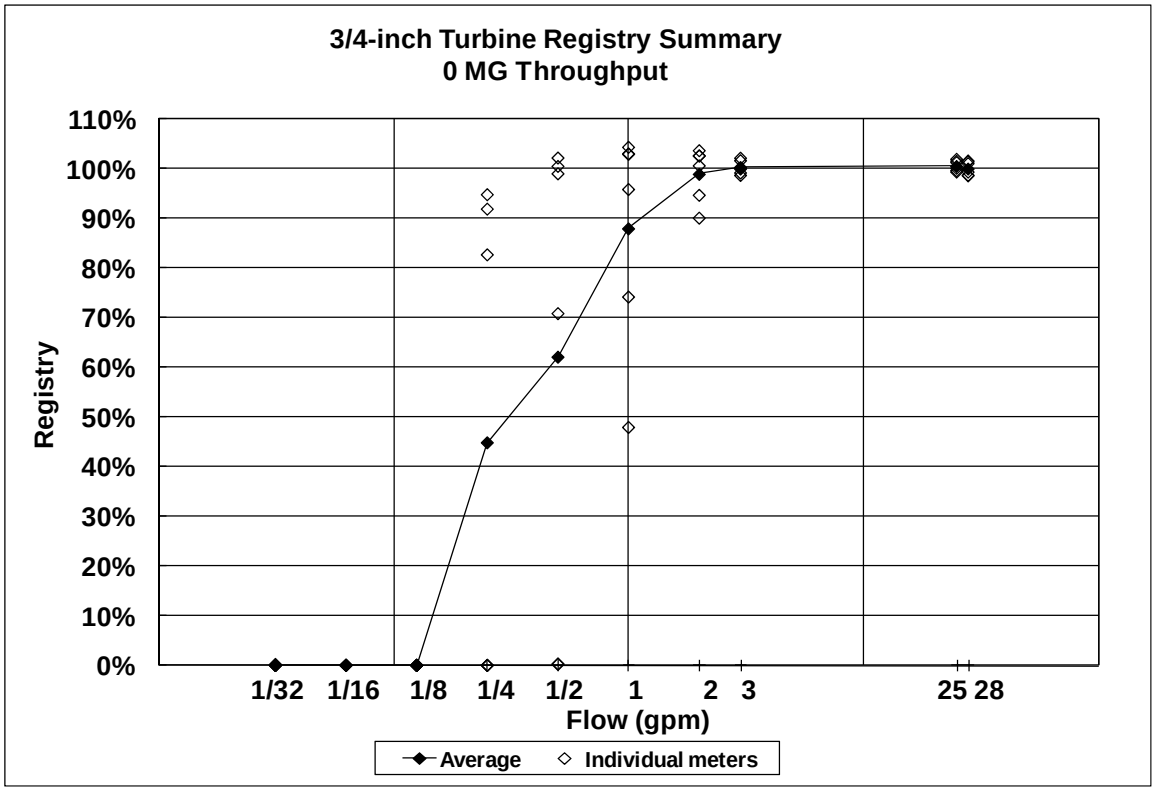

Figure 3.61 3/4-inch turbine 0 MG throughput

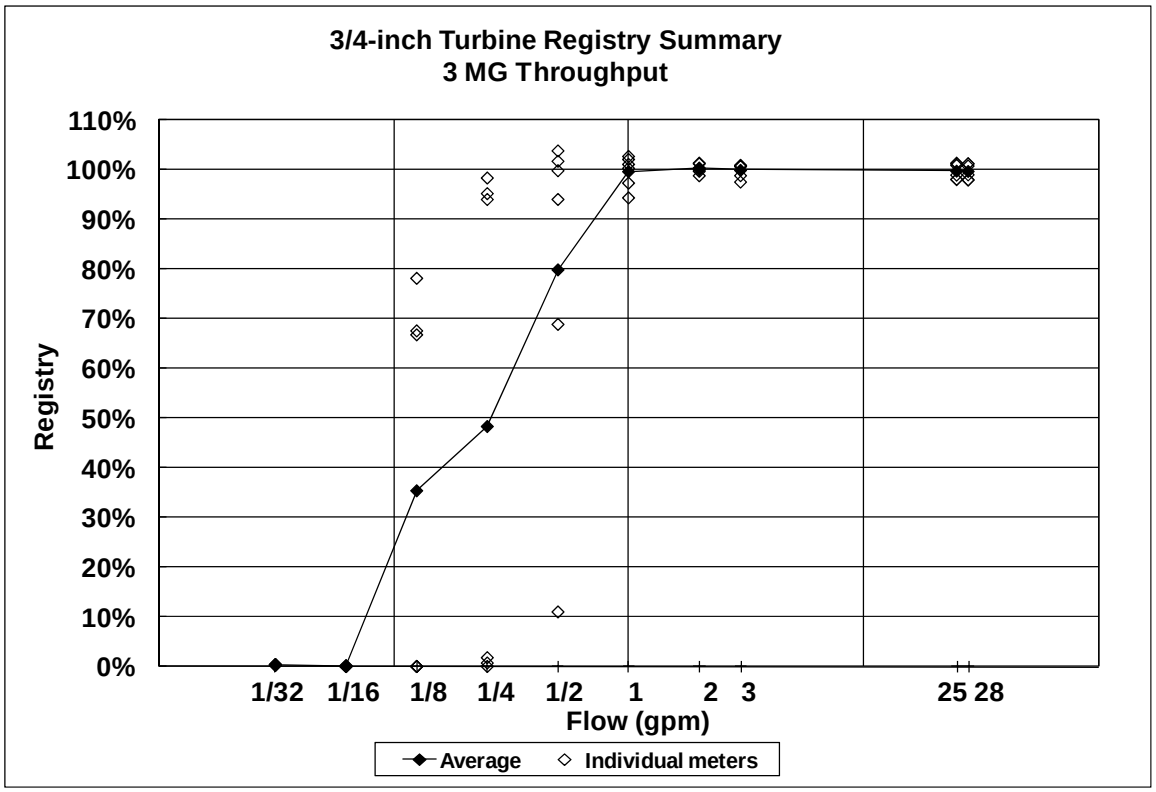

Figure 3.62 3/4-inch turbine 3 MG throughput

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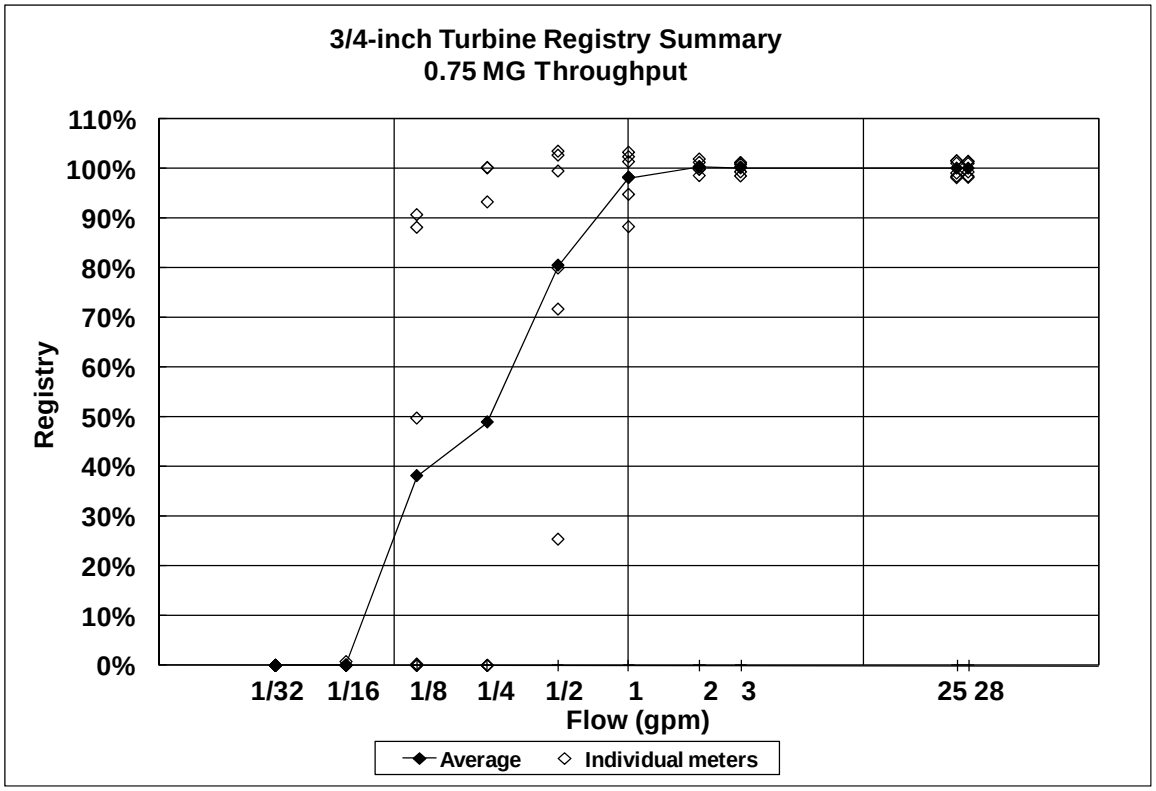

Figure 3.63 3/4-inch turbine 0.75 MG throughput

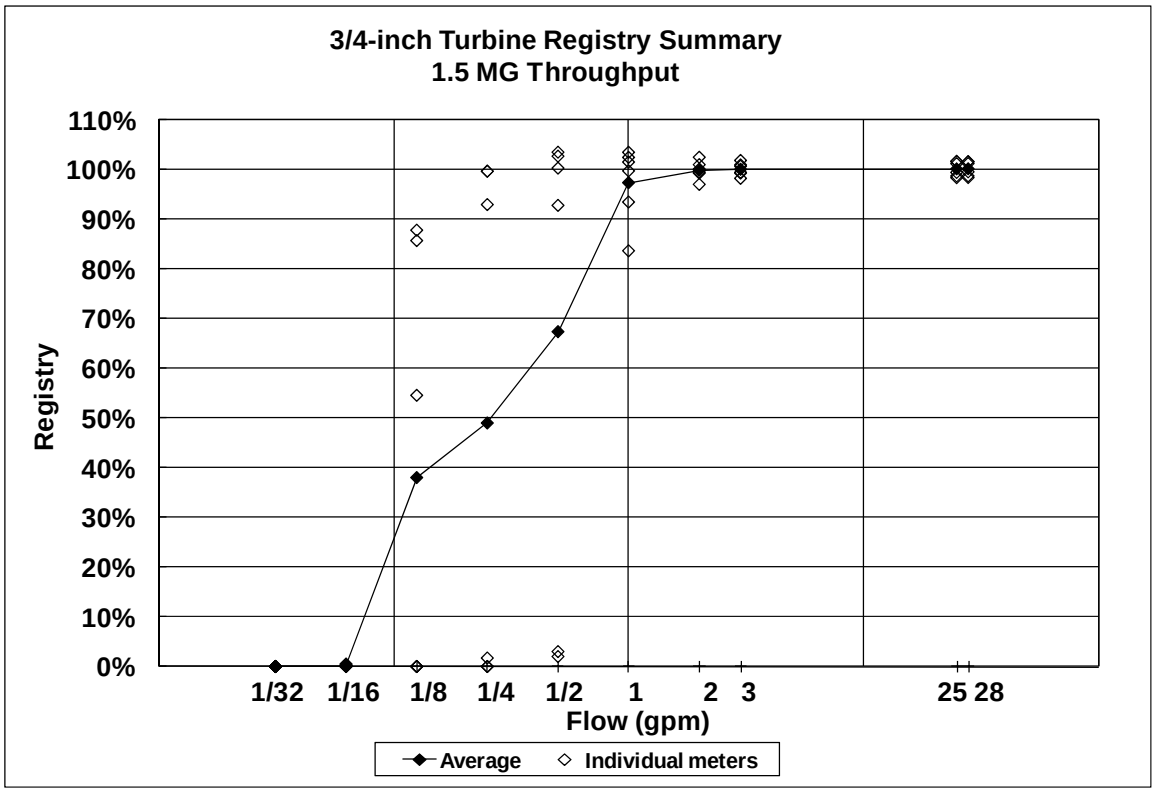

Figure 3.64 3/4-inch turbine 1.5 MG throughput

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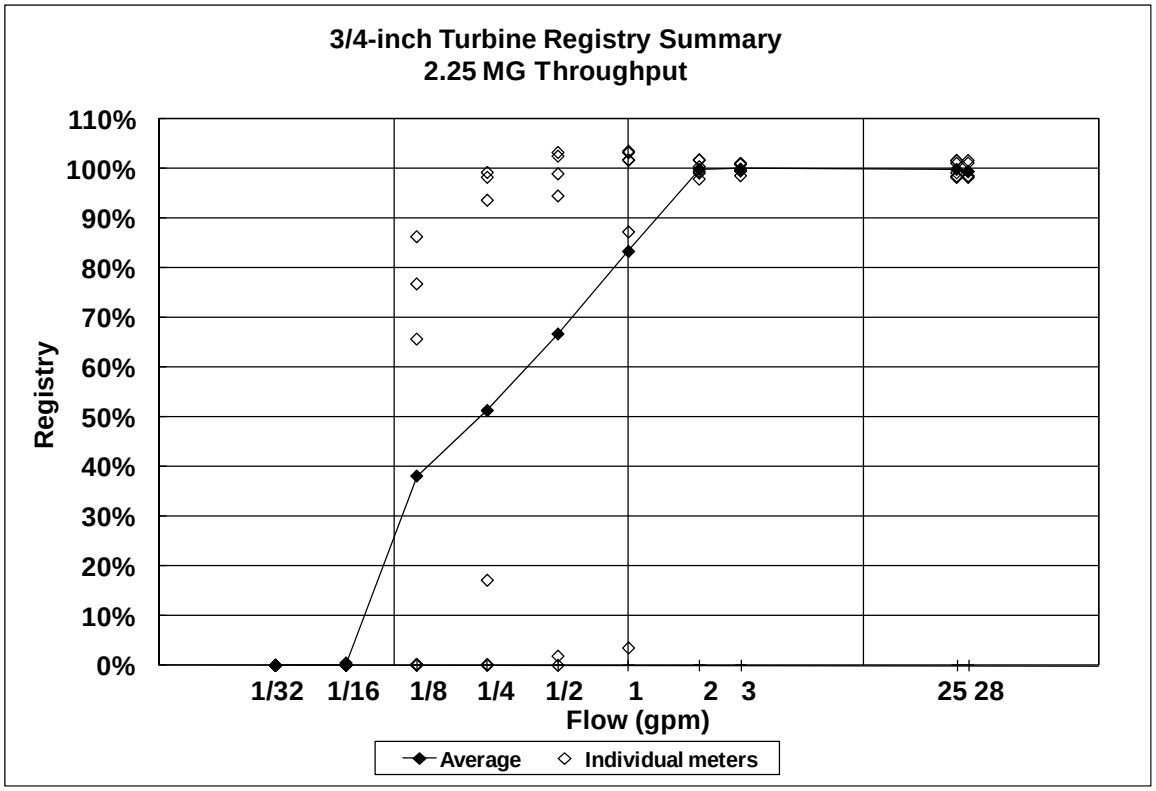

Figure 3.65 3/4-inch turbine 2.25 MG throughput

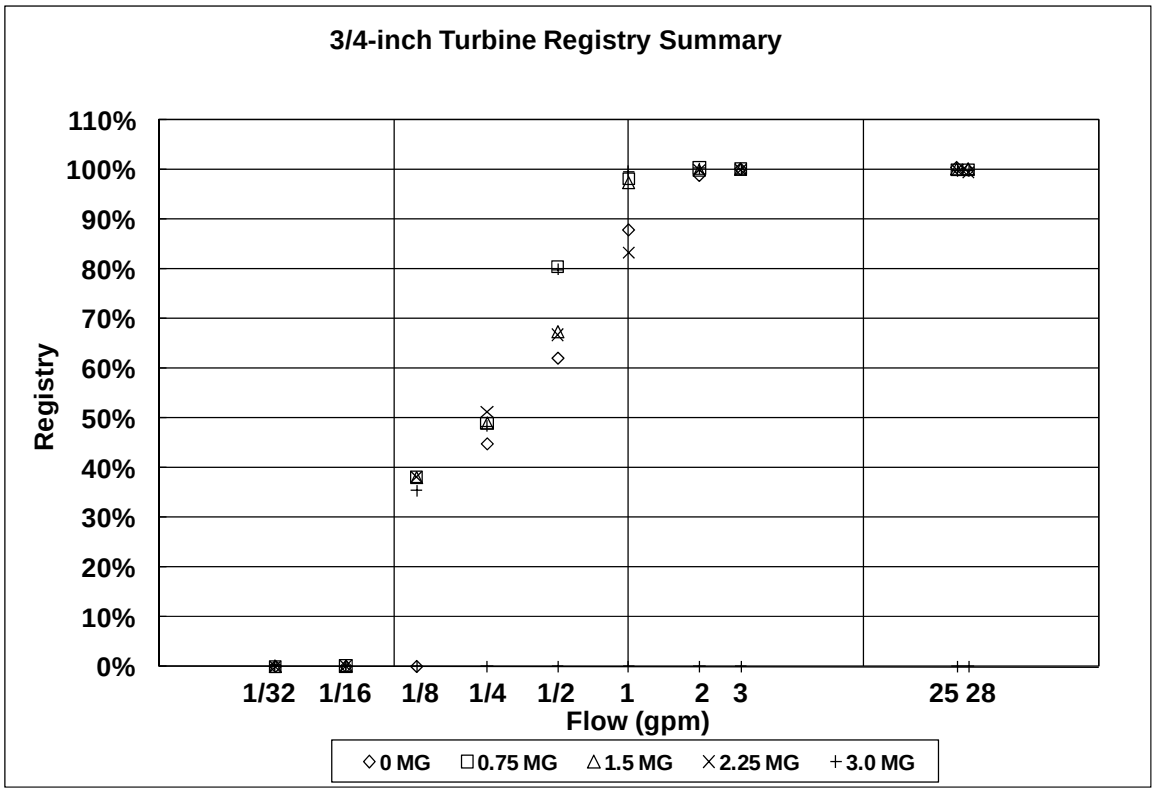

Figure 3.66 3/4-inch turbine registry summary

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1-inch Meters

Figures 3.67 through 3.96 show the results for the 1-inch meters tested in the new condition and their registry at various levels of throughput.

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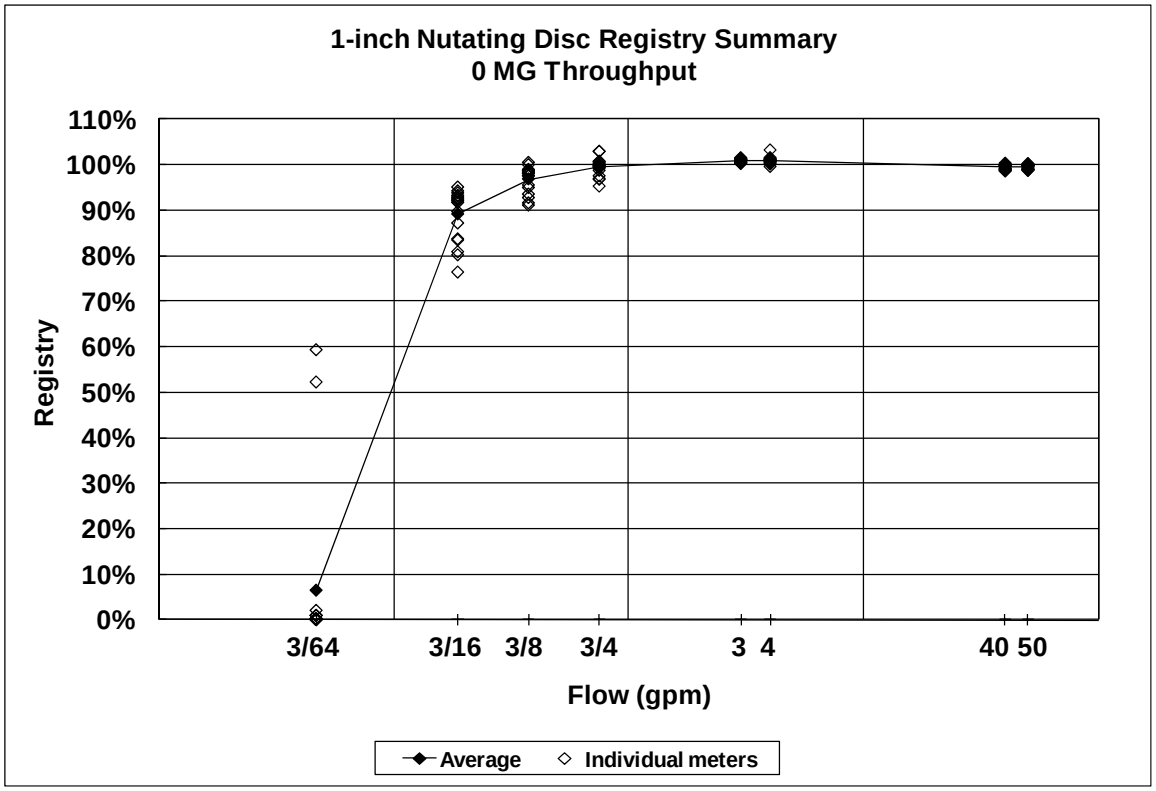

Figure 3.67 1–inch nutating disc 0 MG throughput

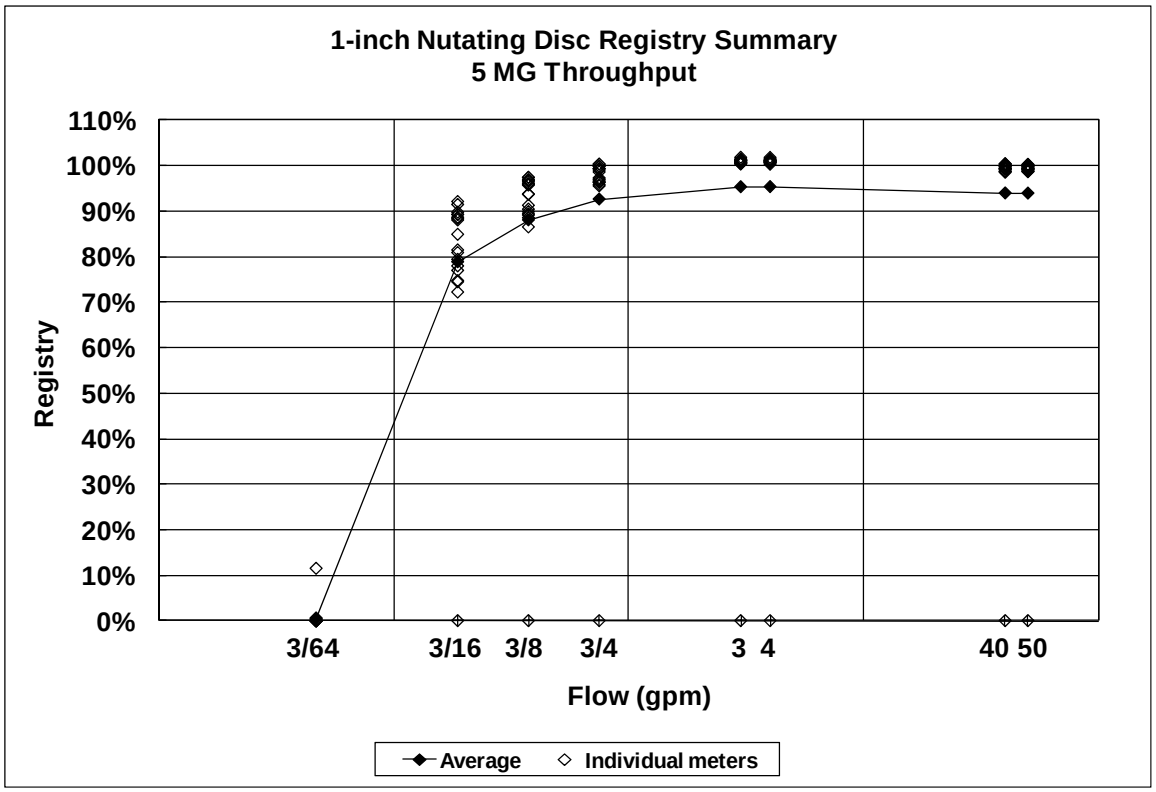

Figure 3.68 1-inch nutating disc 5 MG throughput

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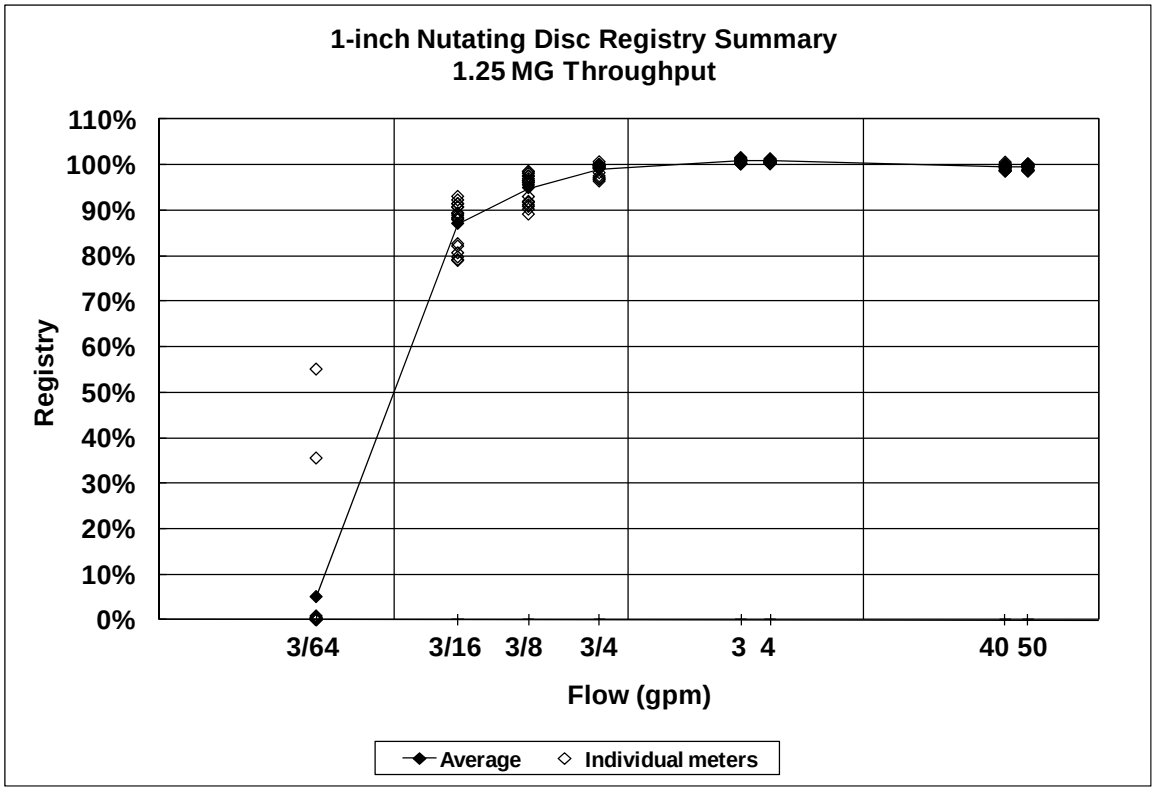

Figure 3.69 1–inch nutating disc 1.25 MG throughput

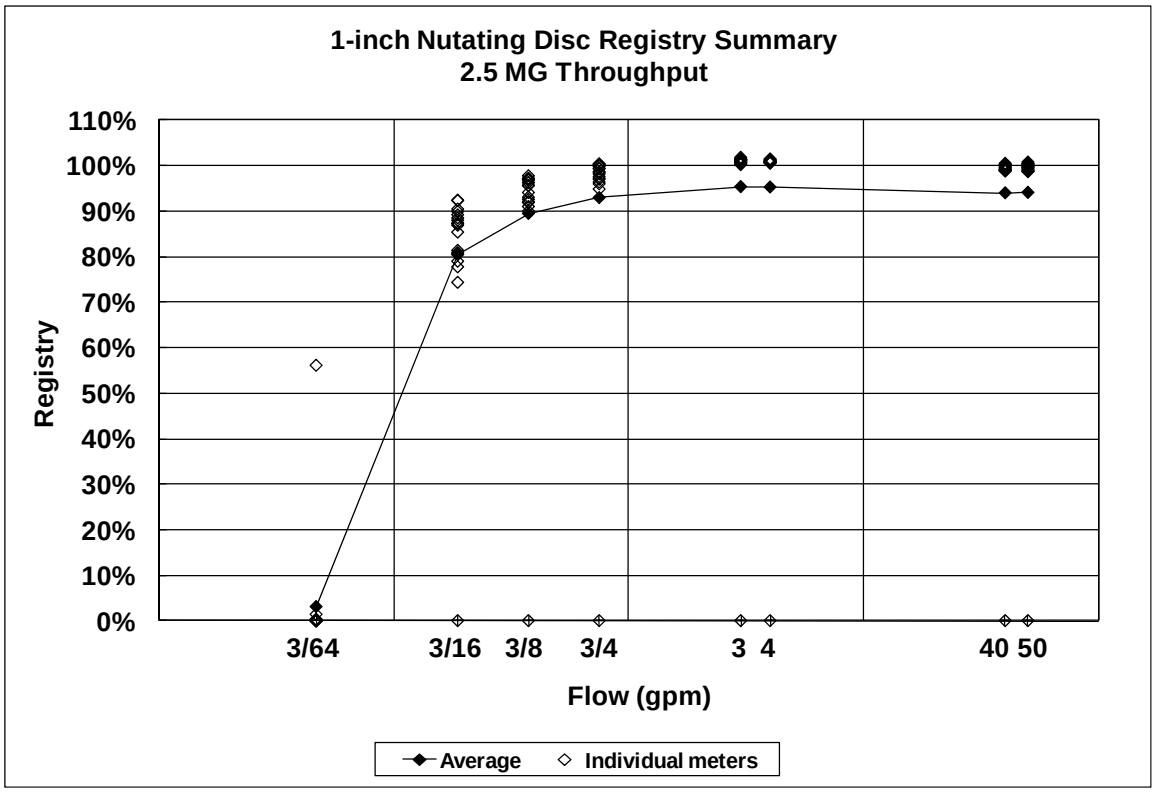

Figure 3.70 1–inch nutating disc 2.5 MG throughput

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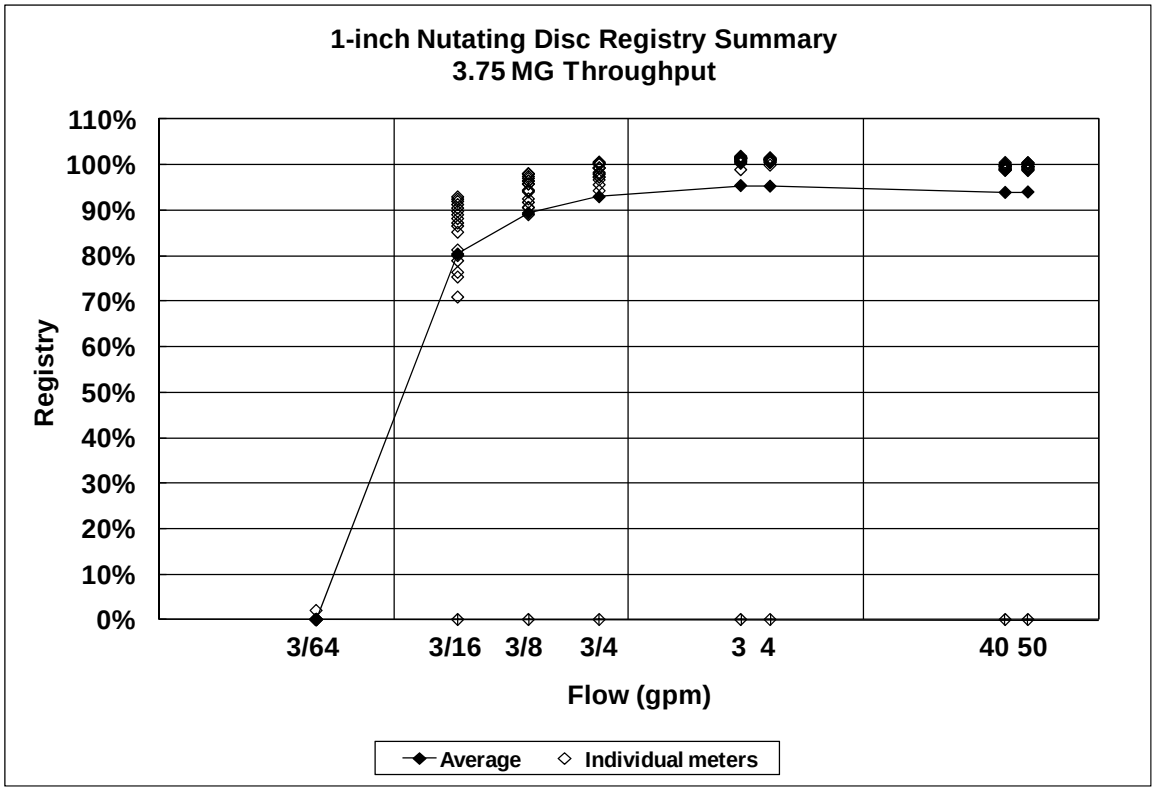

Figure 3.71 1–inch nutating disc 3.75 MG throughput

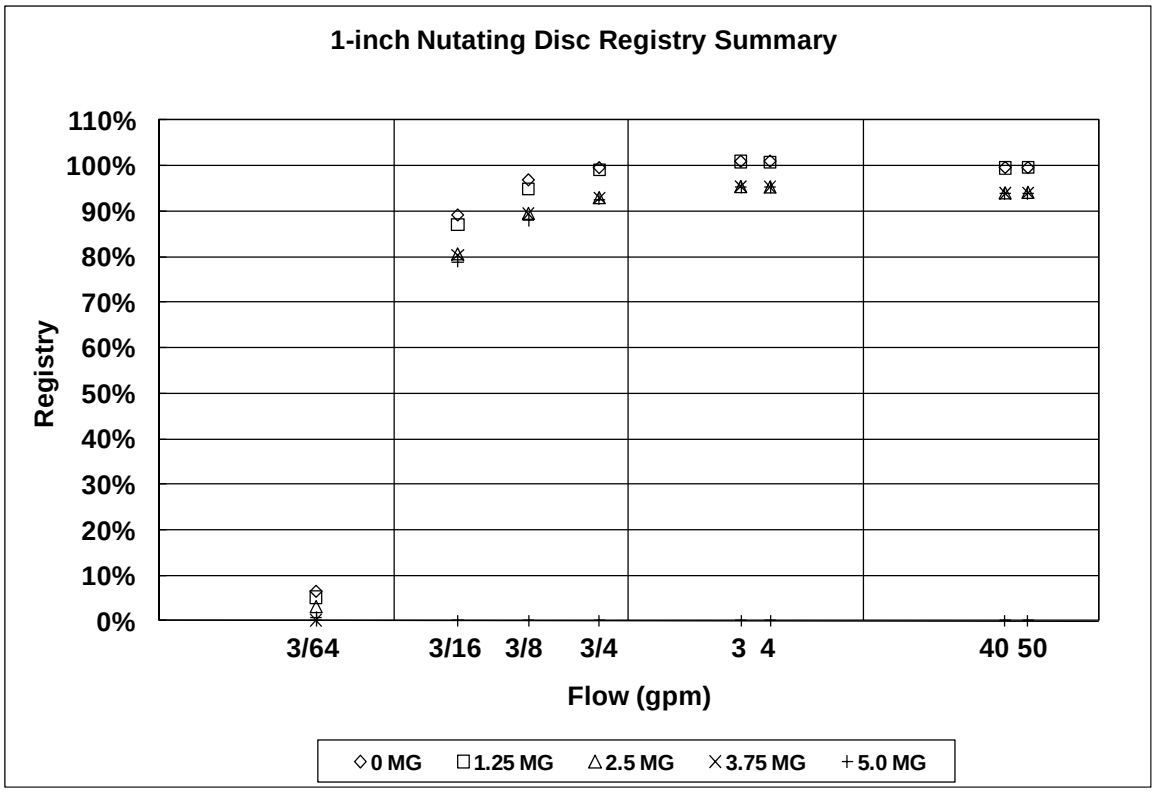

Figure 3.72 1-inch nutating disc registry summary

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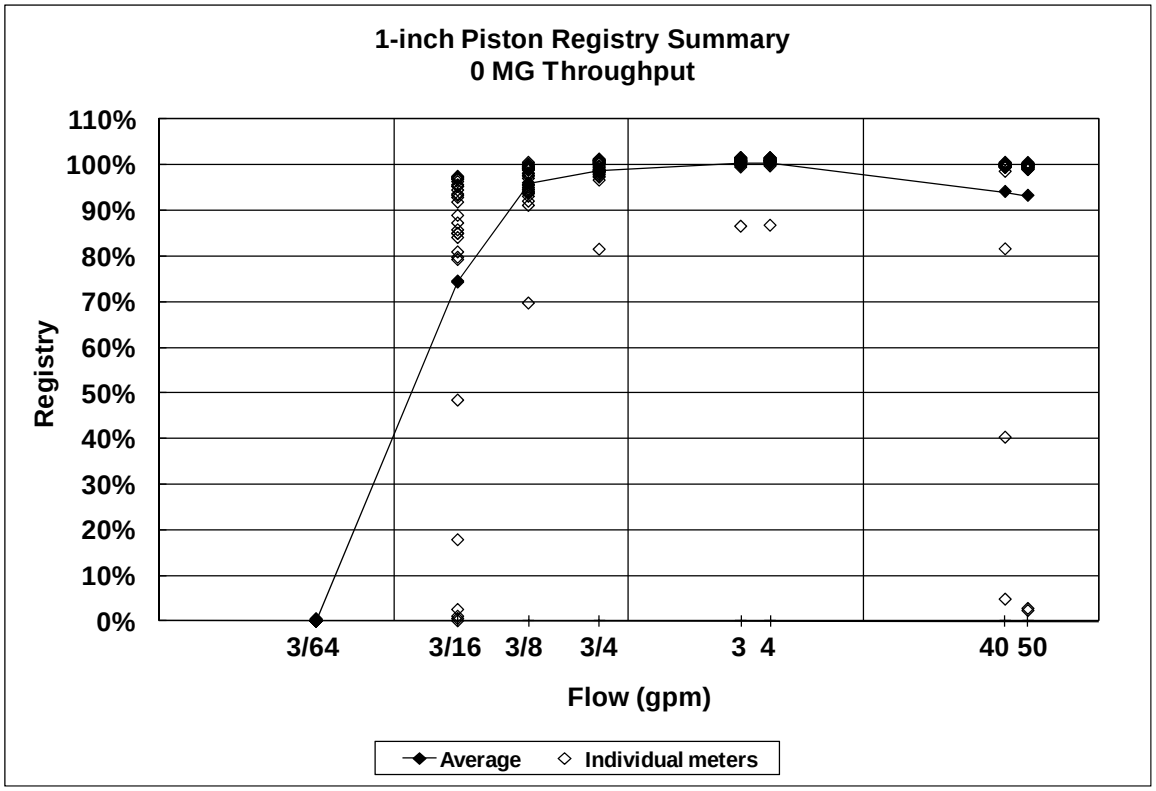

Figure 3.73 1-inch piston 0 MG throughput

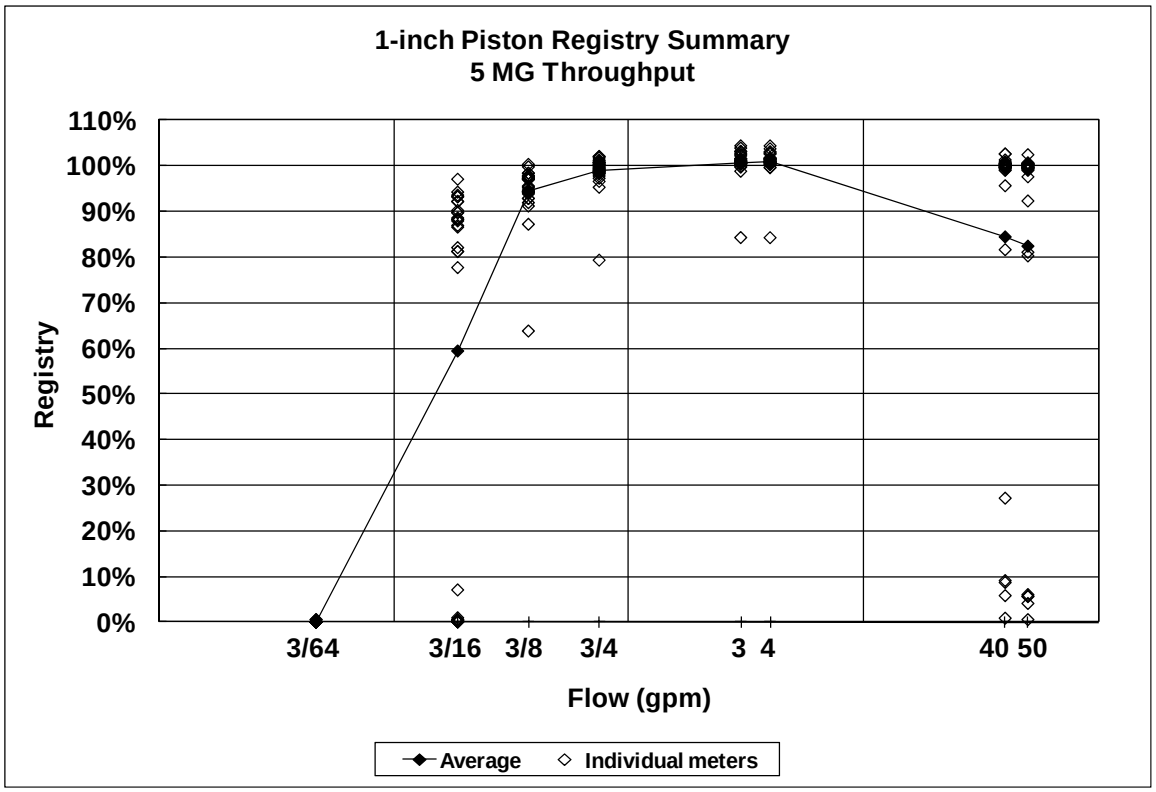

Figure 3.74 1-inch piston 5 MG throughput

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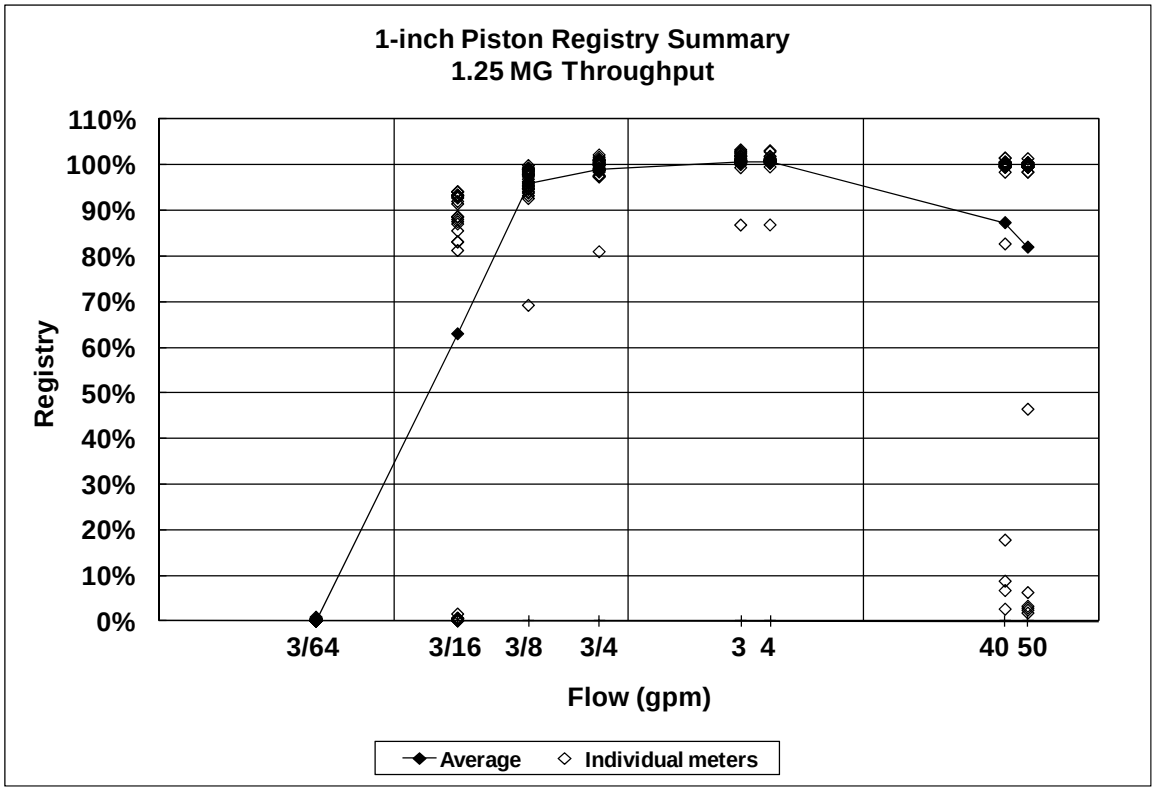

Figure 3.75 1-inch piston 1.25 MG throughput

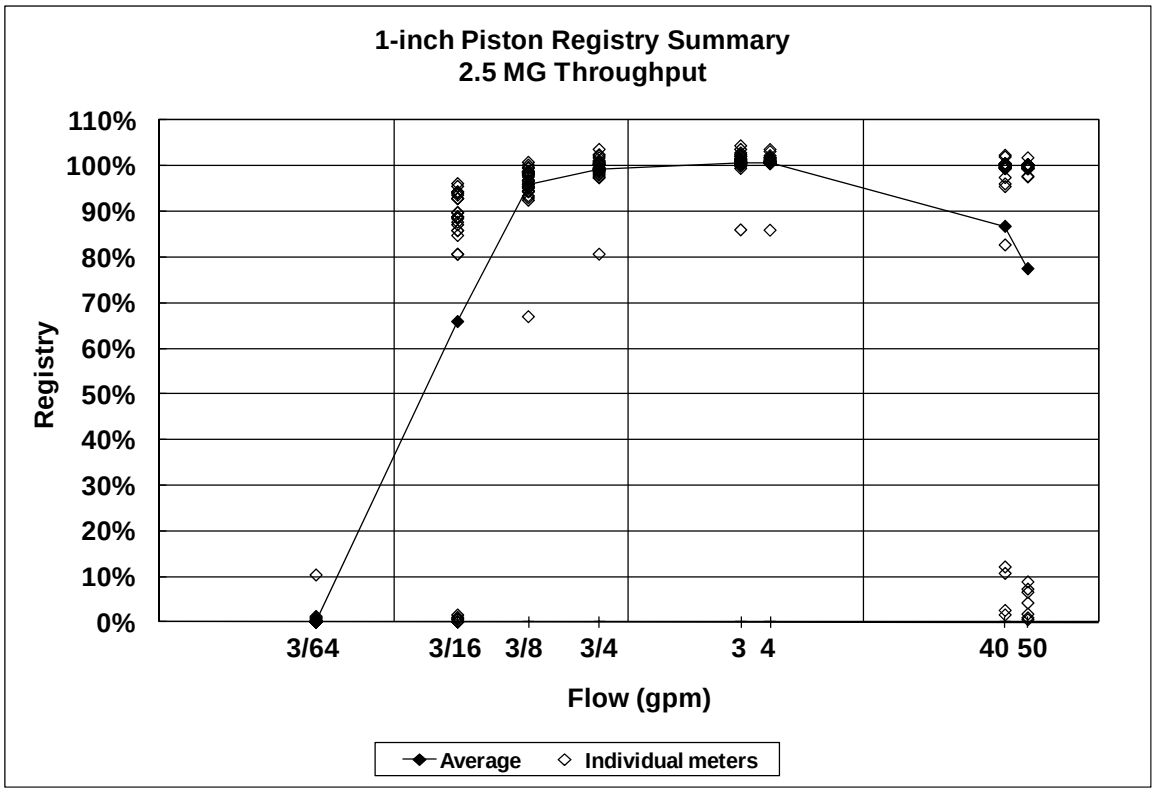

Figure 3.76 1-inch piston 2.5 MG throughput

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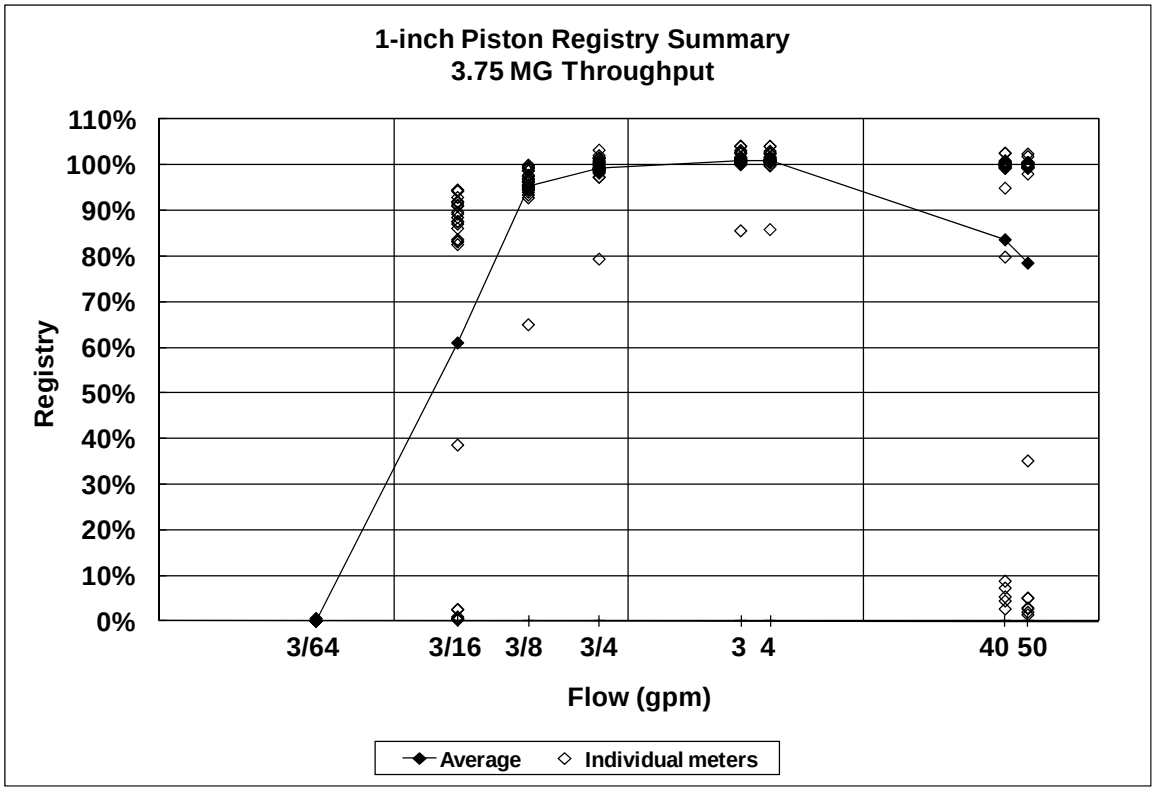

Figure 3.77 1-inch piston 3.75 MG throughput

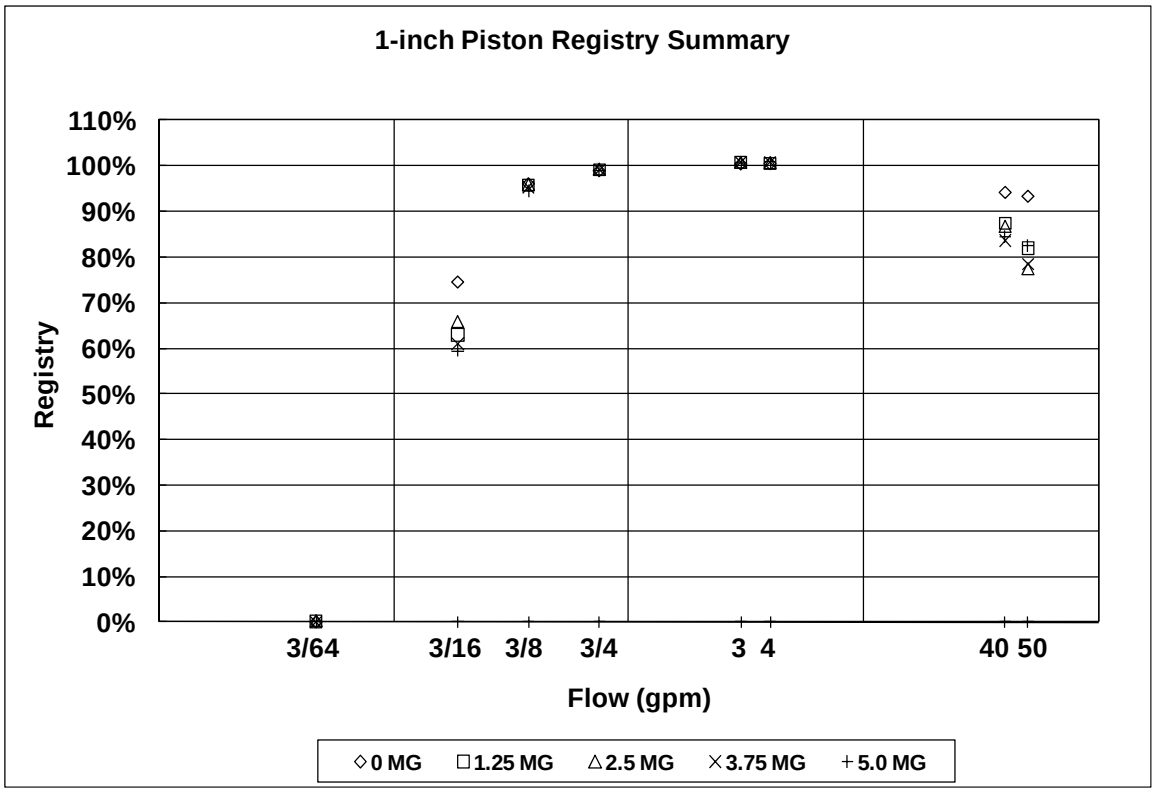

Figure 3.78 1-inch piston registry summary

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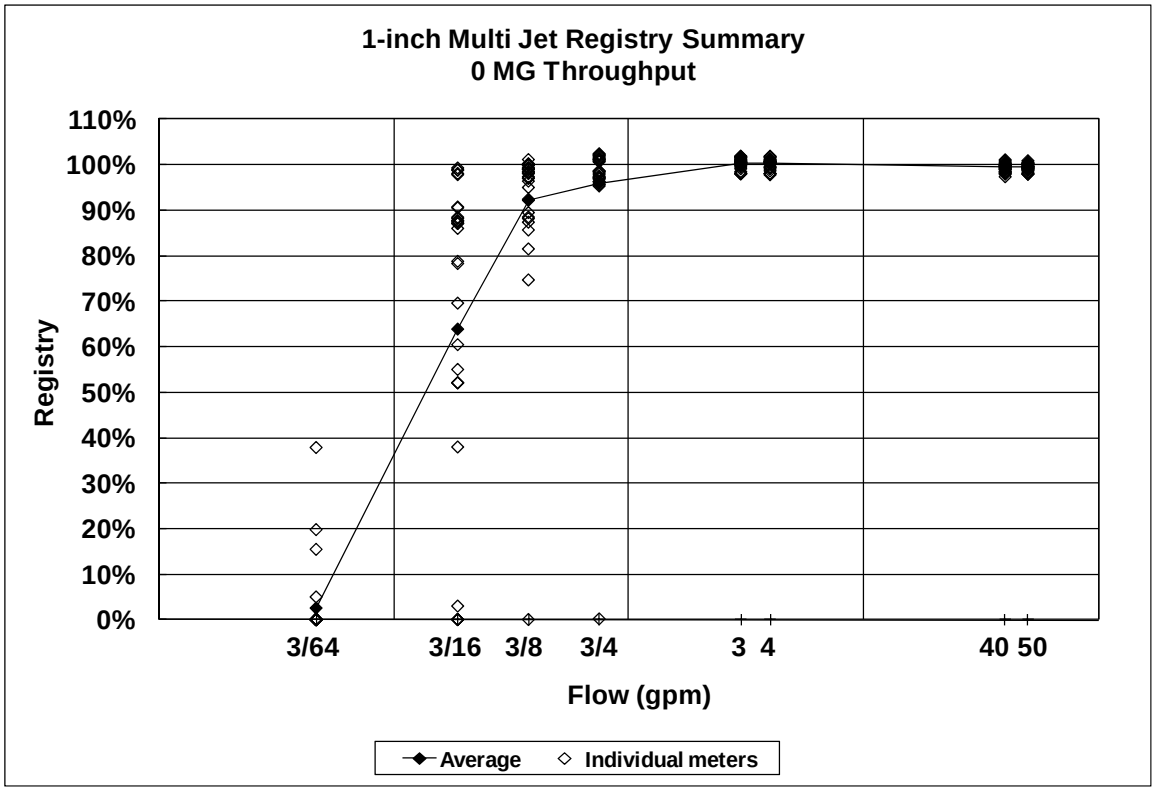

Figure 3.79 1-inch multi-jet 0 MG throughput

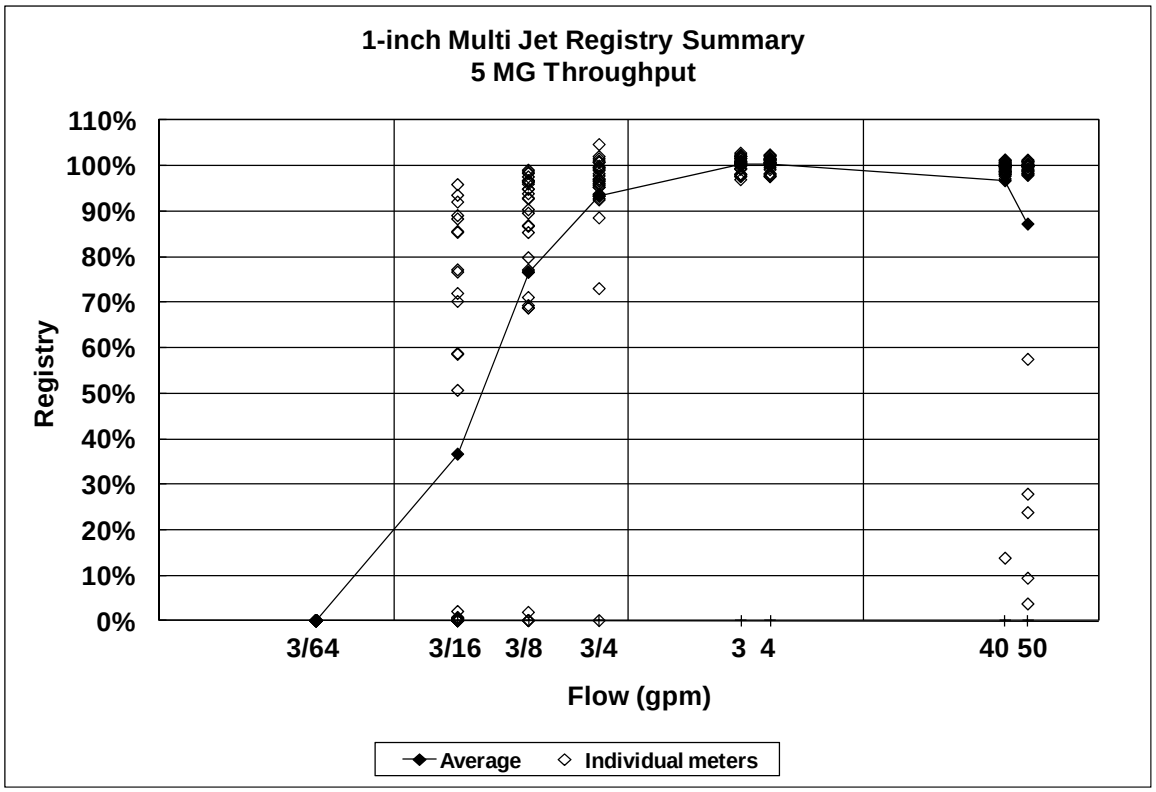

Figure 3.80 1-inch multi-jet 5 MG throughput

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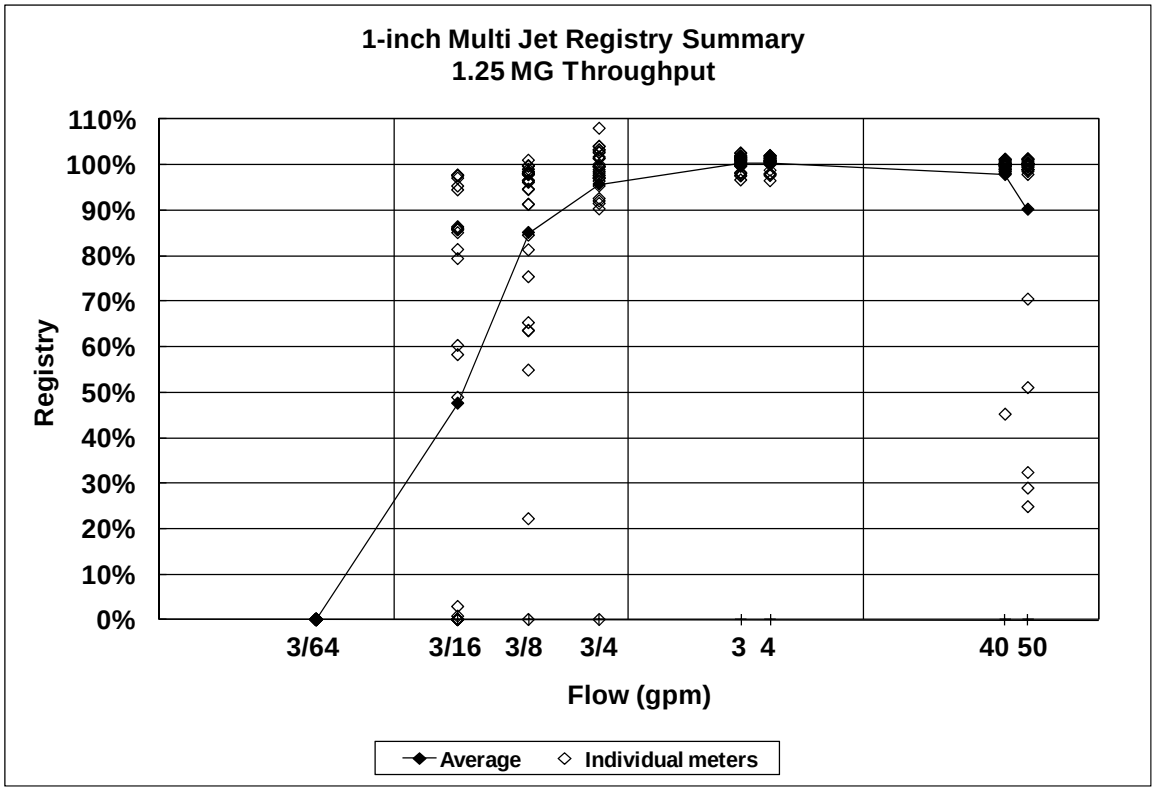

Figure 3.81 1-inch multi-jet 1.25 MG throughput

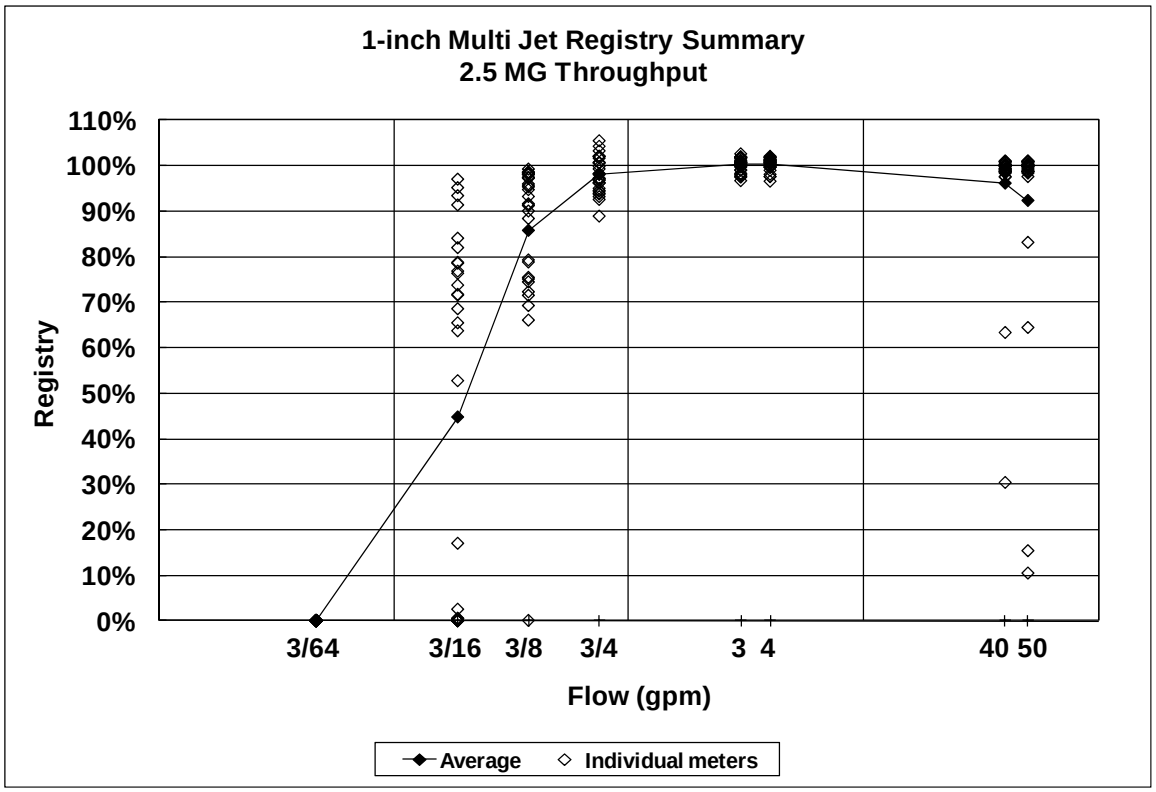

Figure 3.82 1-inch multi-jet 2.5 MG throughput

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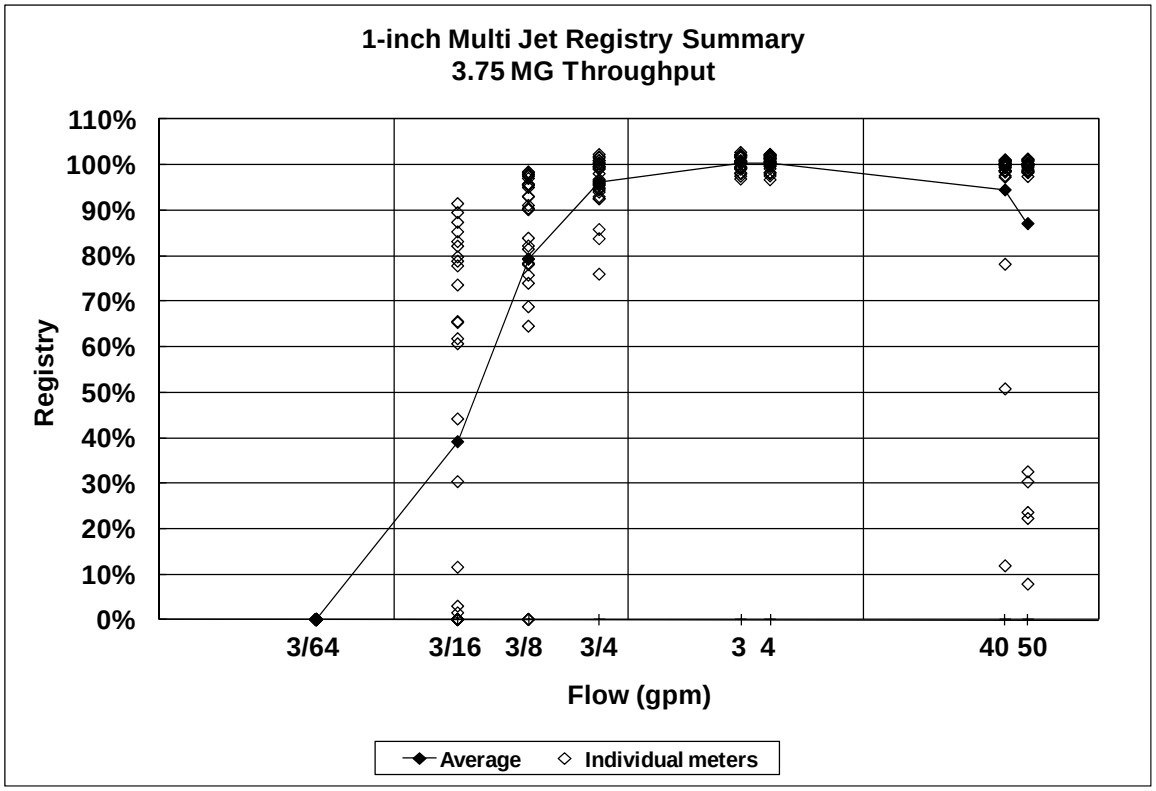

Figure 3.83 1-inch multi-jet 3.75 MG throughput

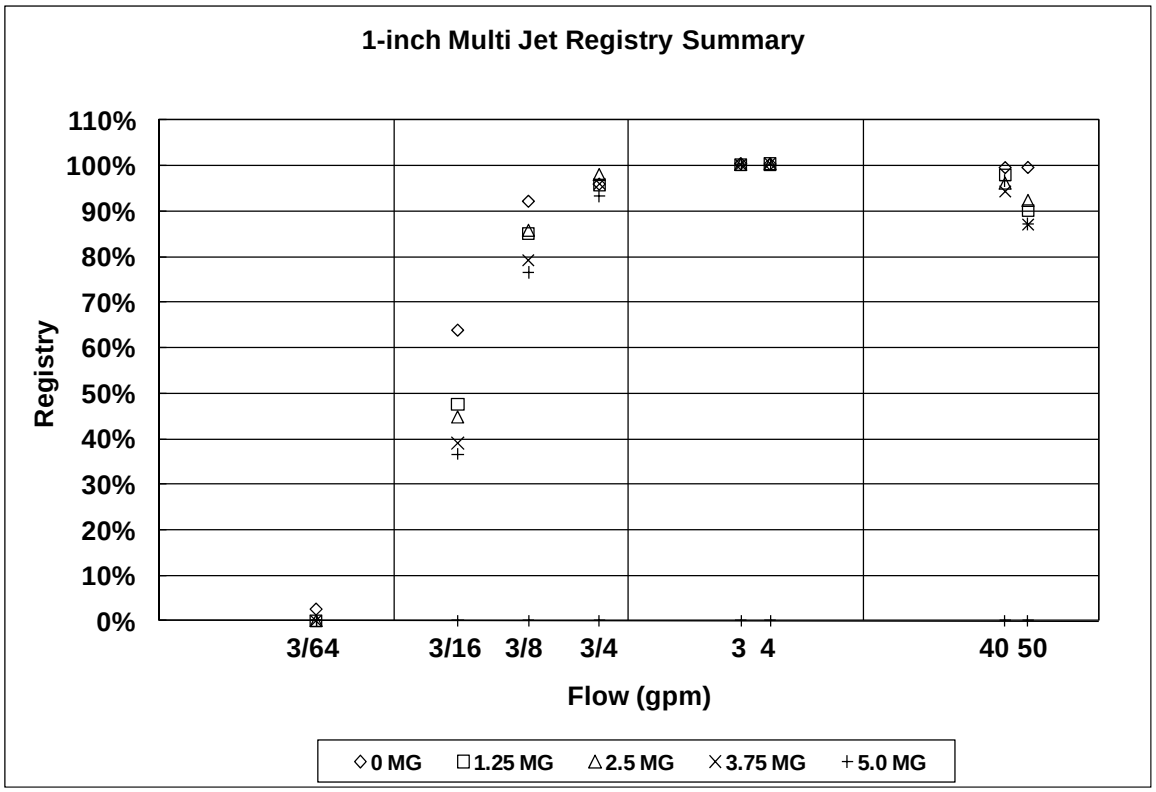

Figure 3.84 1-inch multi-jet registry summary

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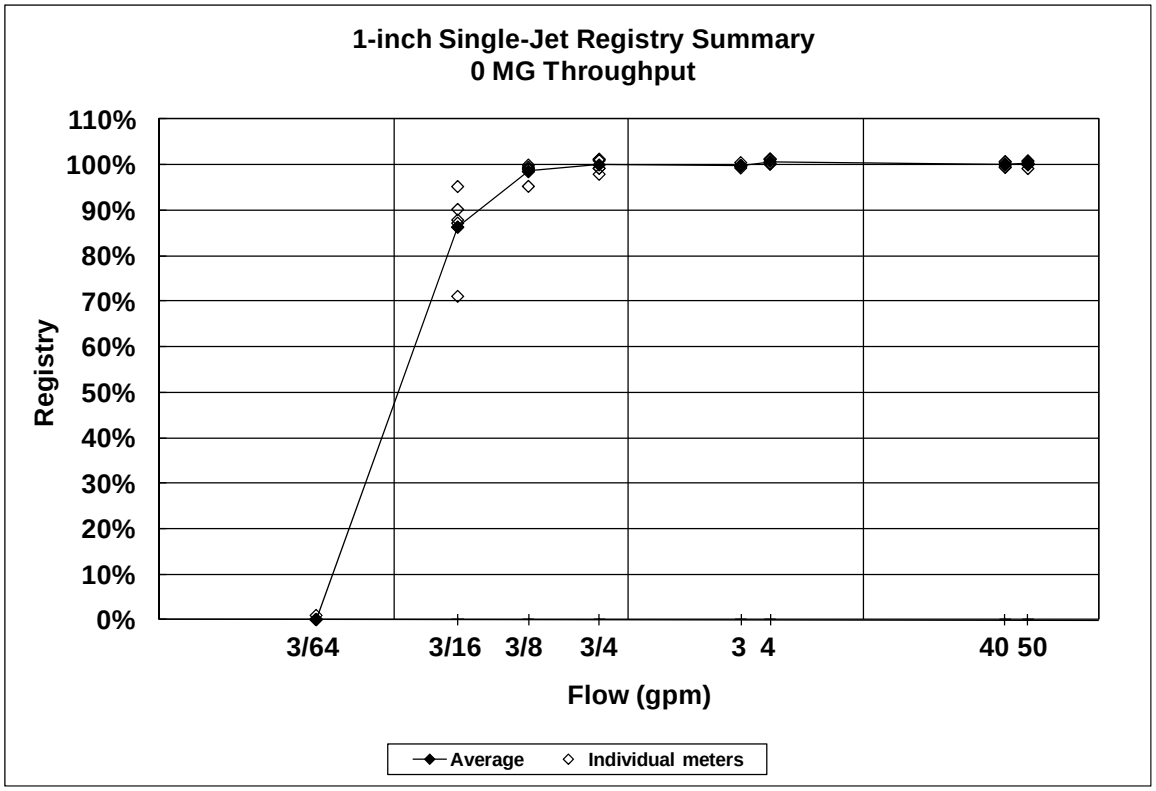

Figure 3.85 1-inch single-jet 0 MG throughput

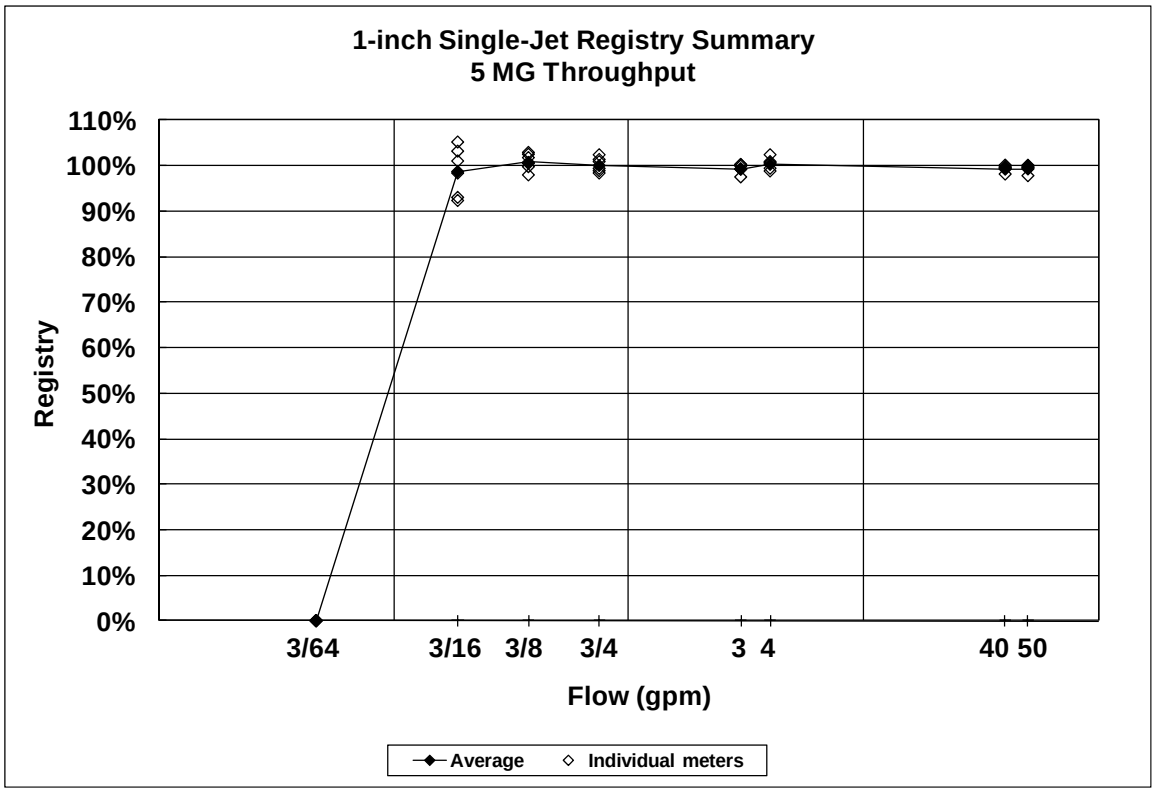

Figure 3.86 1-inch single-jet 5 MG throughput

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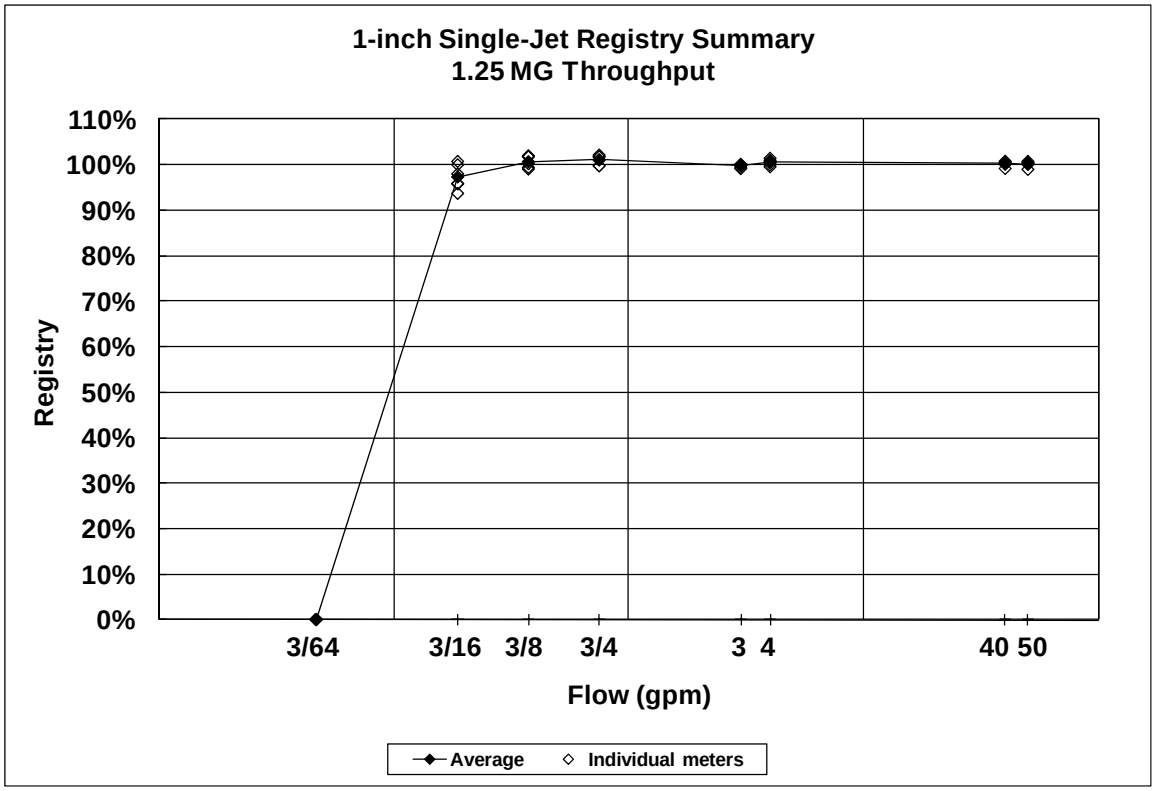

Figure 3.87 1-inch single-jet 1.25 MG throughput

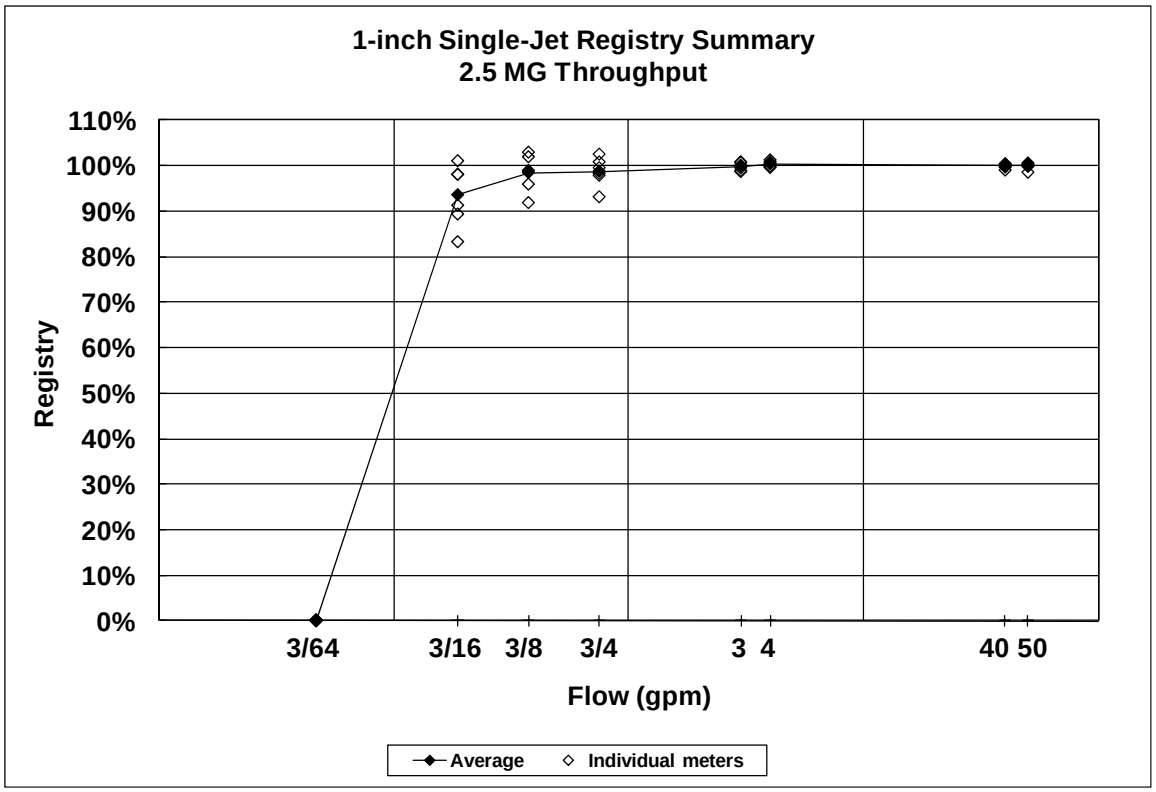

Figure 3.88 1-inch single-jet 2.5 MG throughput

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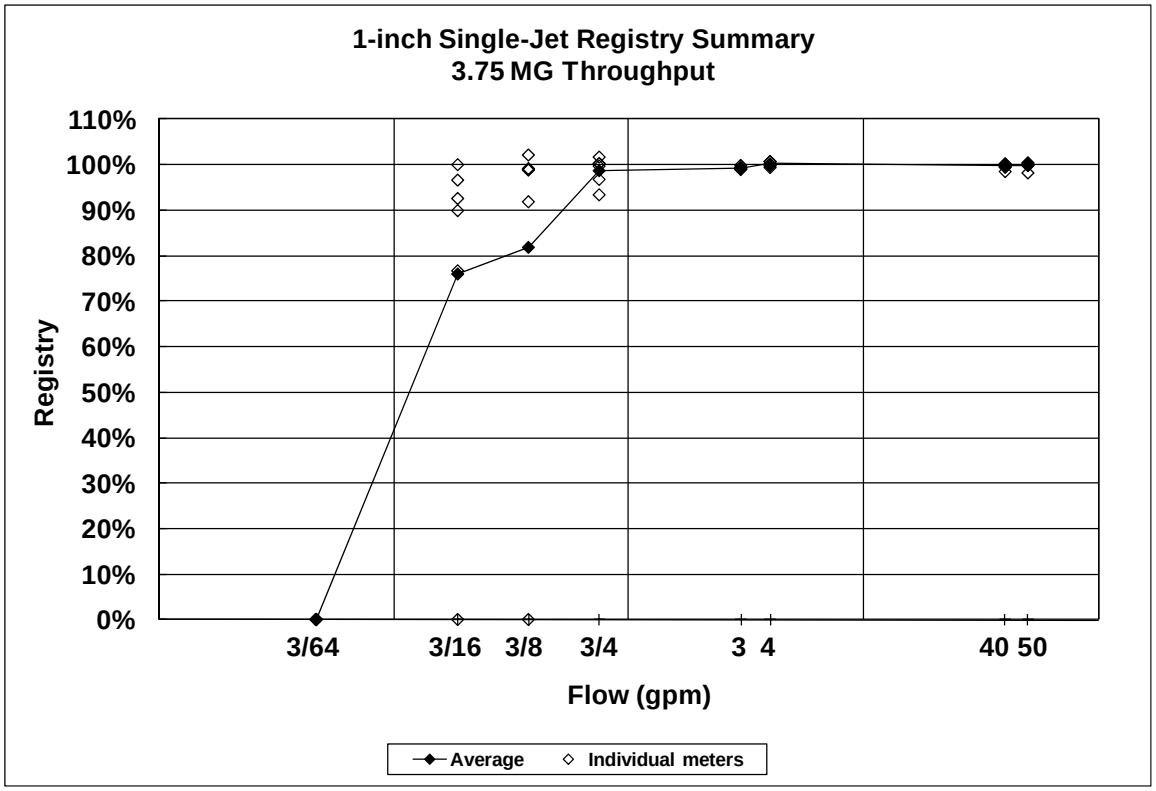

Figure 3.89 1-inch single-jet 3.75 MG throughput

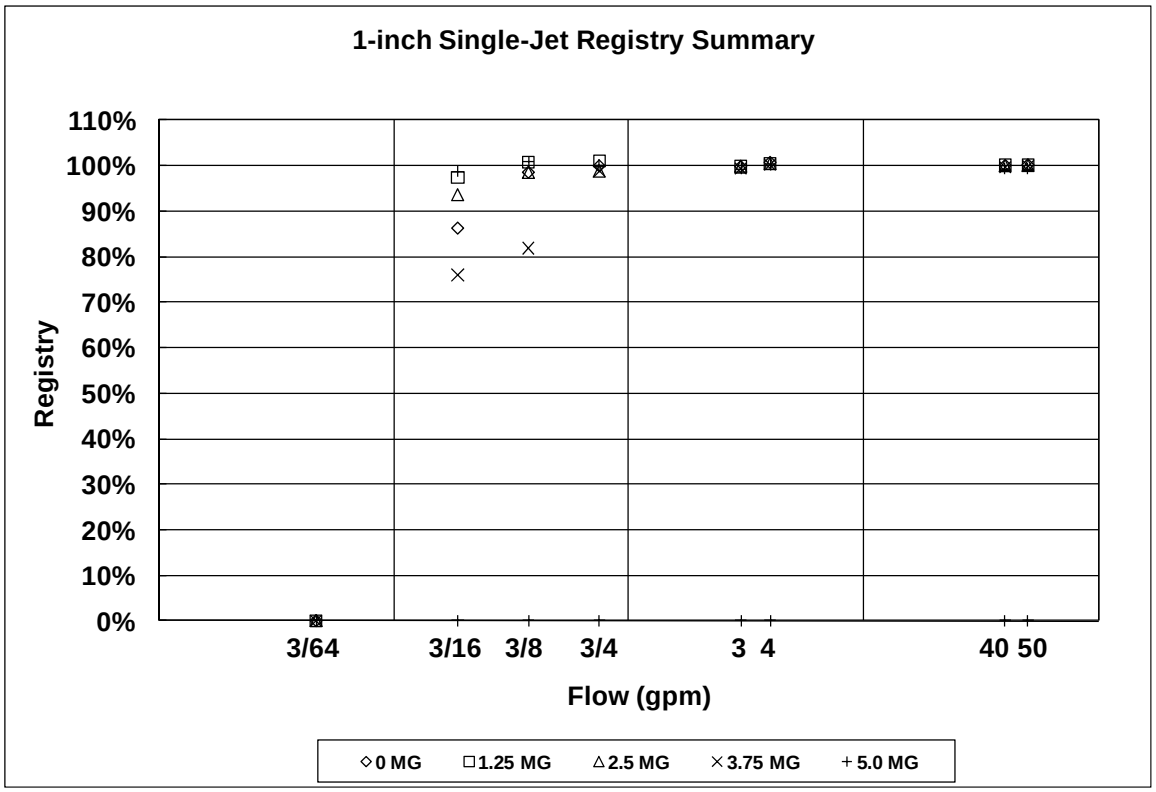

Figure 3.90 1-inch single-jet registry summary

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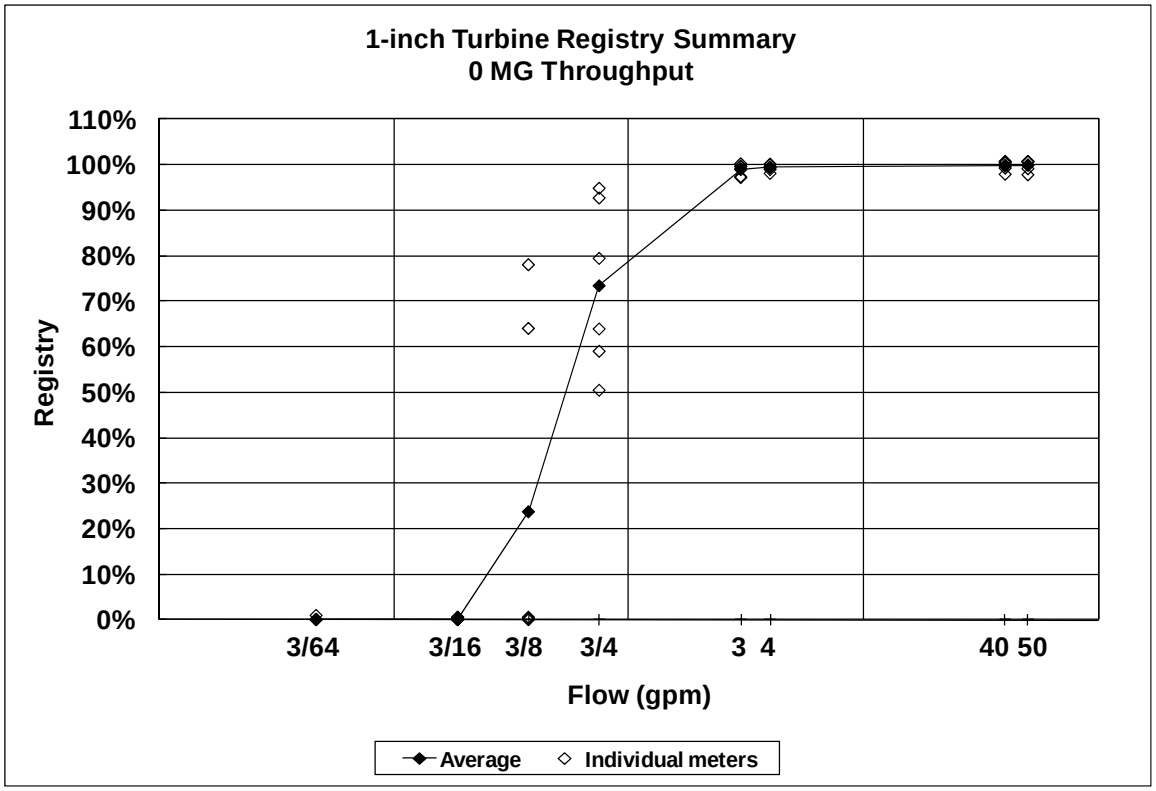

Figure 3.91 1-inch turbine 0 MG throughput

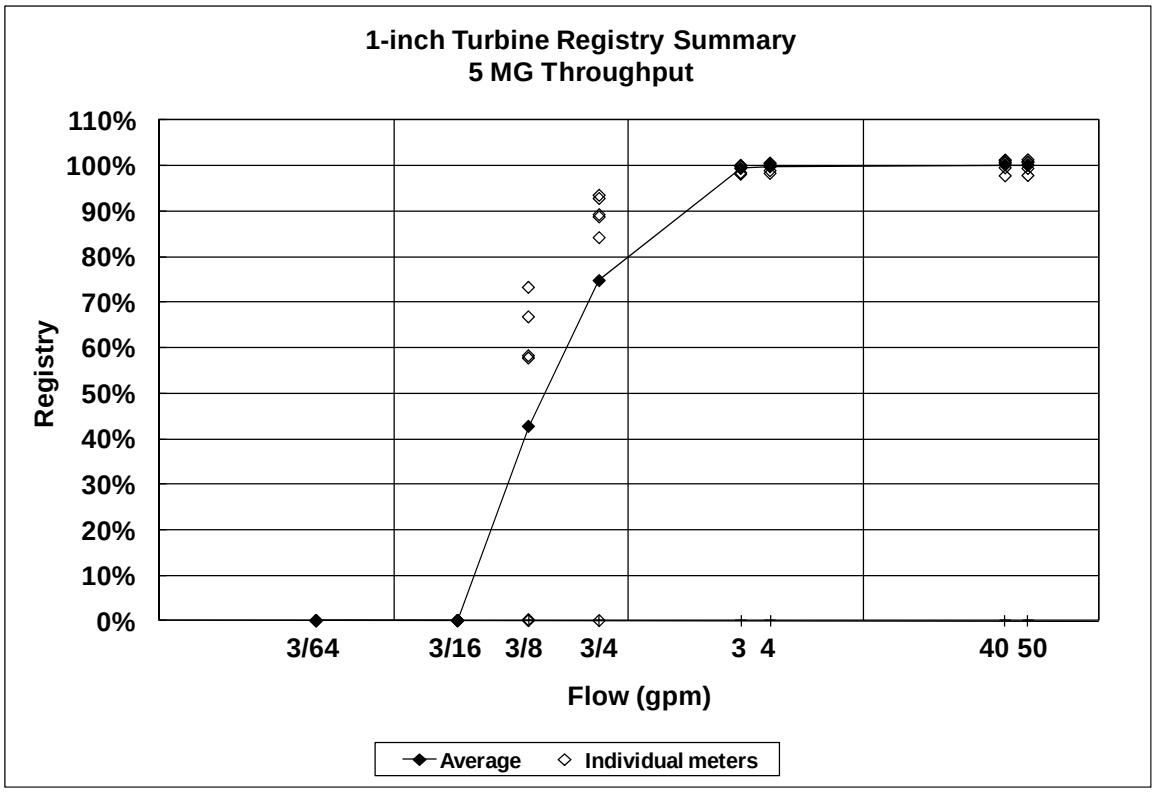

Figure 3.92 1-inch turbine 5 MG throughput

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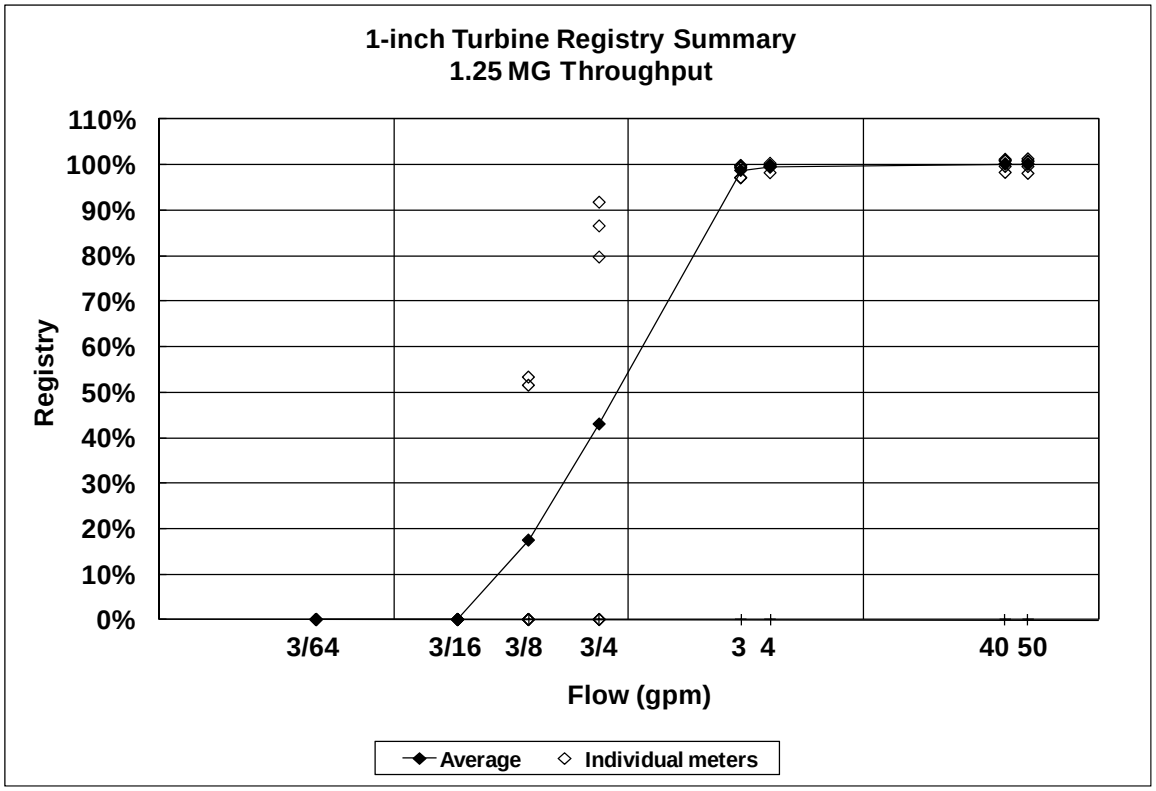

Figure 3.93 1-inch turbine 1.25 MG throughput

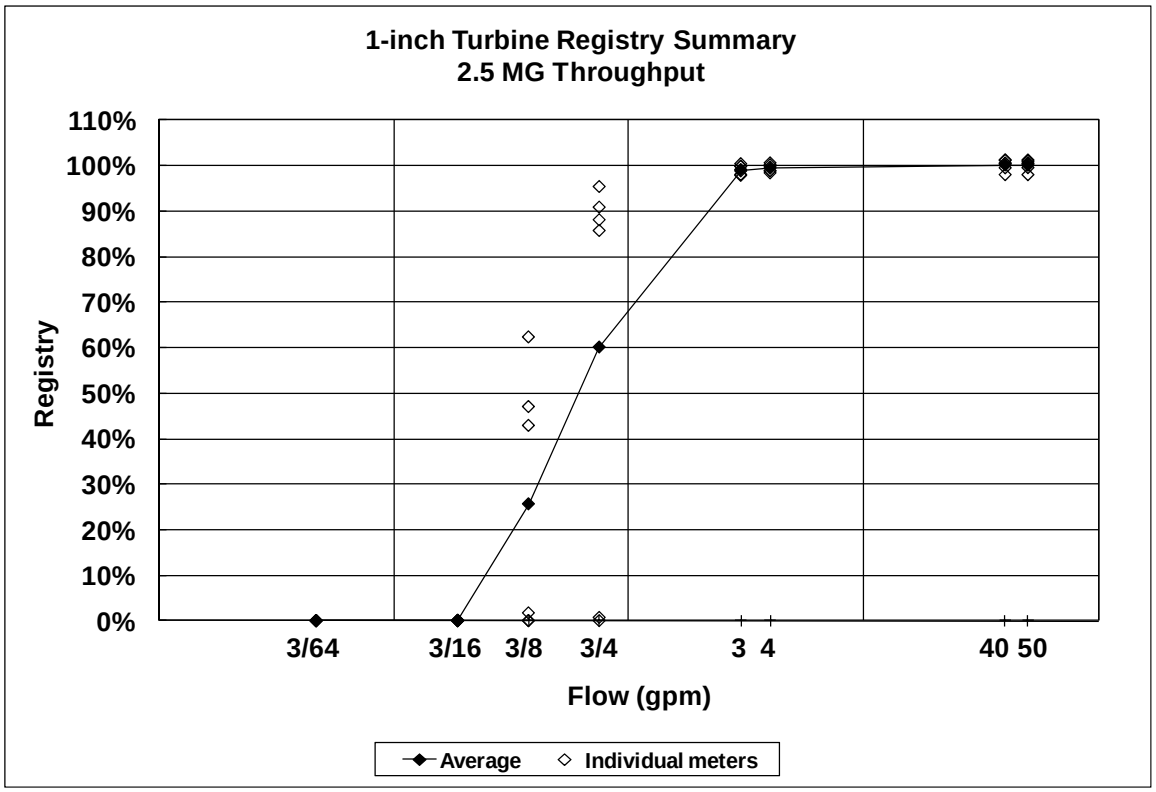

Figure 3.94 1-inch turbine 2.5 MG throughput

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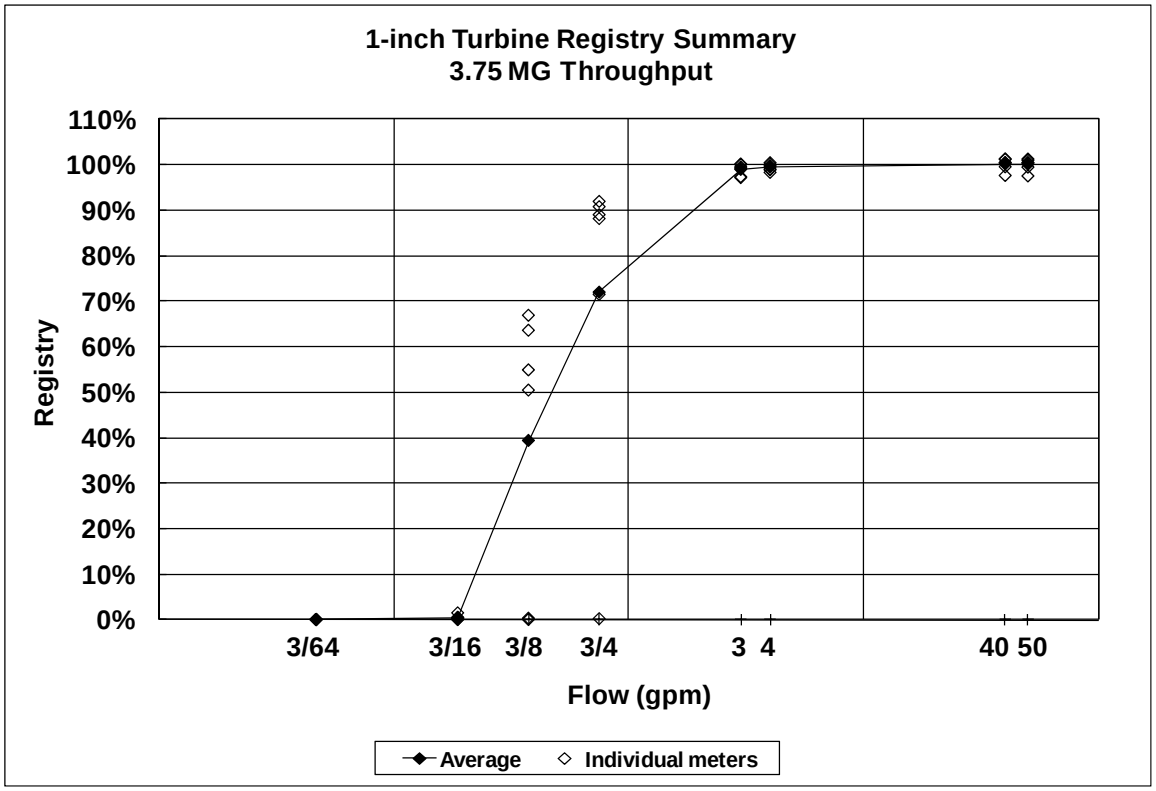

Figure 3.95 1-inch turbine 3.75 MG throughput

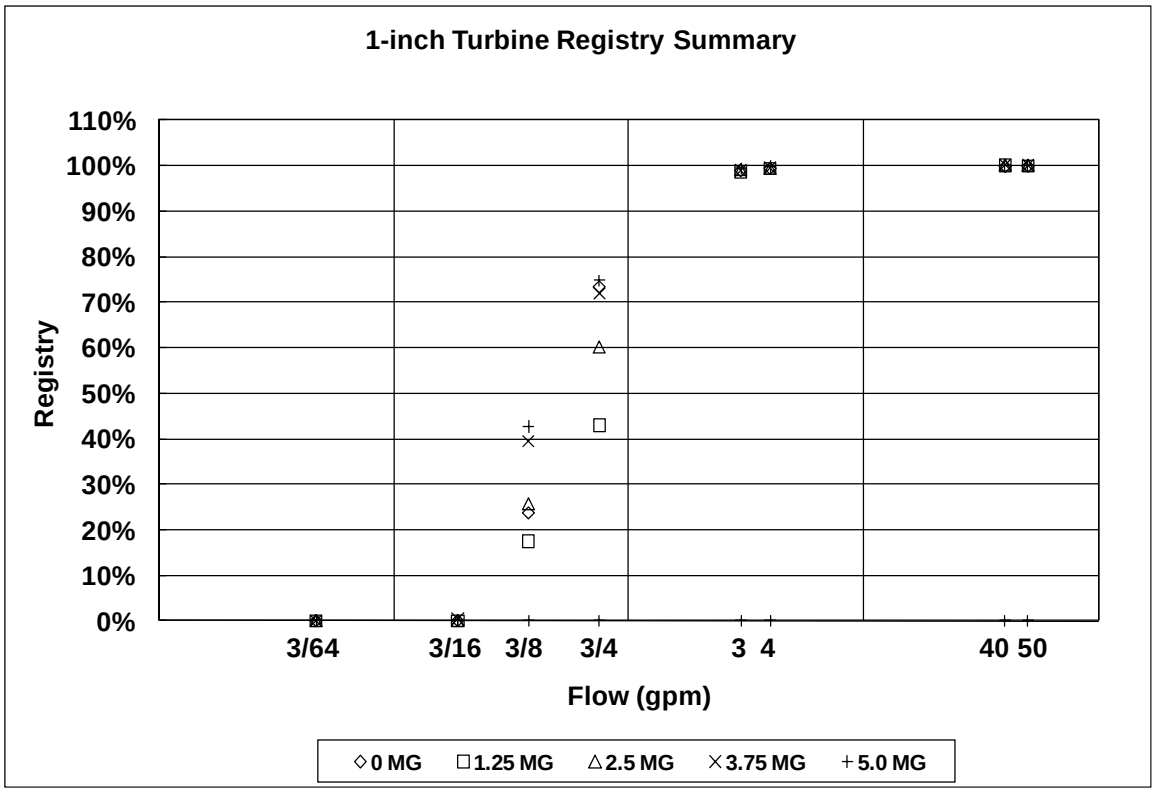

Figure 3.96 1-inch turbine registry summary

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1 1/2-inch Meters

Figures 3.97 through 3.121 show the results for the 1 1/2-inch meters tested in the new condition and their registry at various levels of throughput.

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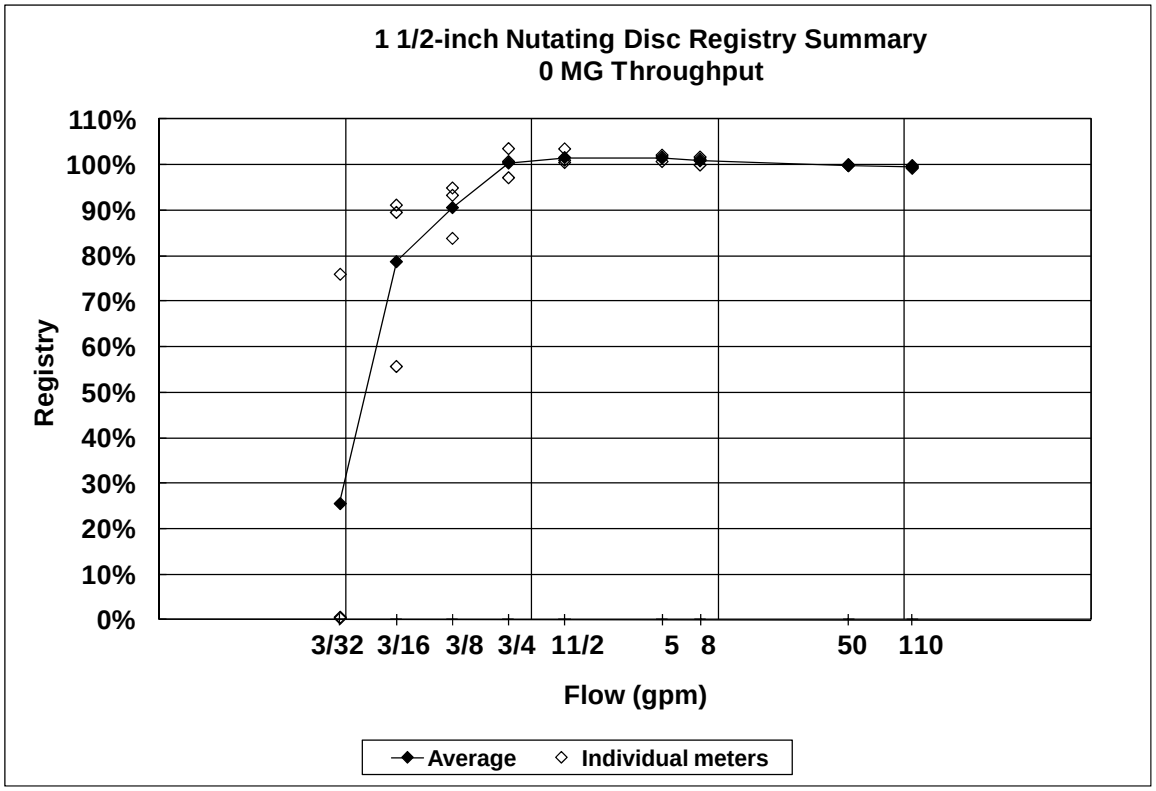

Figure 3.97 1 1/2–inch nutating disc 0 MG throughput

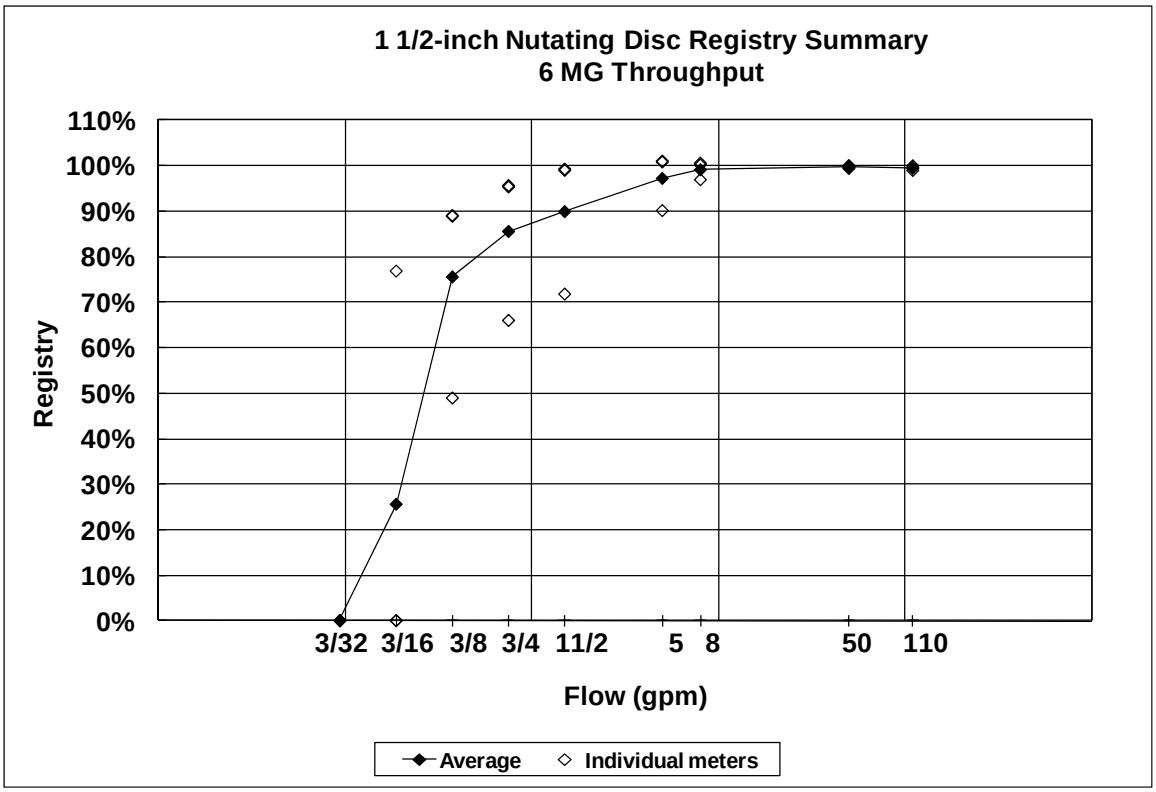

Figure 3.98 1 1/2-inch nutating disc 6 MG throughput

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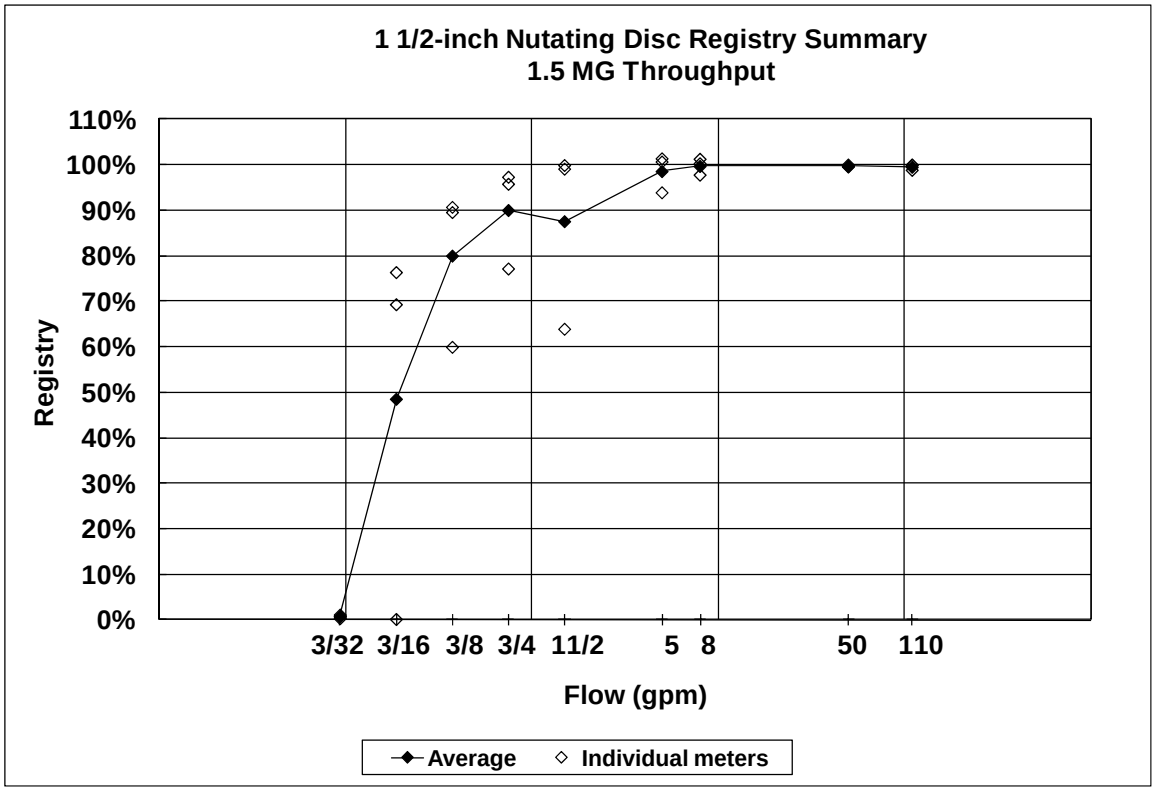

Figure 3.99 1 1/2–inch nutating disc 1.5 MG throughput

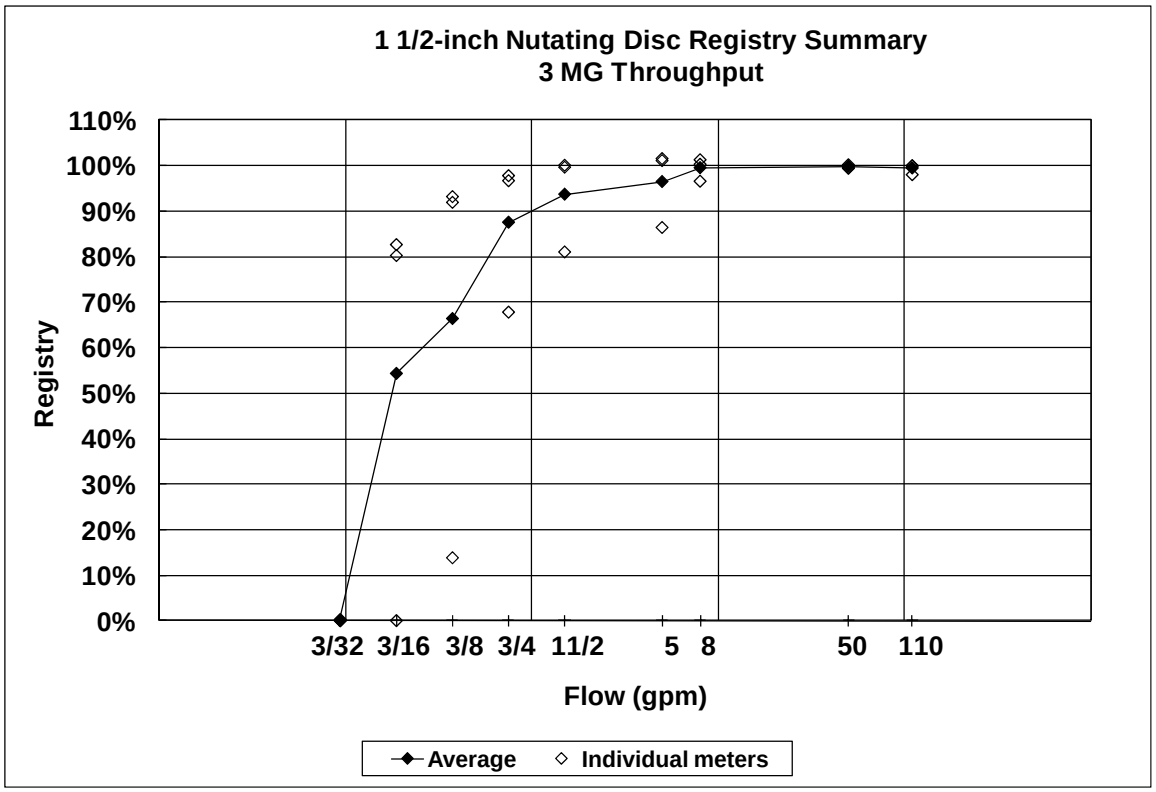

Figure 3.100 1 1/2–inch nutating disc 3 MG throughput

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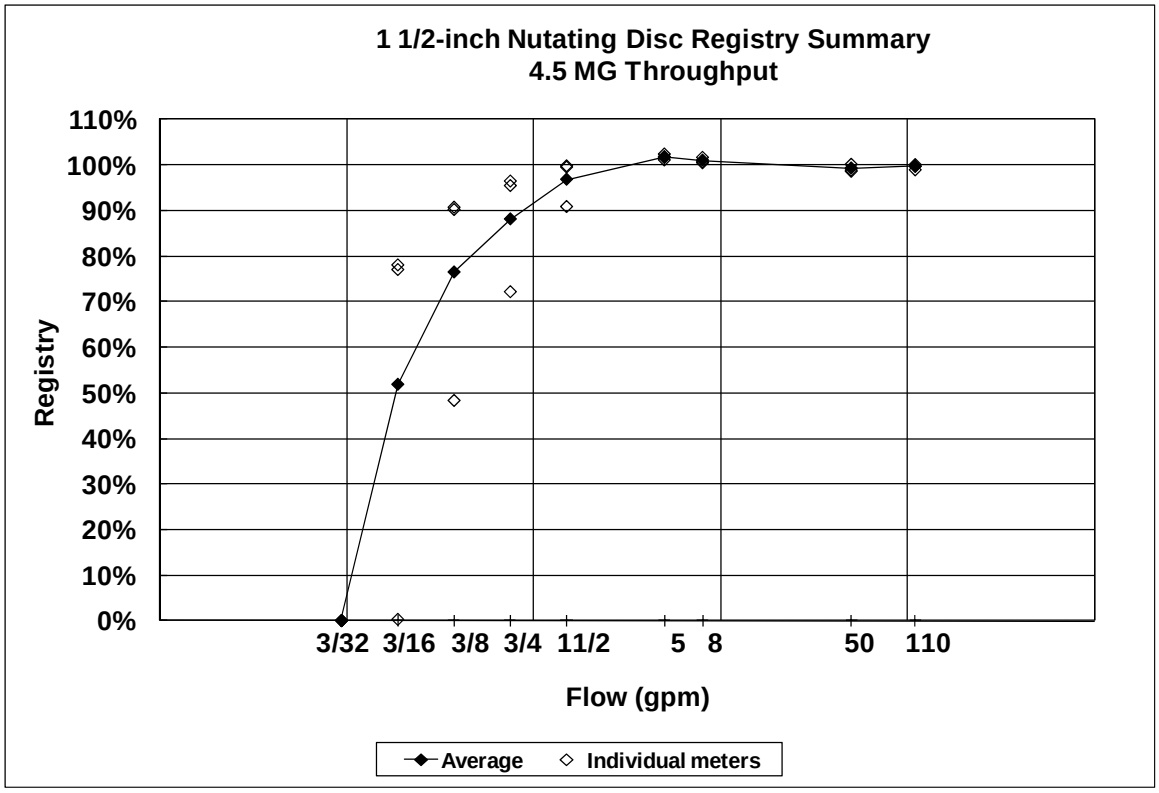

Figure 3.101 1 1/2–inch nutating disc 4.5 MG throughput

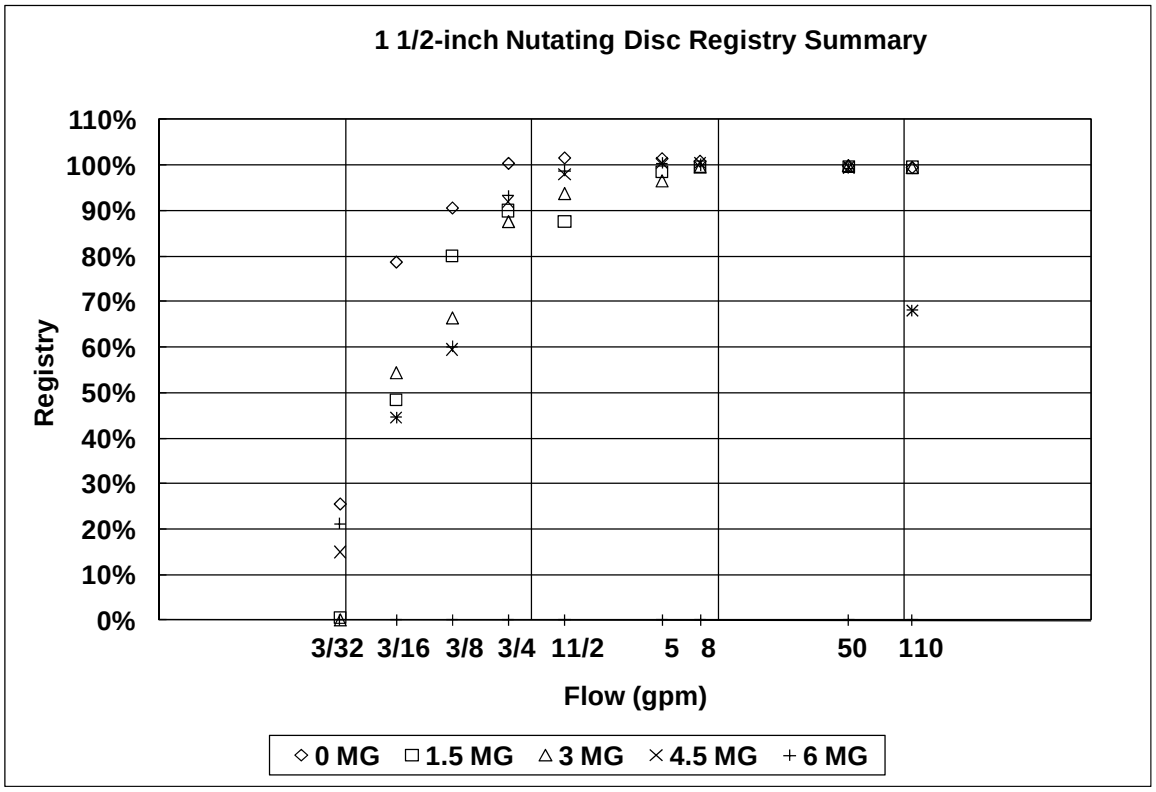

Figure 3.102 1 1/2-inch nutating disc registry summary

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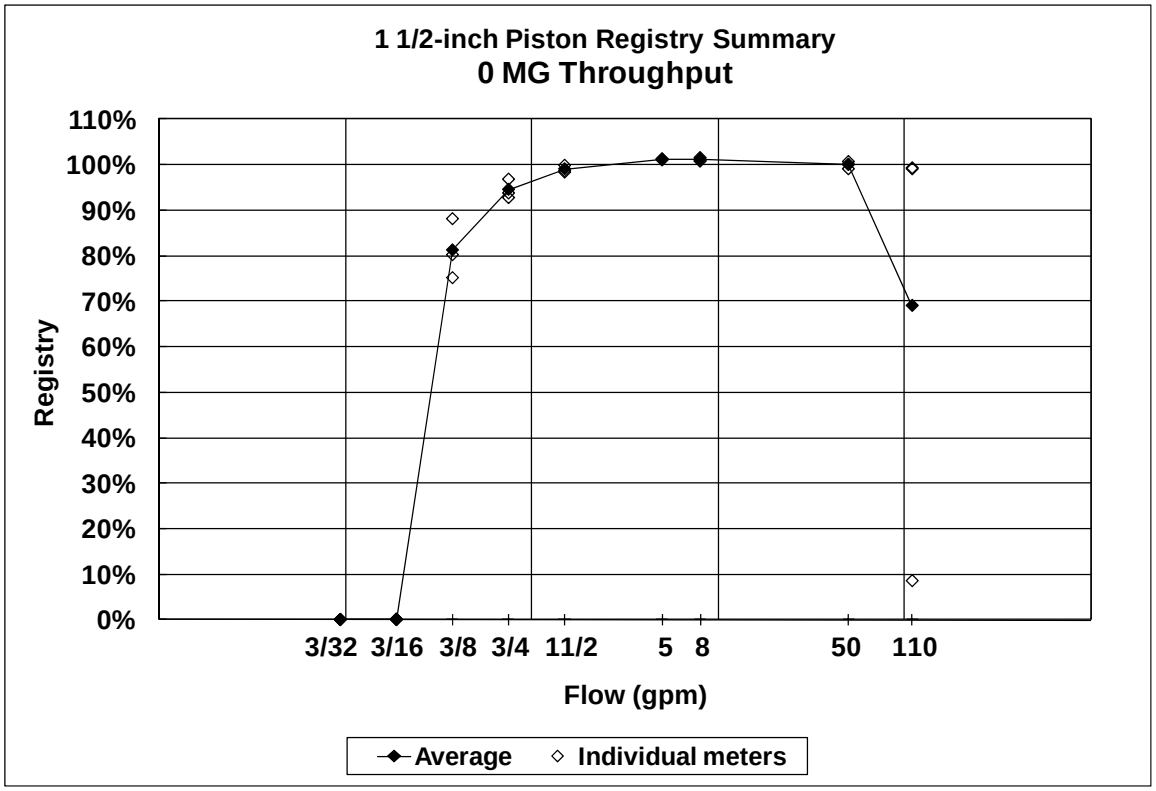

Figure 3.103 1 1/2-inch piston 0 MG throughput

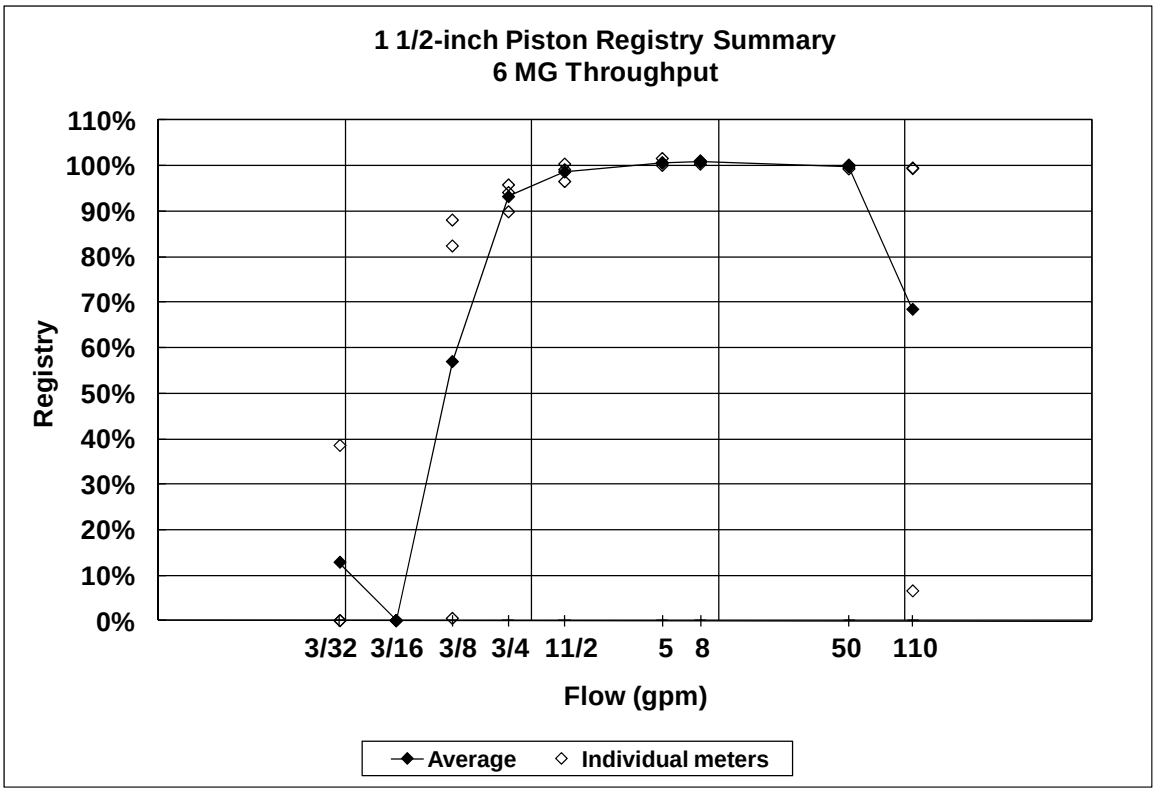

Figure 3.104 1 1/2-inch piston 6 MG throughput

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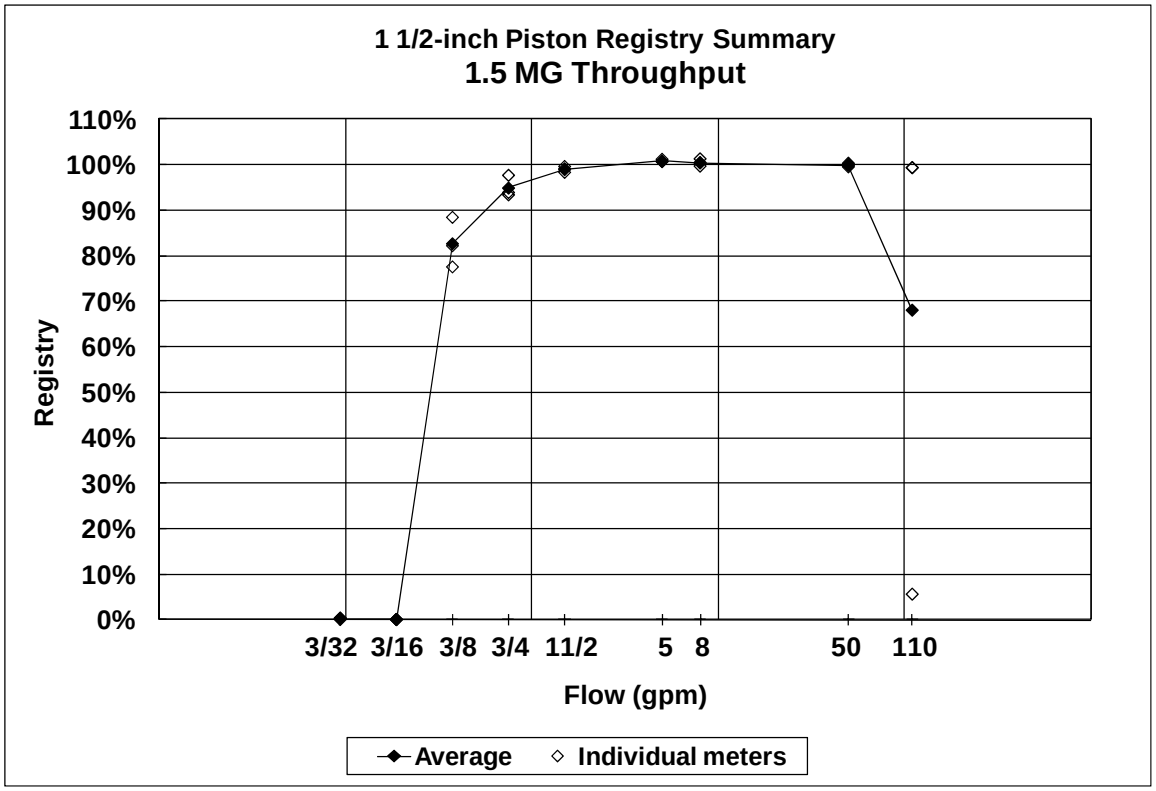

Figure 3.105 1 1/2-inch piston 1.5 MG throughput

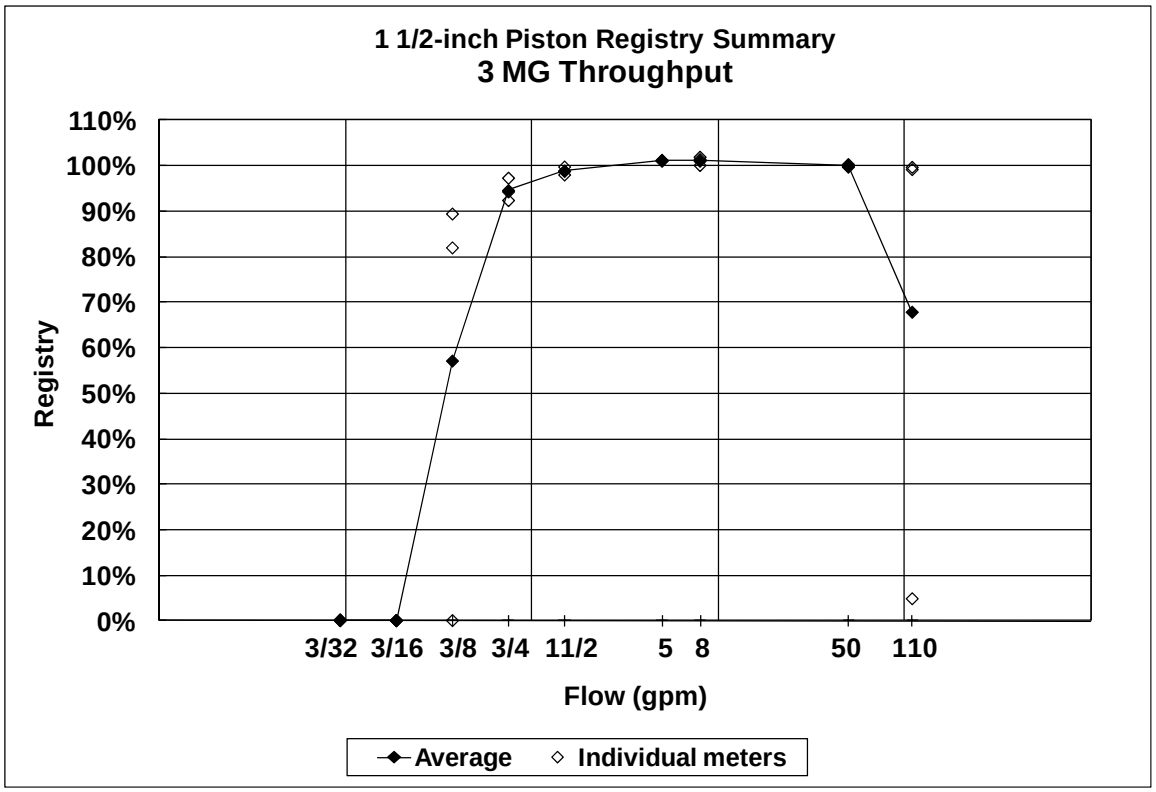

Figure 3.106 1 1/2-inch piston 3 MG throughput

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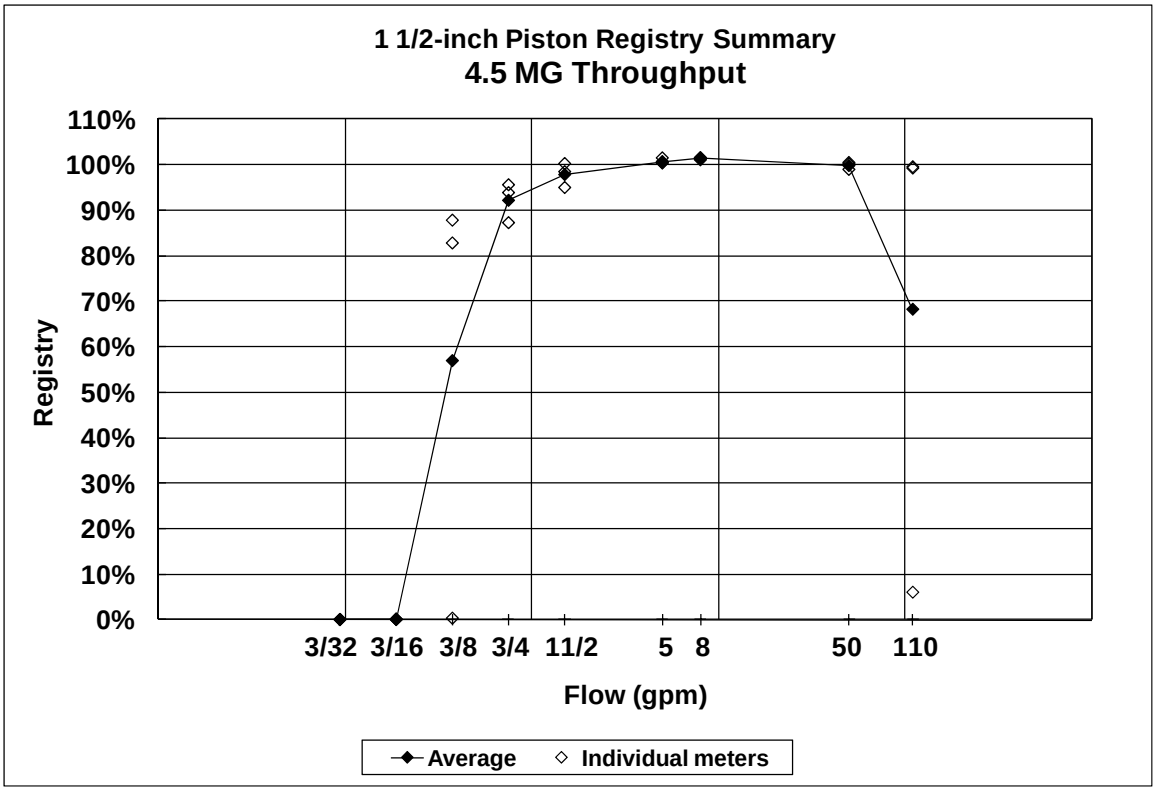

Figure 3.107 1 1/2-inch piston 4.5 MG throughput

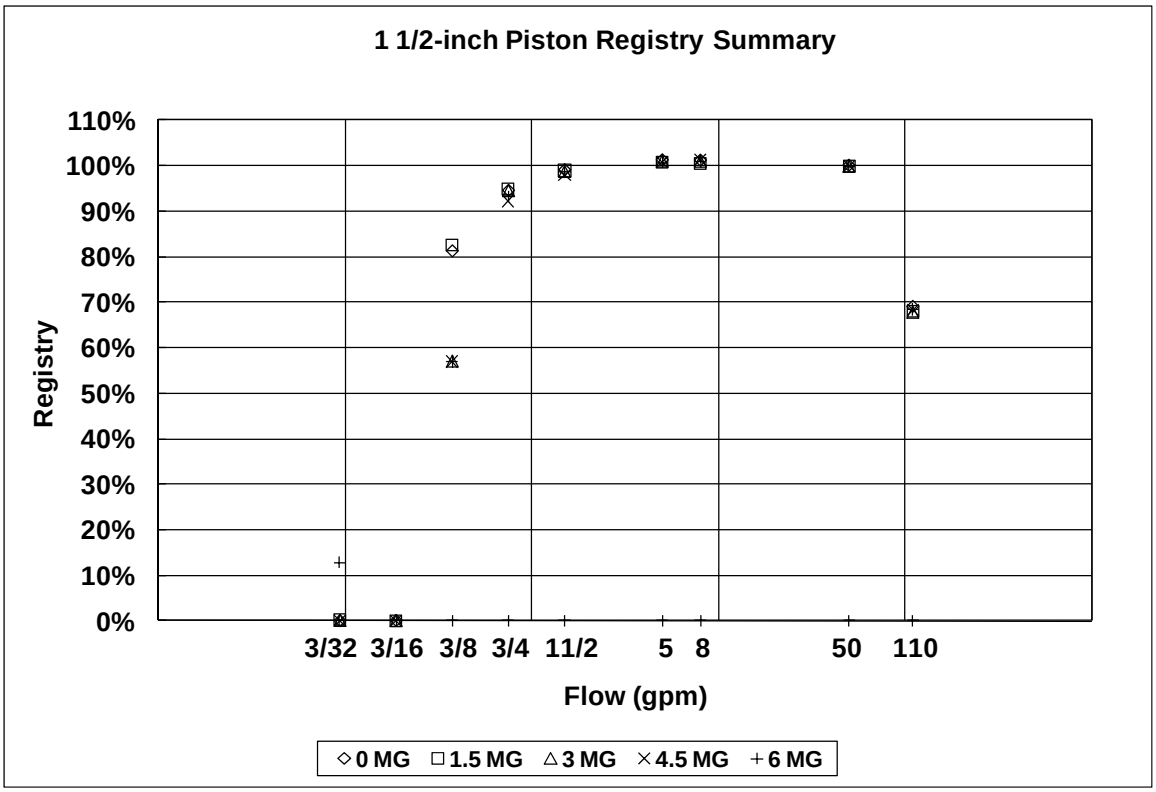

Figure 3.108 1 1/2-inch piston registry summary

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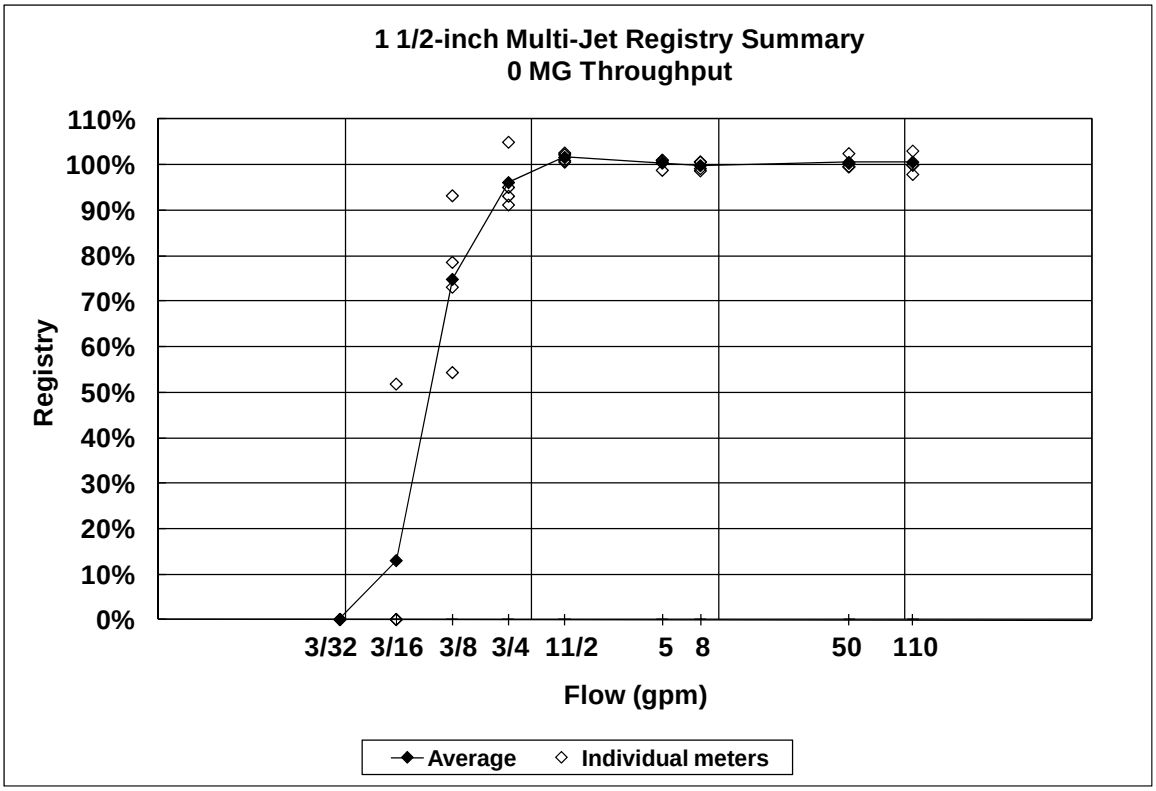

Figure 3.109 1 1/2-inch multi-jet 0 MG throughput

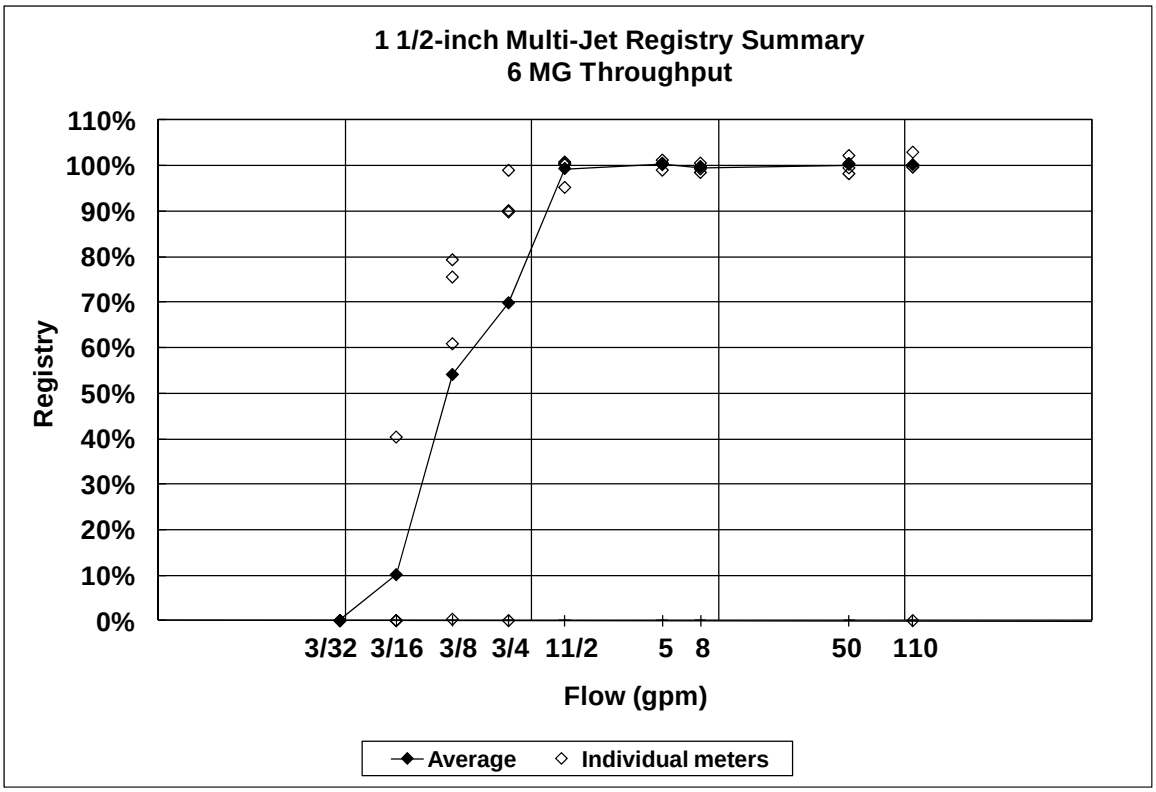

Figure 3.110 1 1/2-inch multi-jet 6 MG throughput

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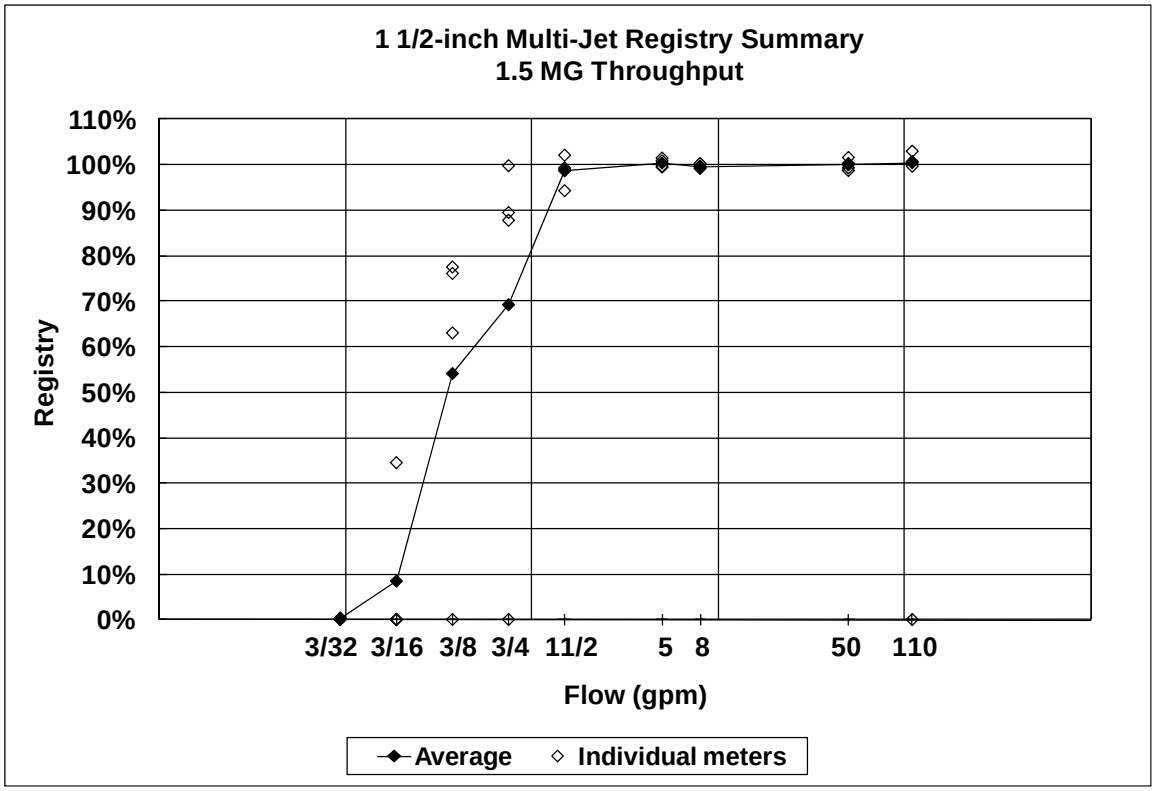

Figure 3.111 1 1/2-inch multi-jet 1.5 MG throughput

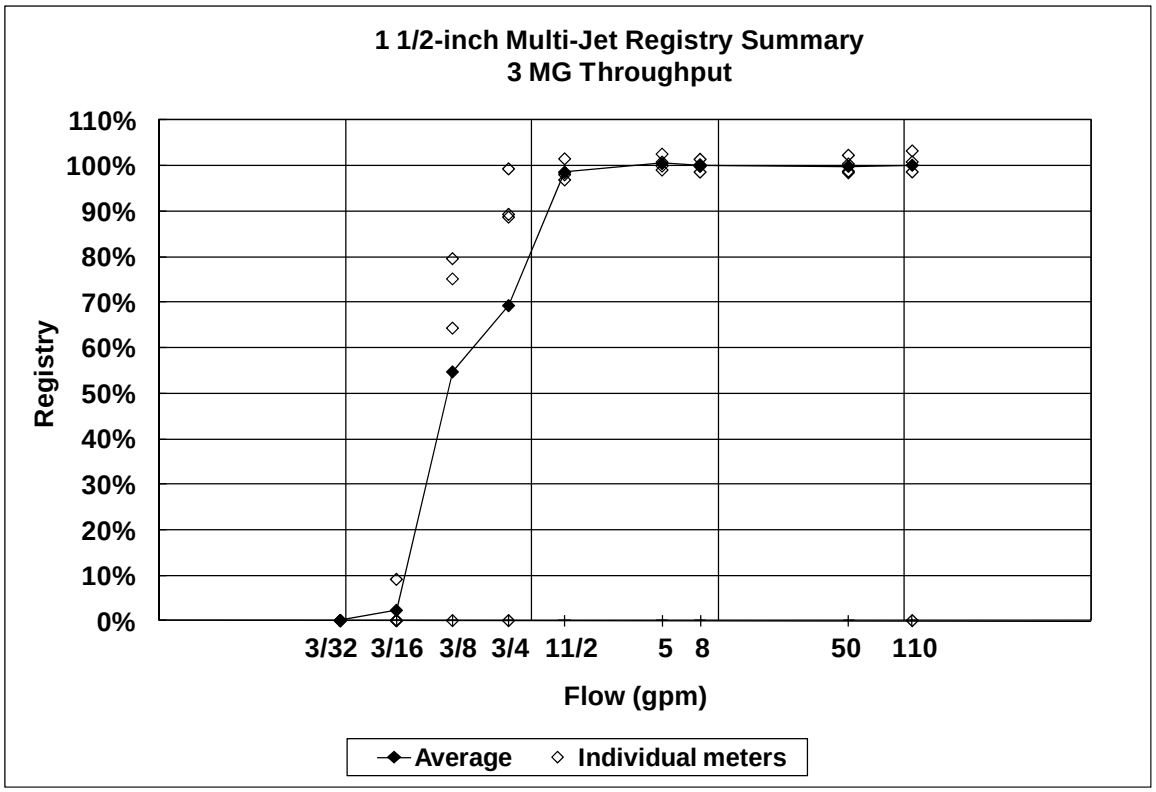

Figure 3.112 1 1/2-inch multi-jet 3 MG throughput

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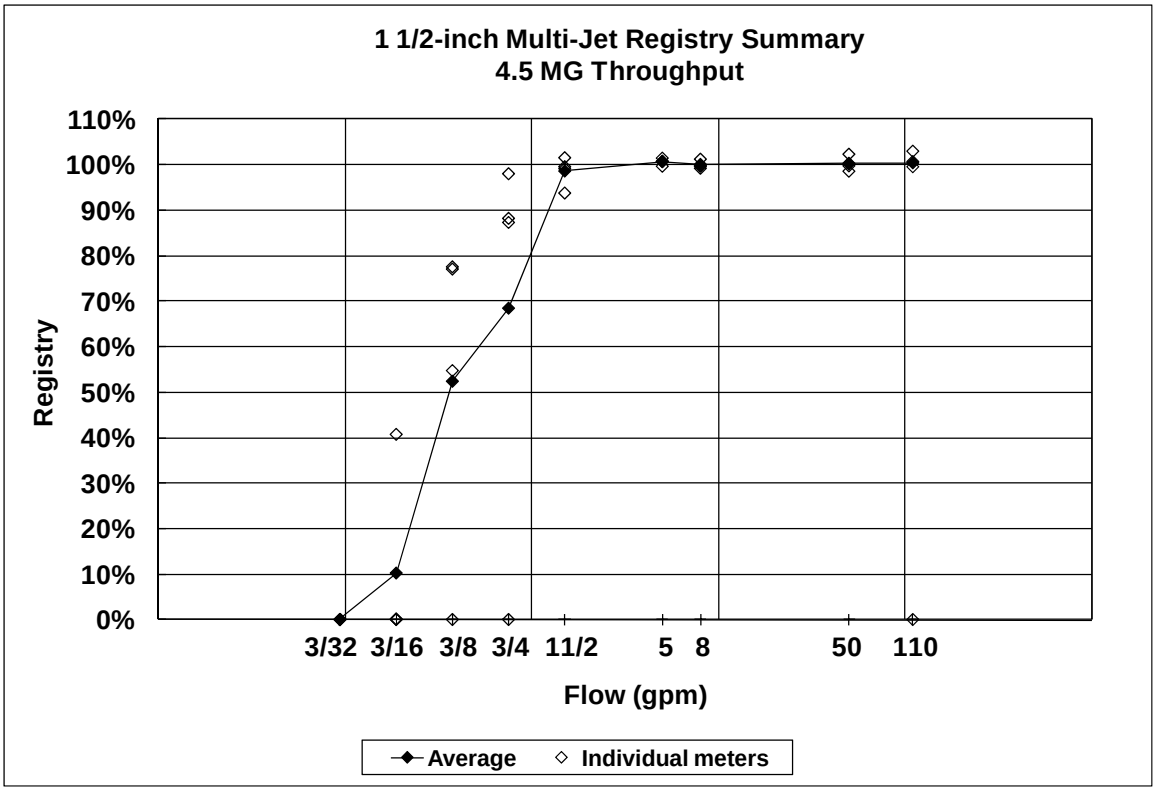

Figure 3.113 1 1/2-inch multi-jet 4.5 MG throughput

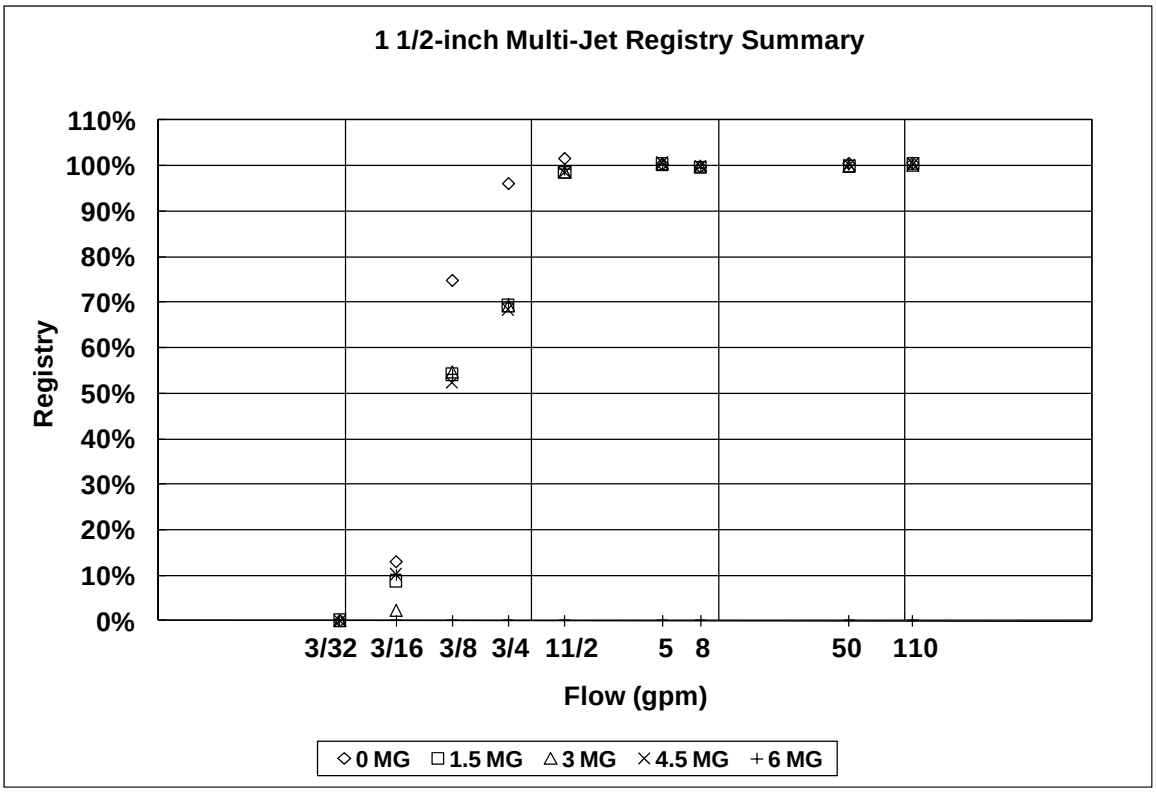

Figure 3.114 1 1/2-inch multi-jet registry summary

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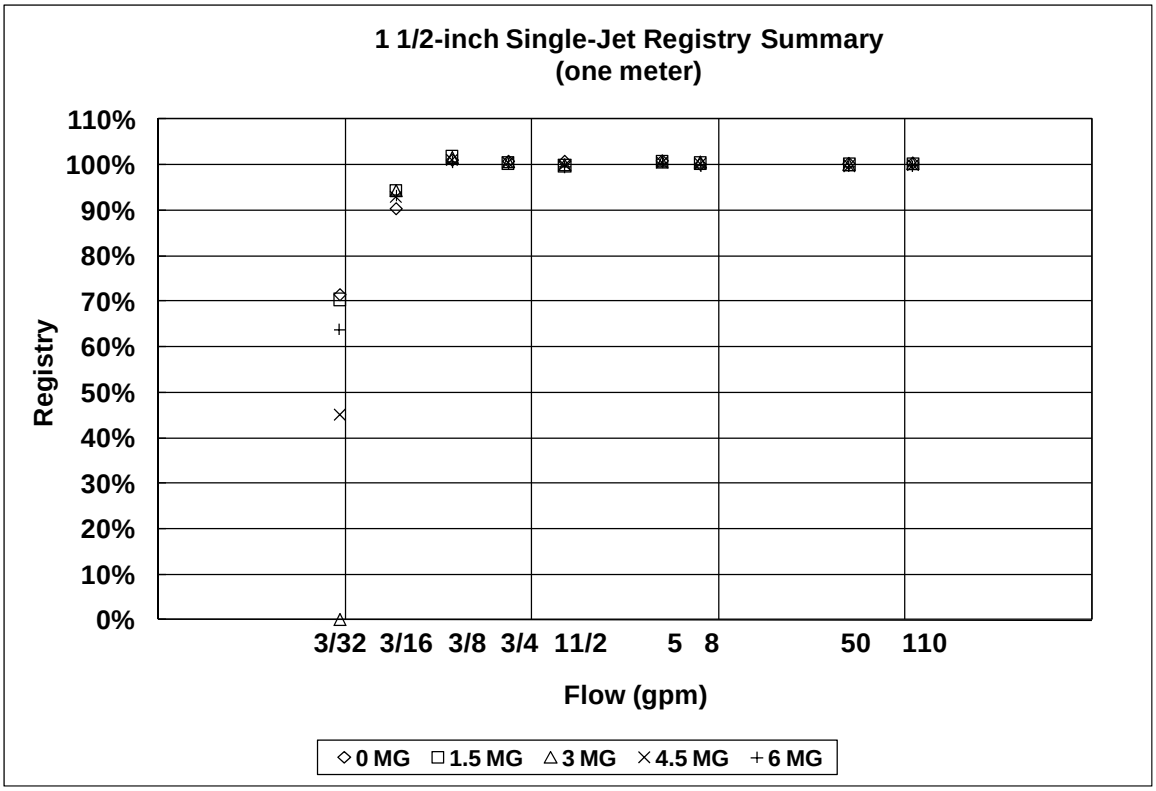

Figure 3.115 1 1/2-inch single-jet registry summary

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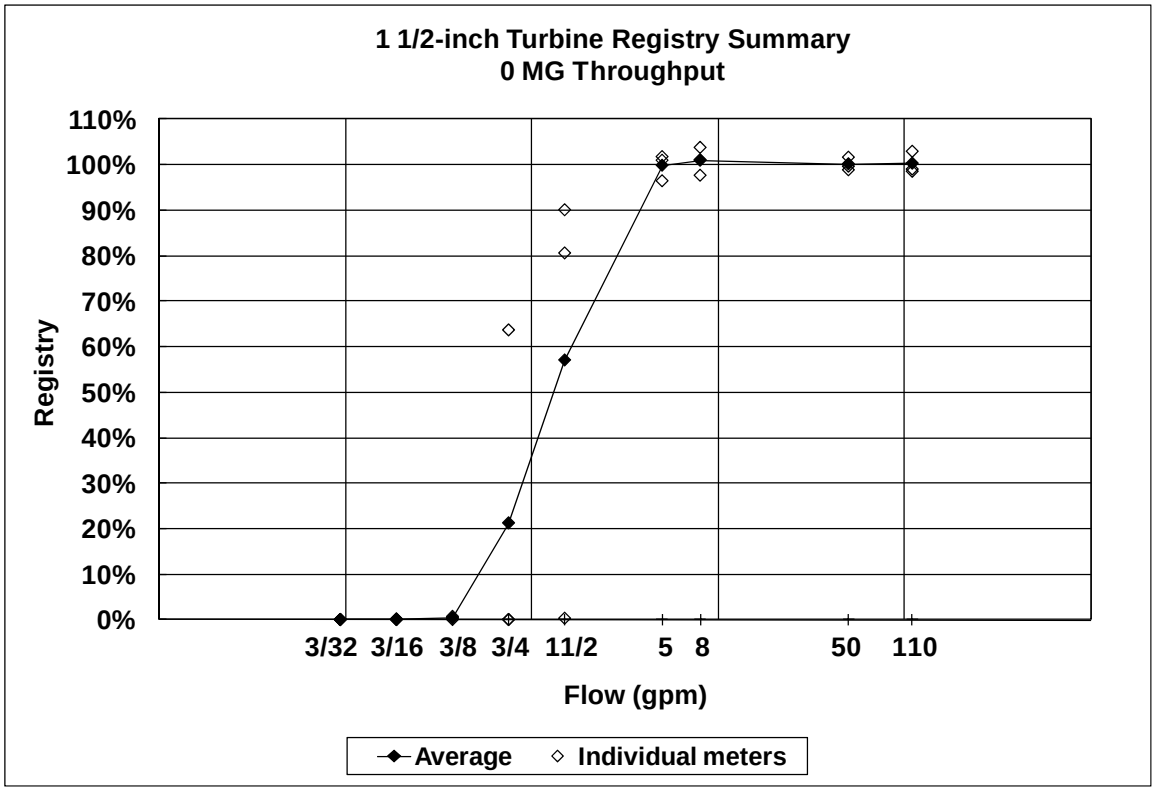

Figure 3.116 1 1/2-inch turbine 0 MG throughput

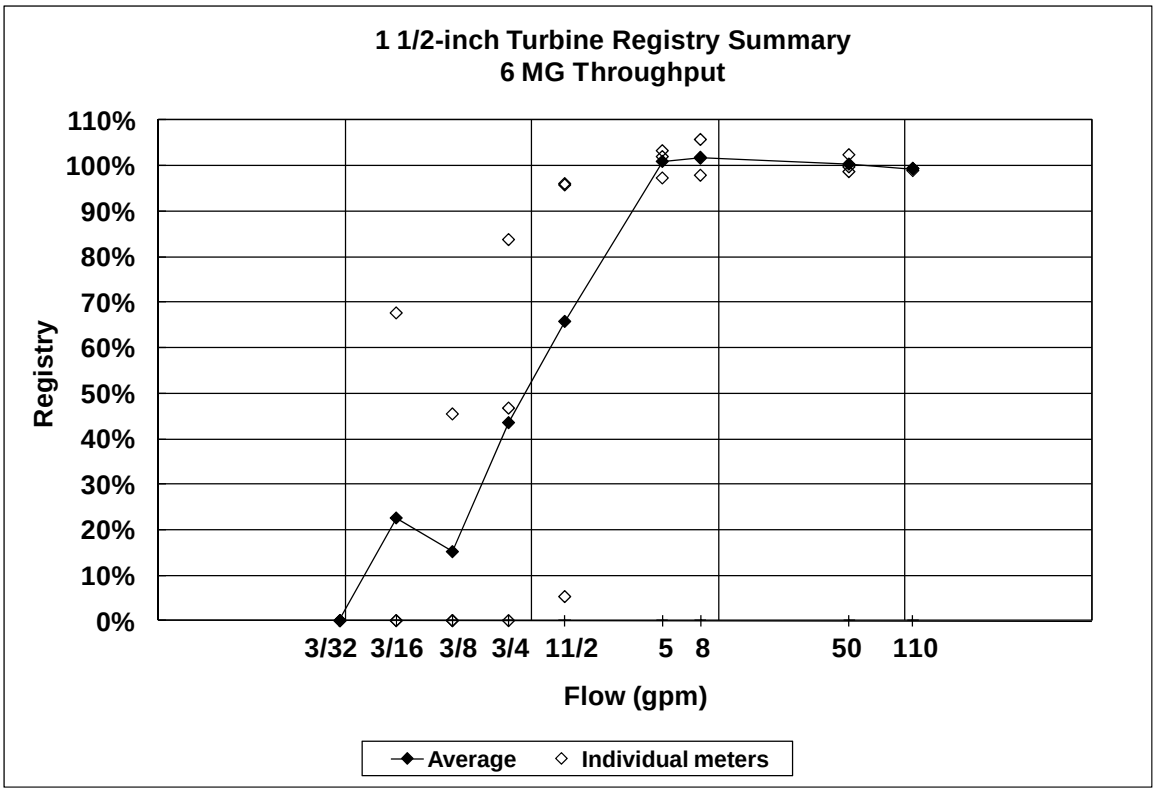

Figure 3.117 1 1/2-inch turbine 6 MG throughput

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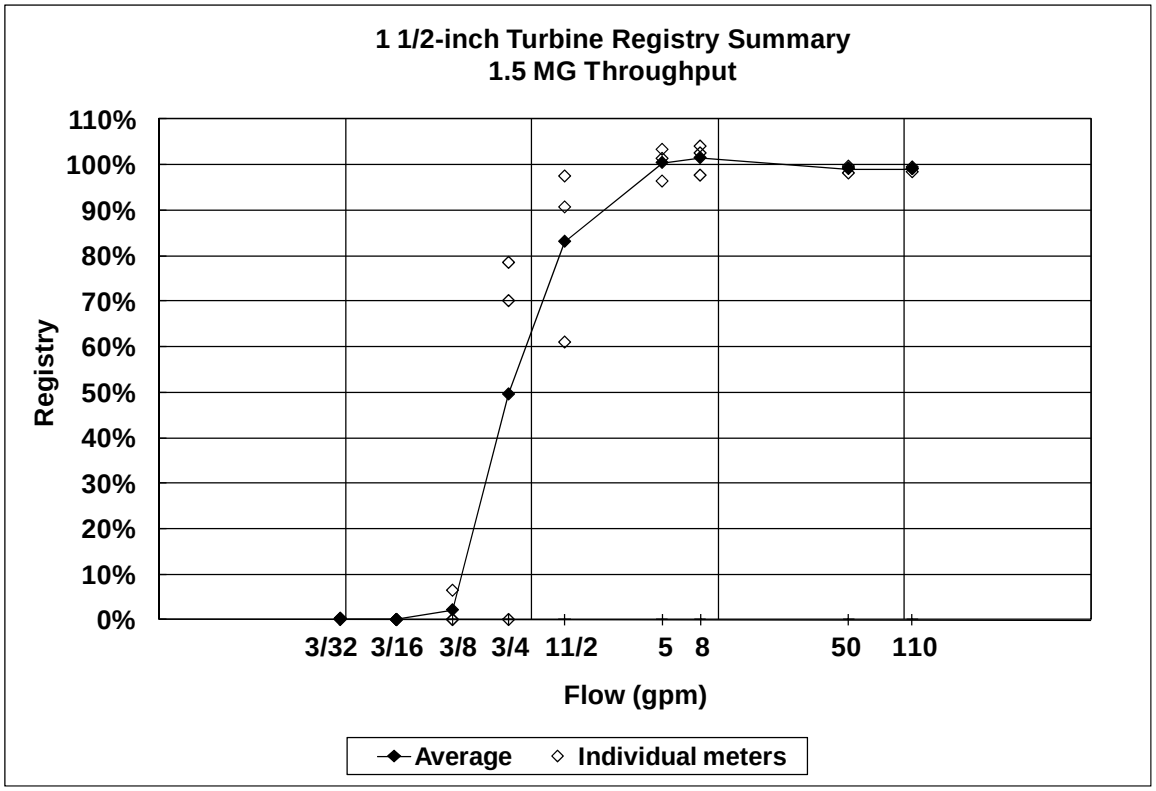

Figure 3.118 1 1/2-inch turbine 1.5 MG throughput

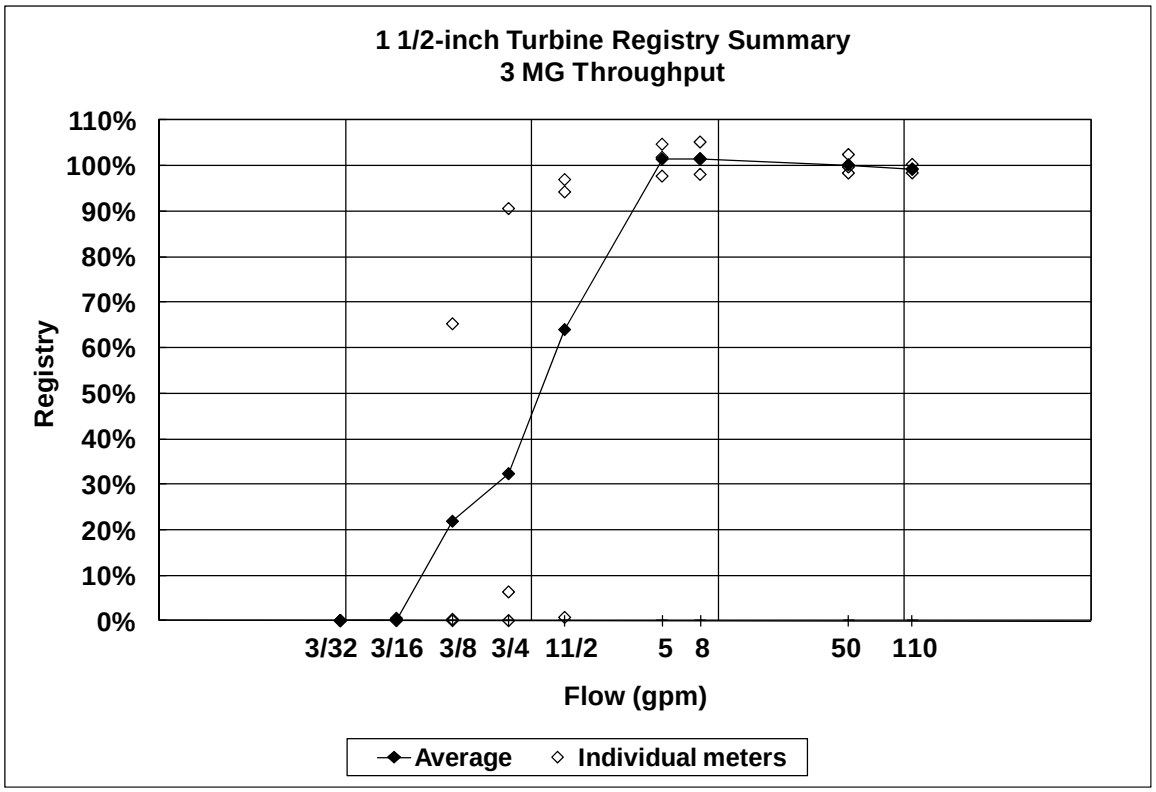

Figure 3.119 1 1/2-inch turbine 3 MG throughput

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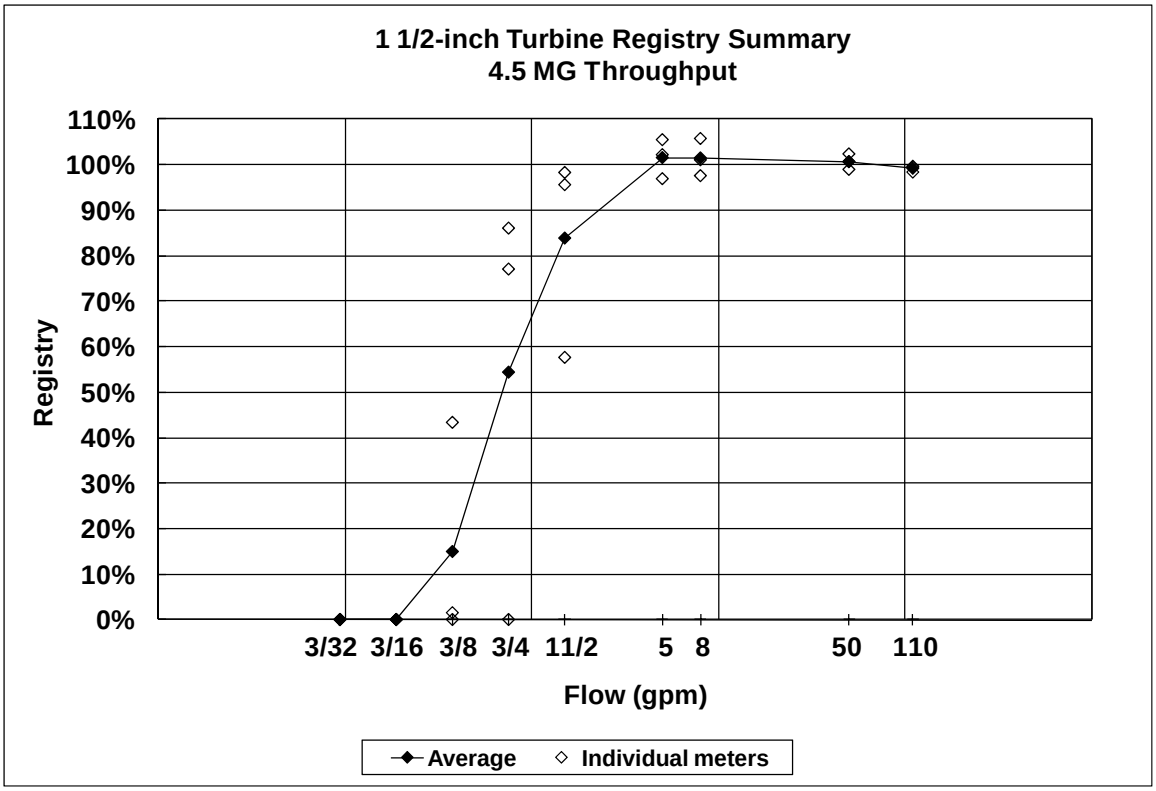

Figure 3.120 1 1/2-inch turbine 4.5 MG throughput

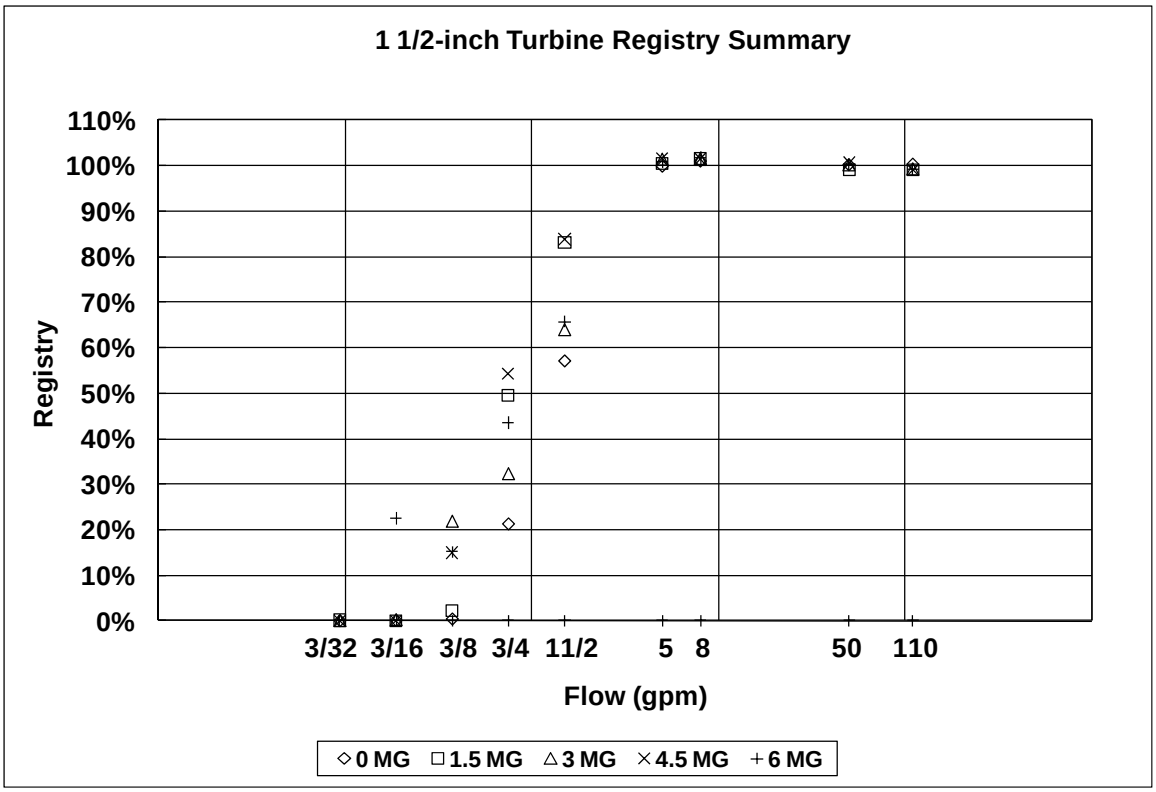

Figure 3.121 1 1/2-inch turbine registry summary

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2-inch Meters

Figures 3.122 through 3.152 show the results for the 2-inch meters tested in the new condition and their registry at various levels of throughput.

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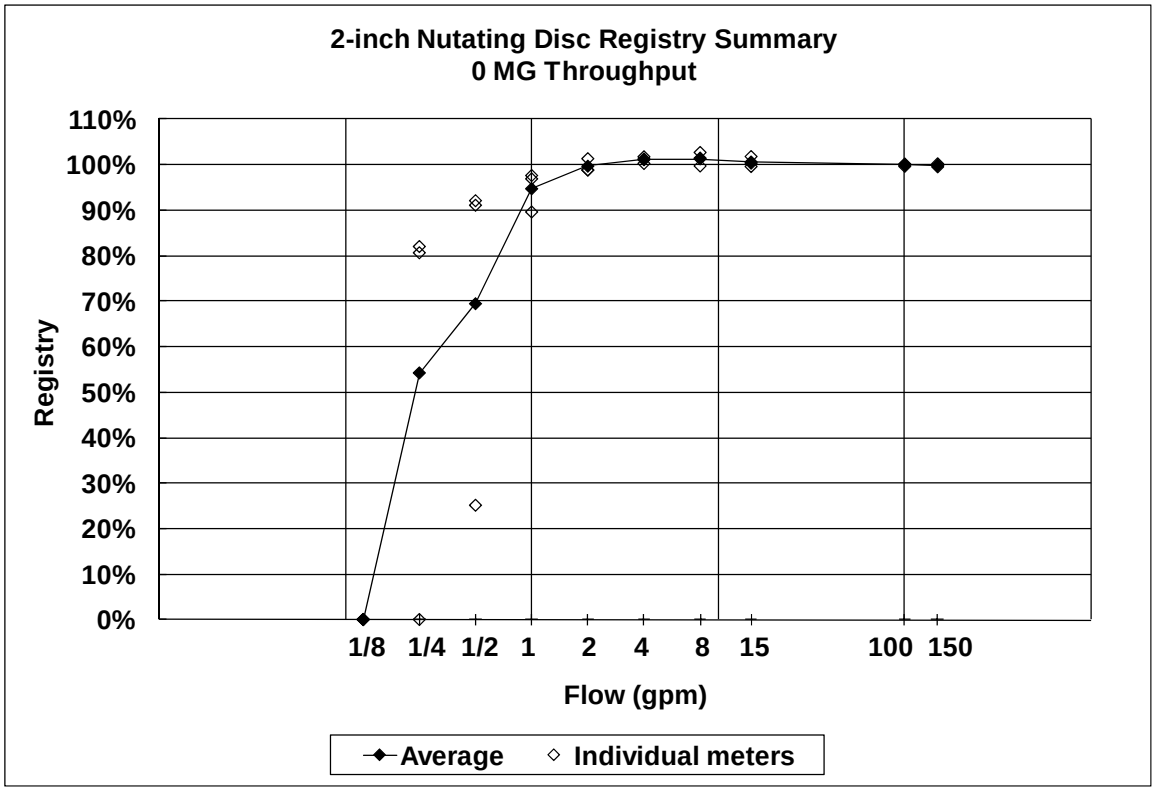

Figure 3.122 2–inch nutating disc 0 MG throughput

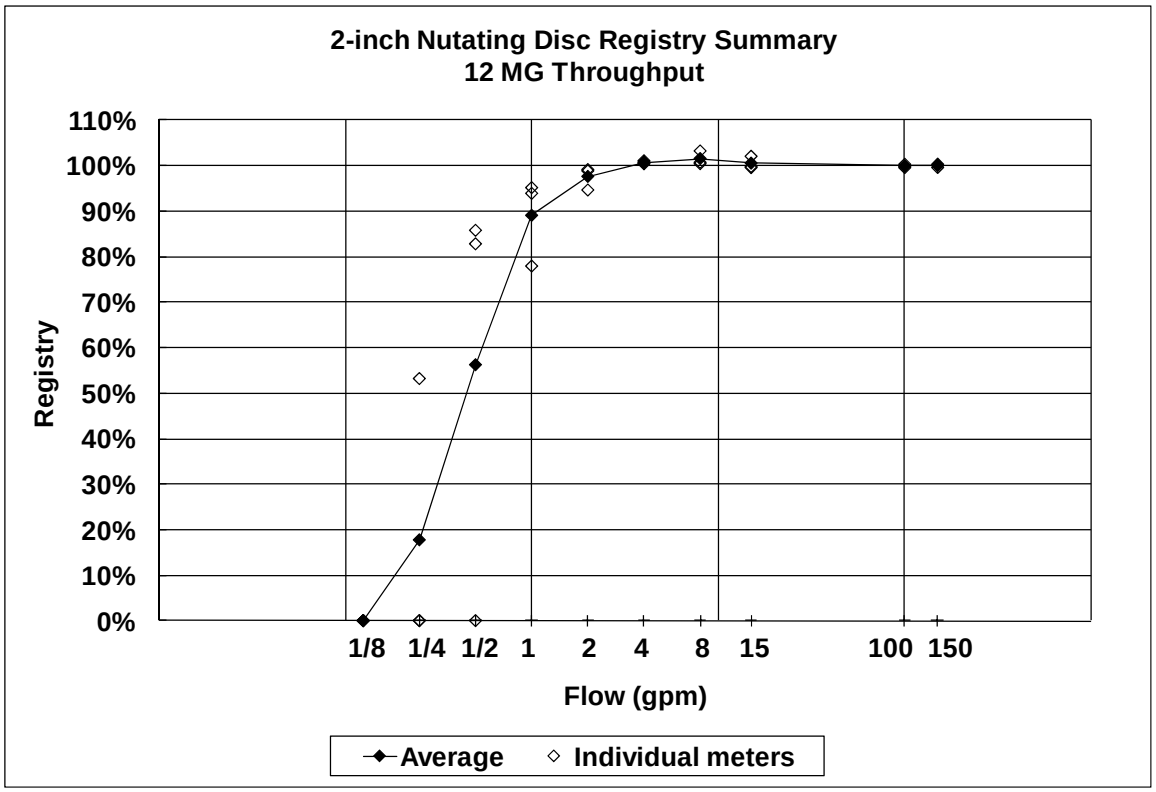

Figure 3.123 2-inch nutating disc 12 MG throughput

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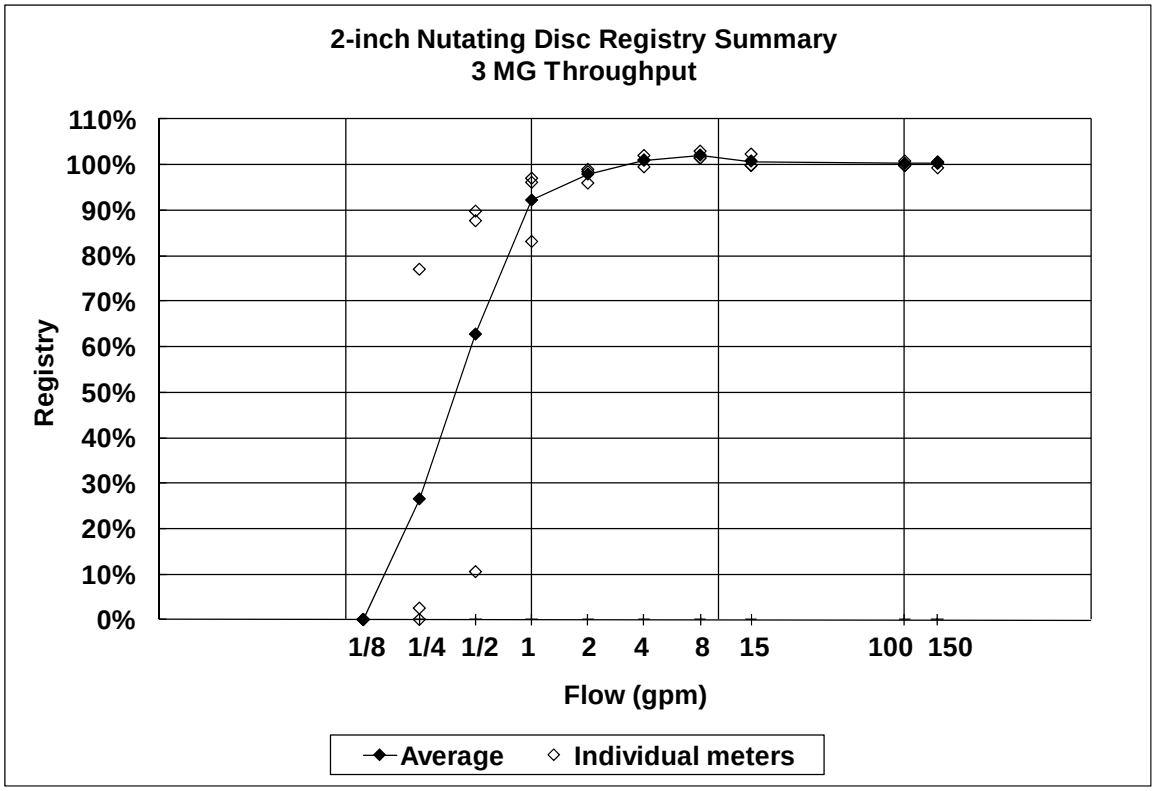

Figure 3.124 2–inch nutating disc 3 MG throughput

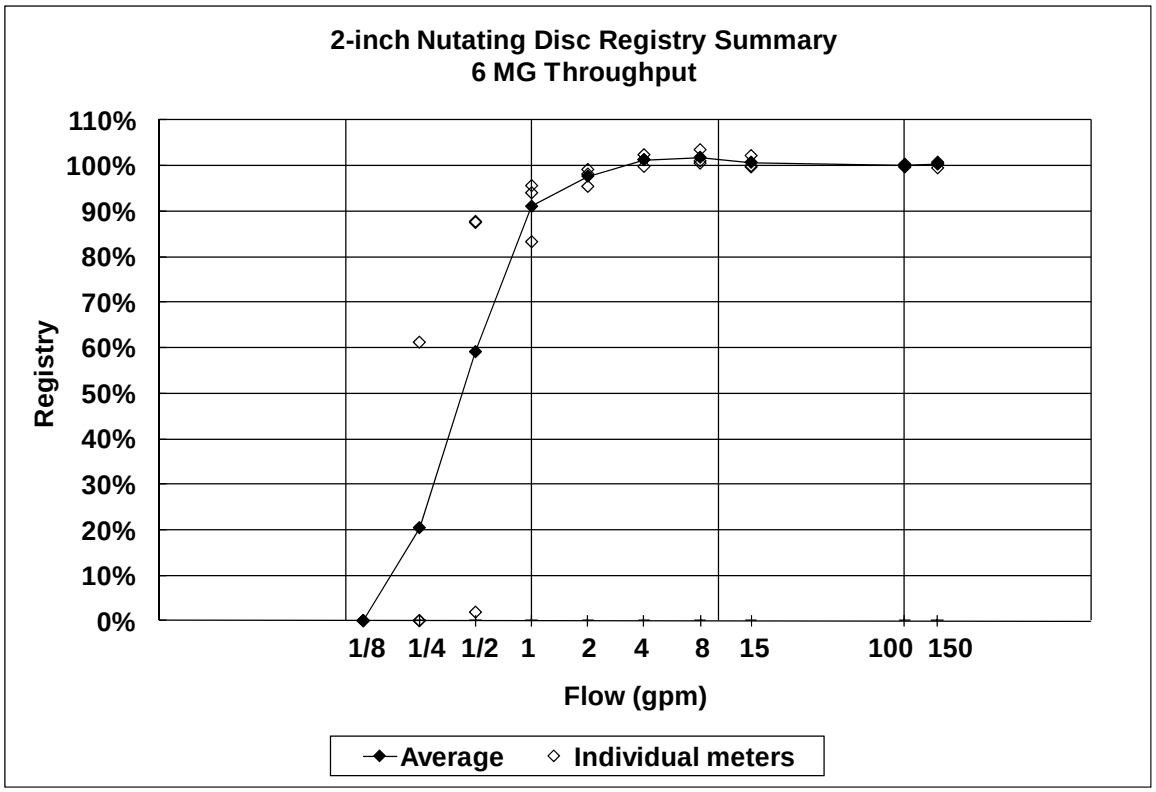

Figure 3.125 2–inch nutating disc 6 MG throughput

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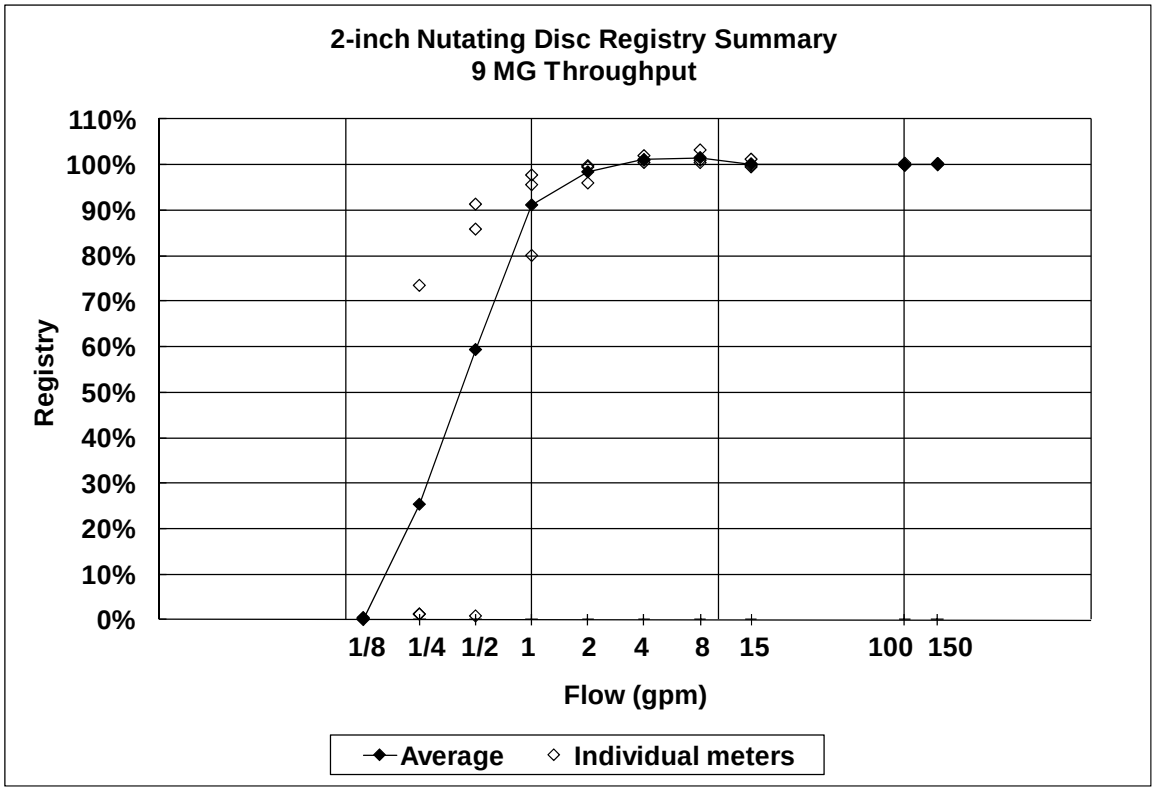

Figure 3.126 2–inch nutating disc 9 MG throughput

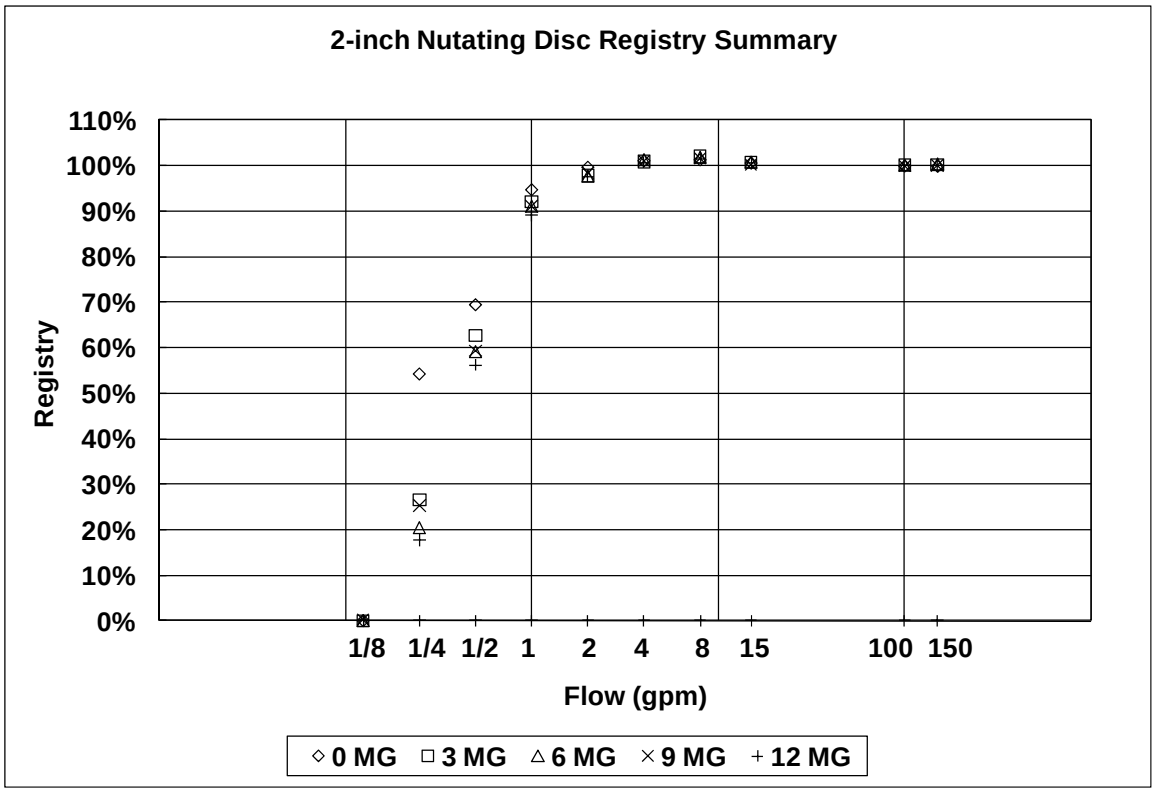

Figure 3.127 2-inch nutating disc registry summary

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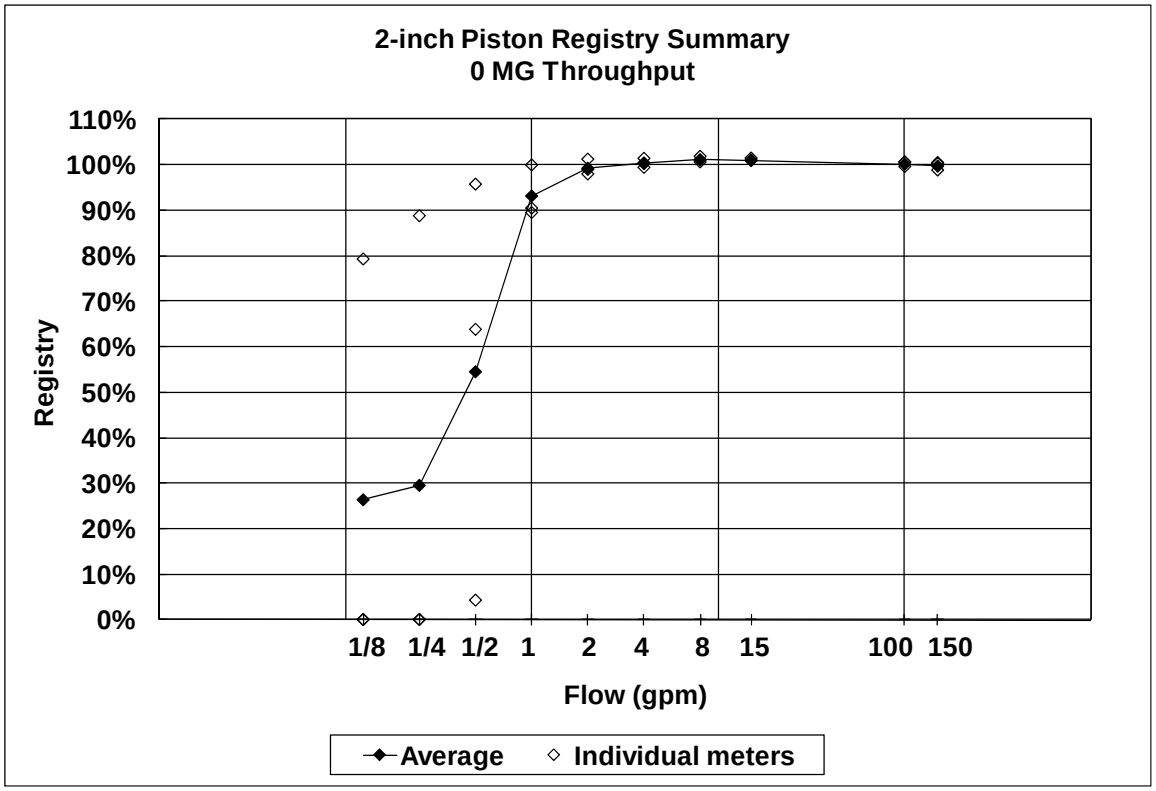

Figure 3.128 2-inch piston 0 MG throughput

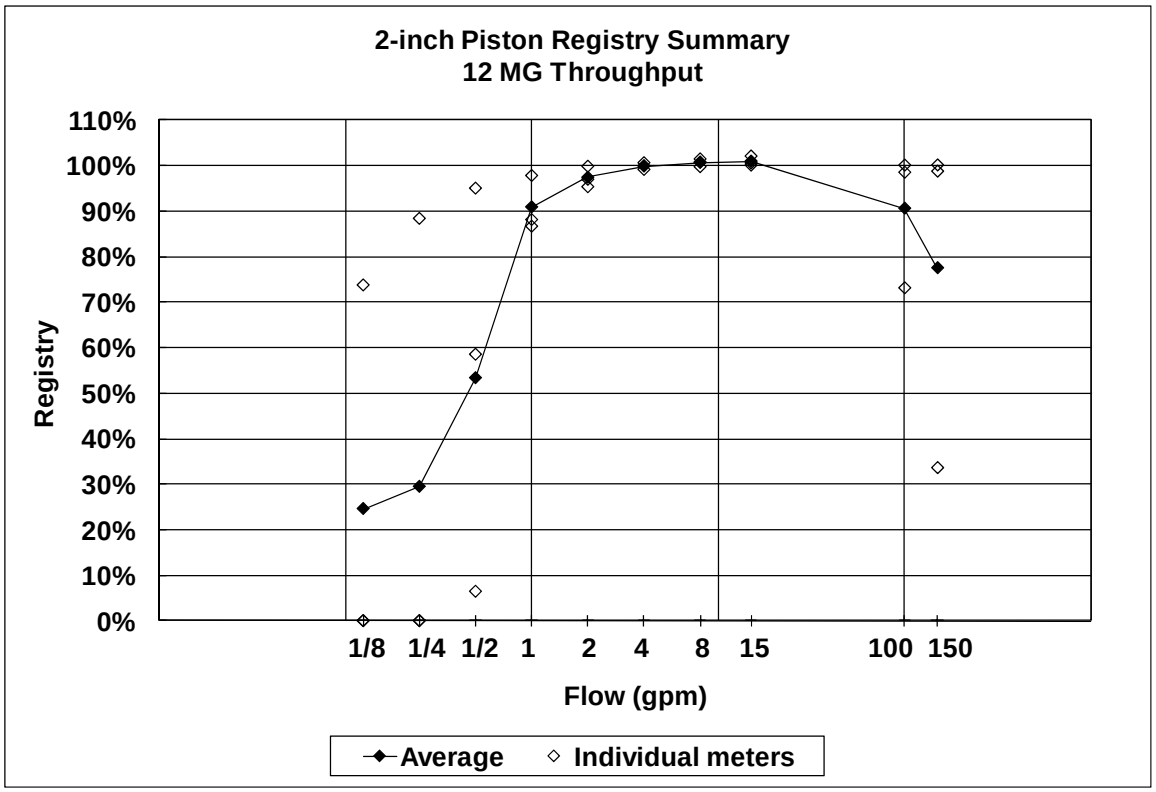

Figure 3.129 2-inch piston 12 MG throughput

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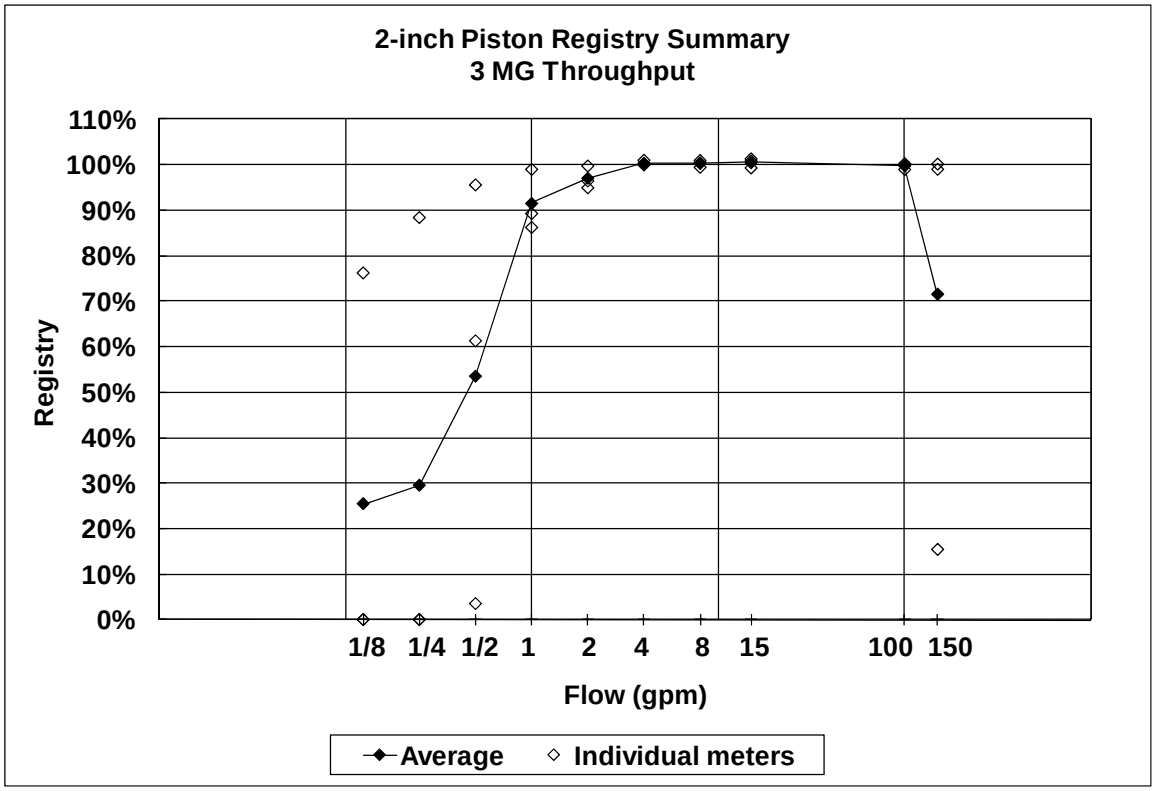

Figure 3.130 2-inch piston 3 MG throughput

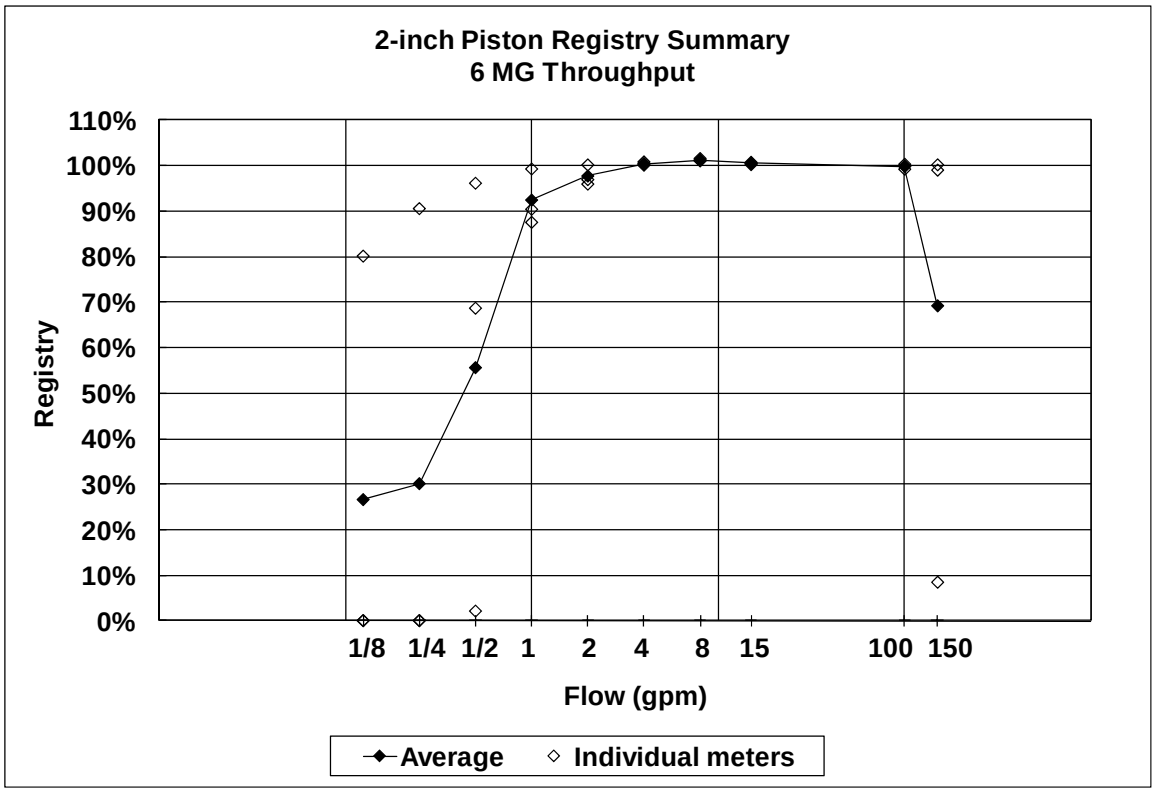

Figure 3.131 2-inch piston 6 MG throughput

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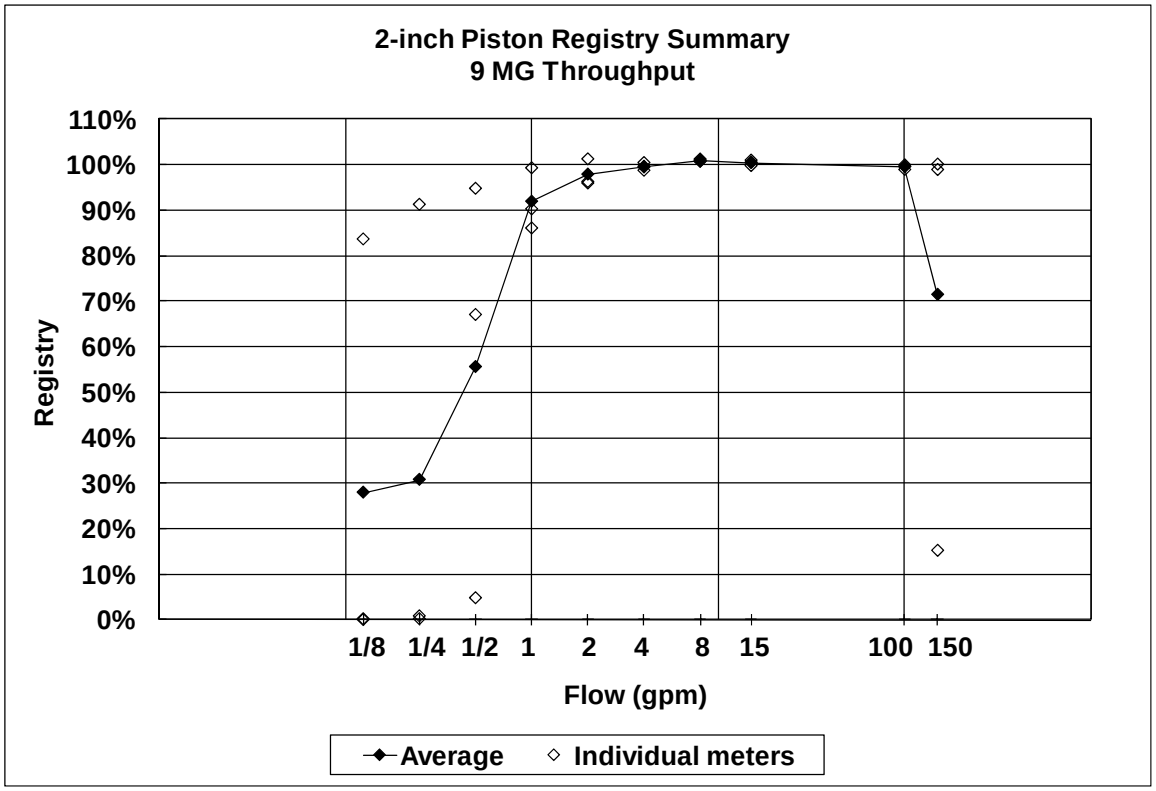

Figure 3.132 2-inch piston 9 MG throughput

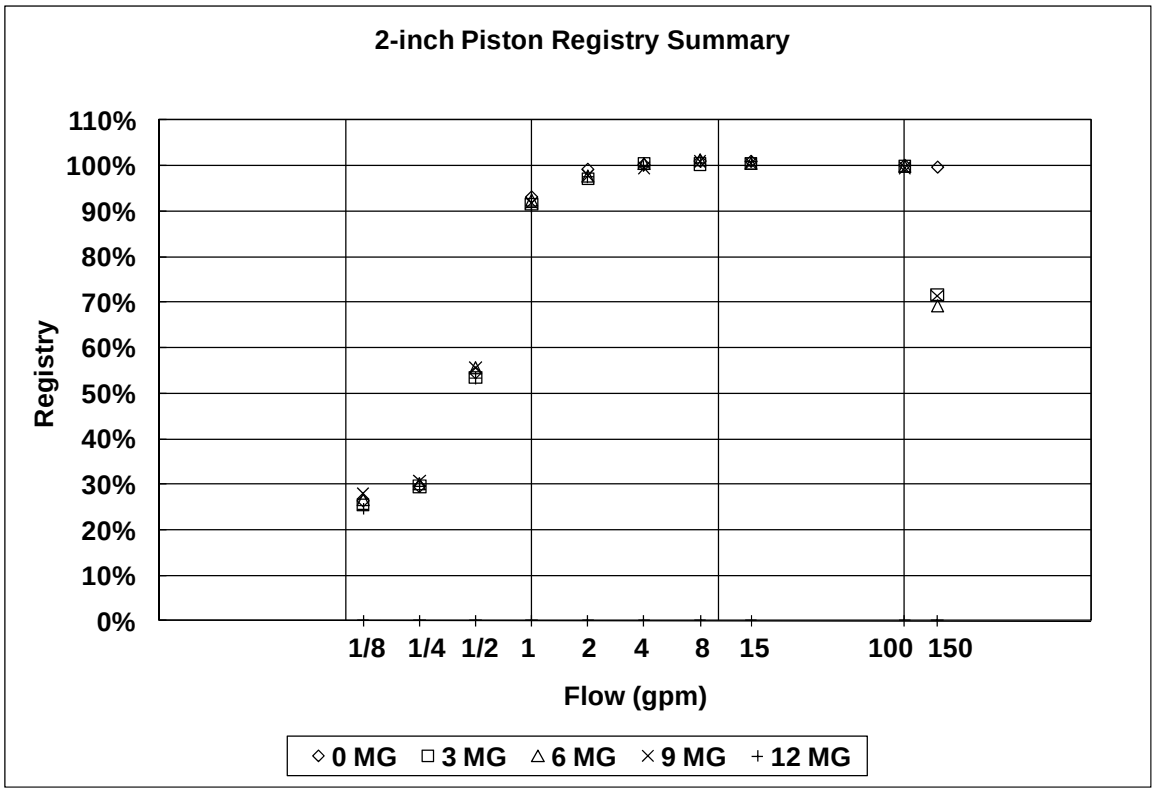

Figure 3.133 2-inch piston registry summary

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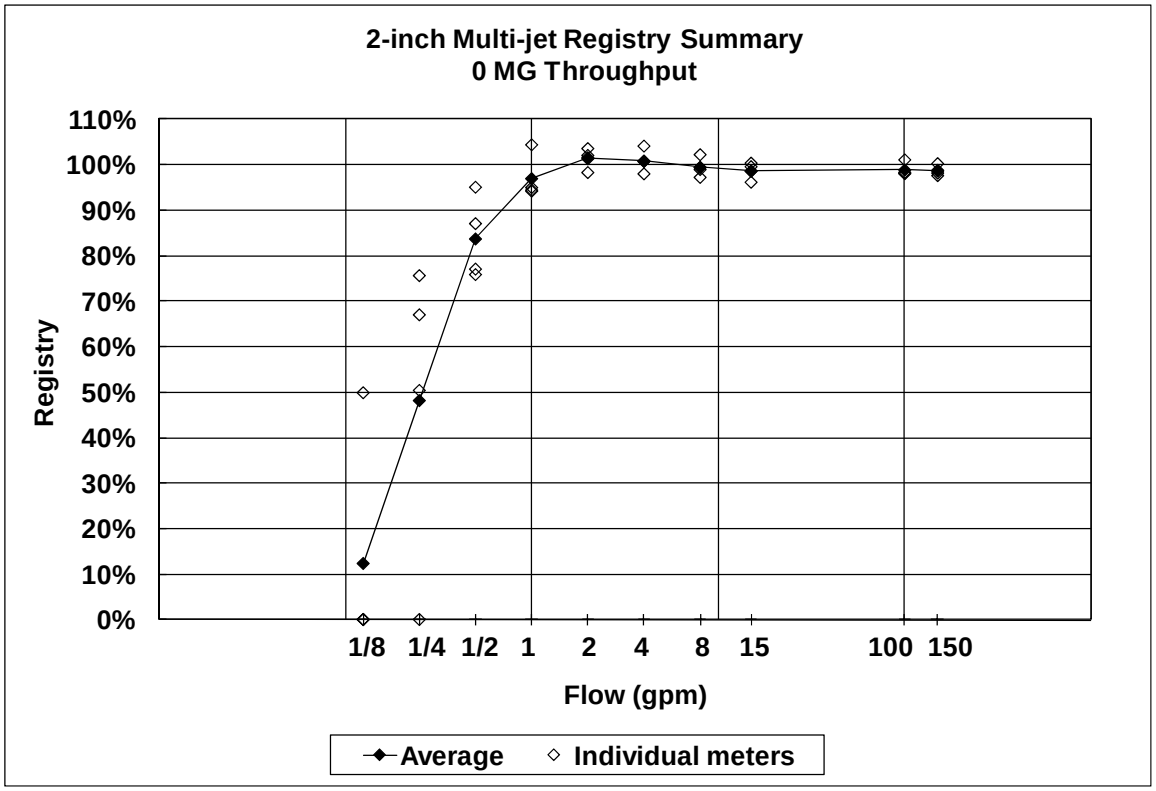

Figure 3.134 2-inch multi-jet 0 MG throughput

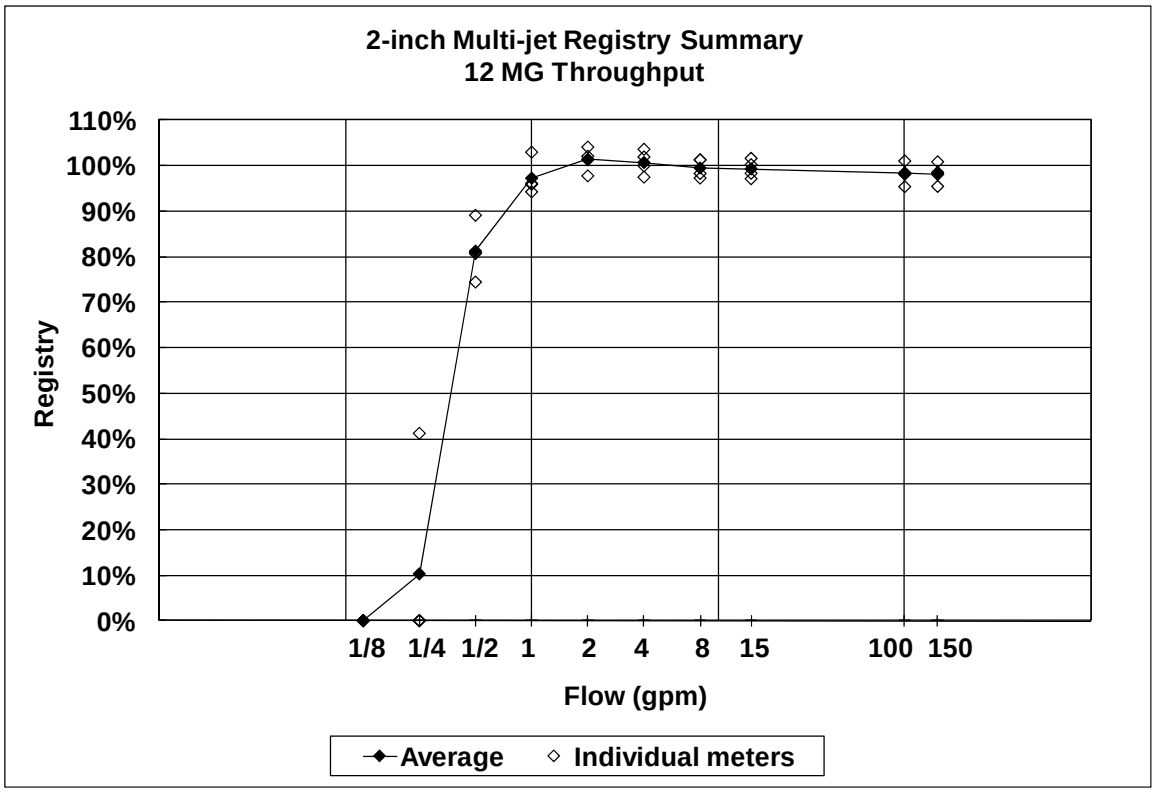

Figure 3.135 2-inch multi-jet 12 MG throughput

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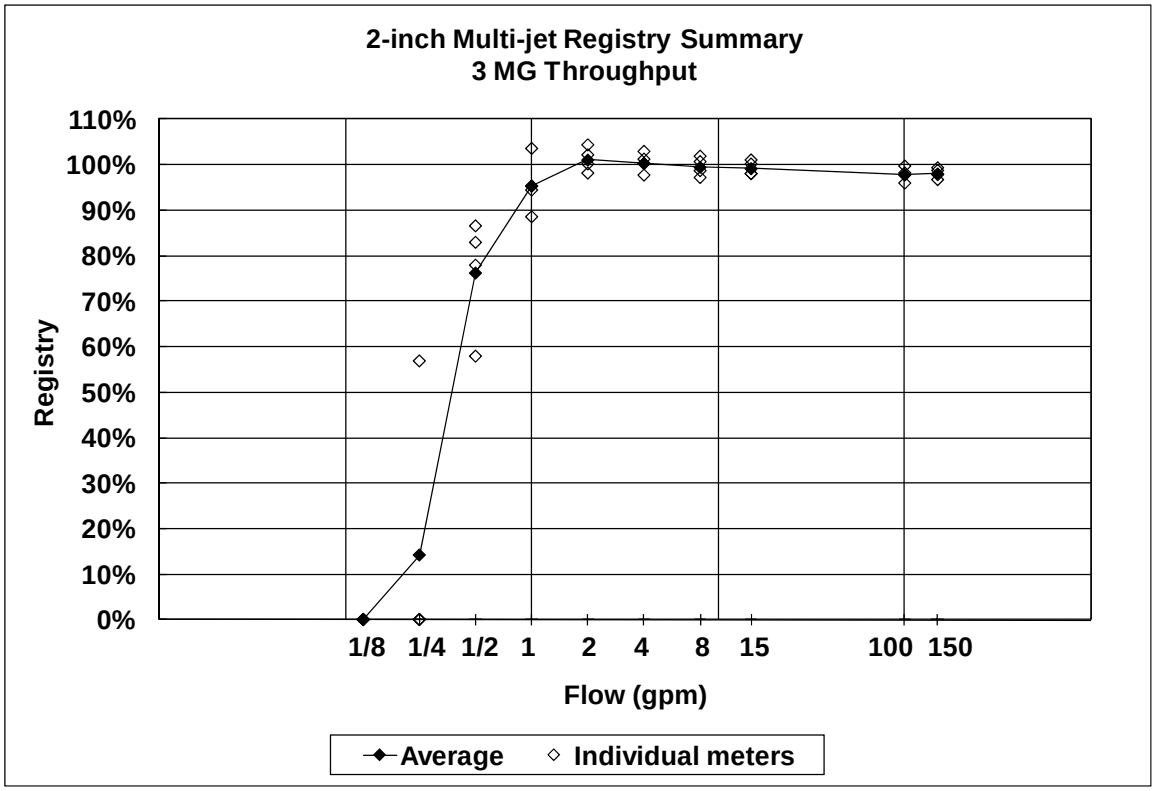

Figure 3.136 2-inch multi-jet 3 MG throughput

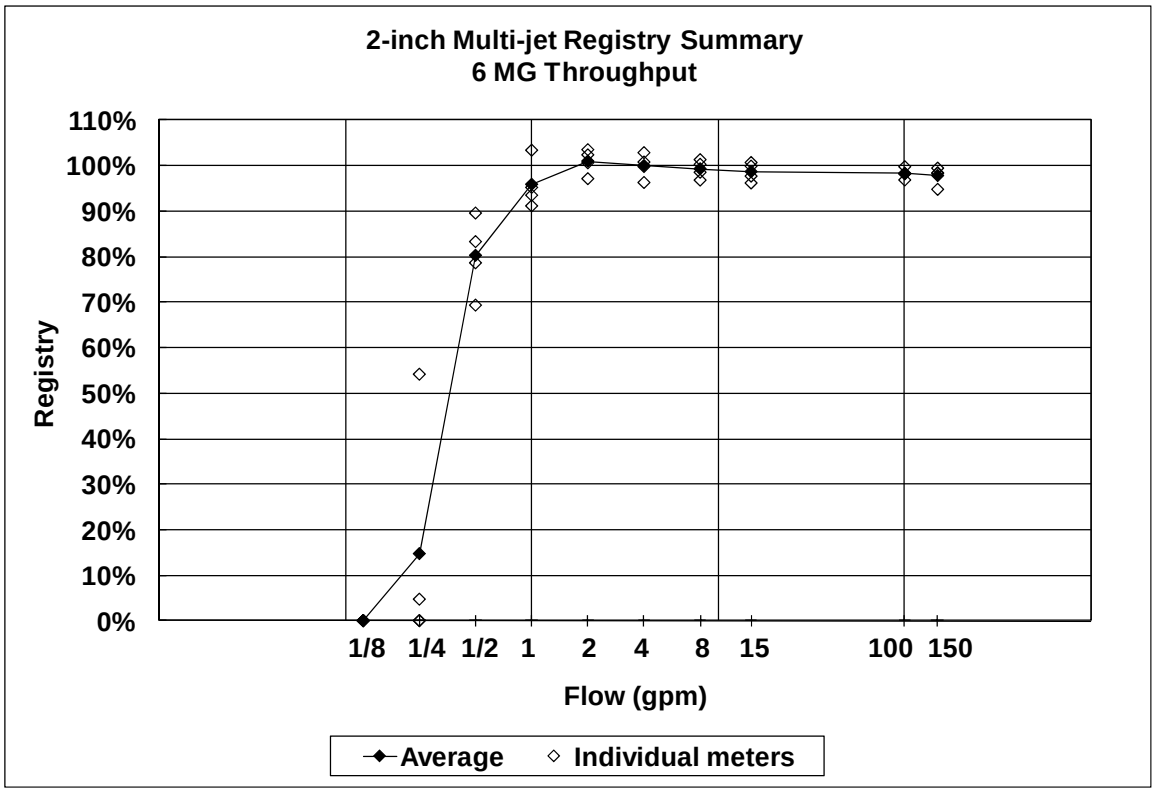

Figure 3.137 2-inch multi-jet 6 MG throughput

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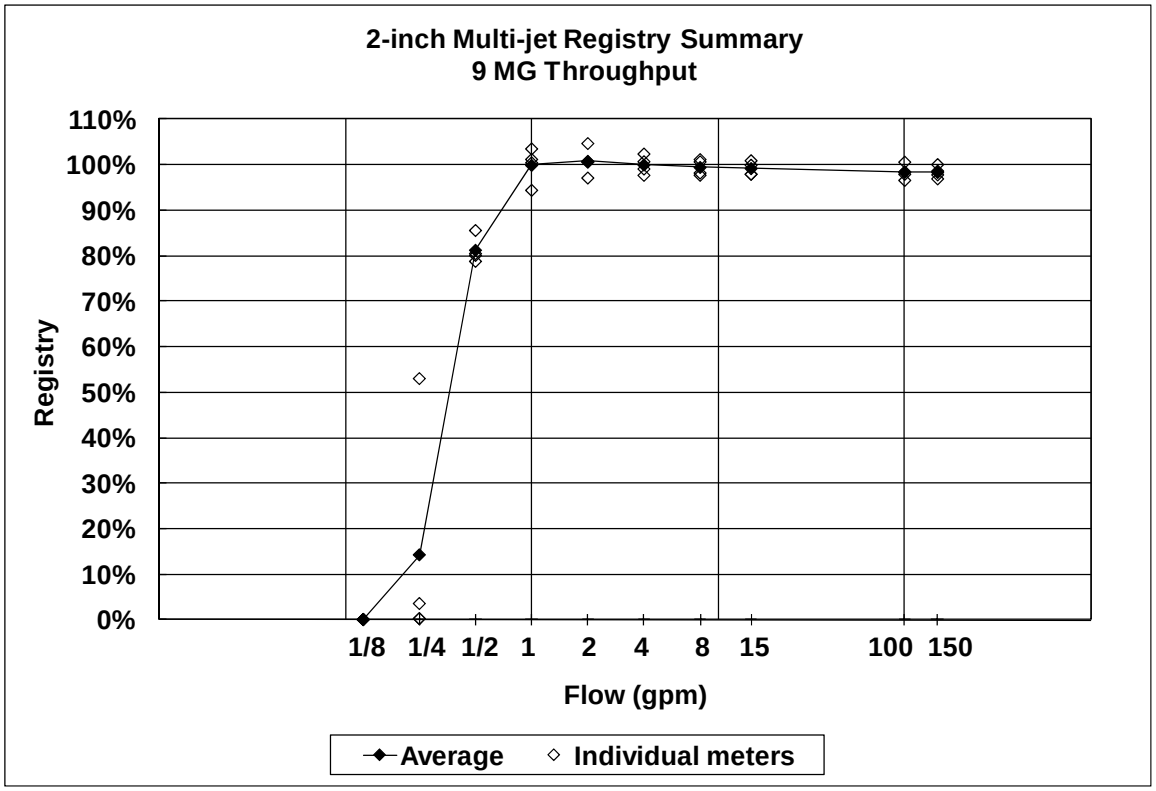

Figure 3.138 2-inch multi-jet 9 MG throughput

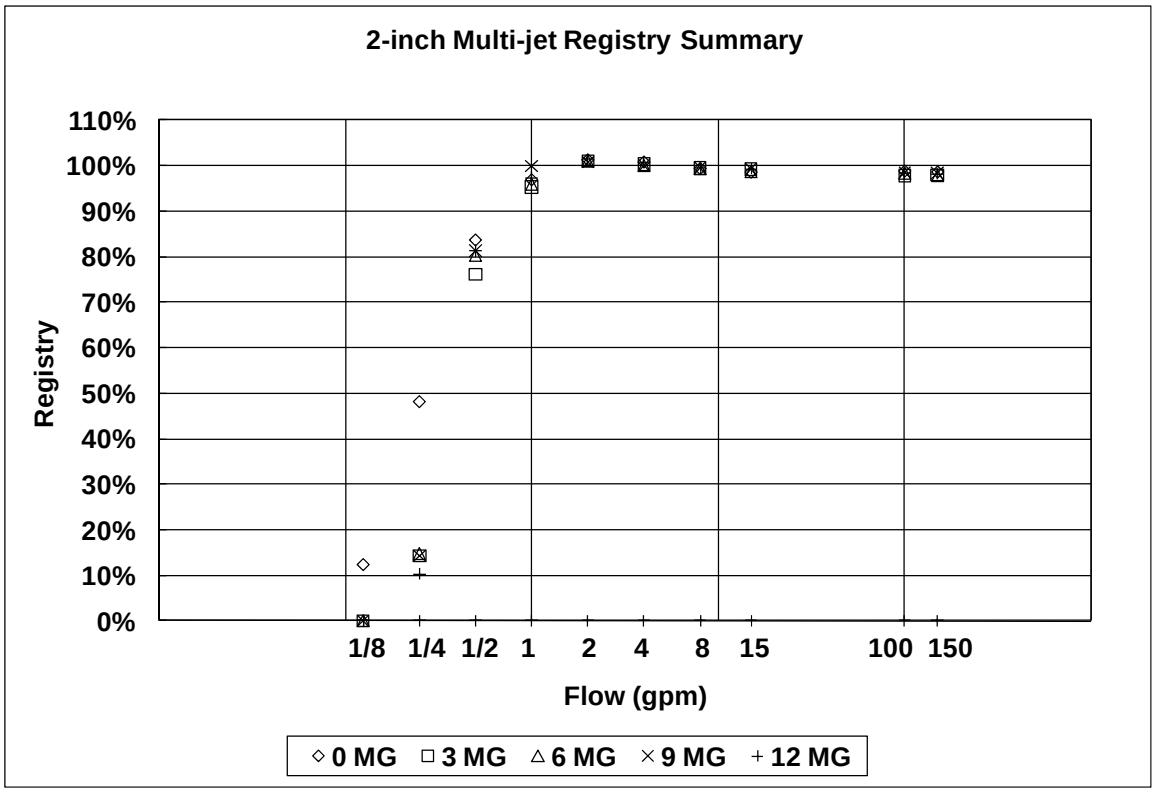

Figure 3.139 2-inch multi-jet registry summary

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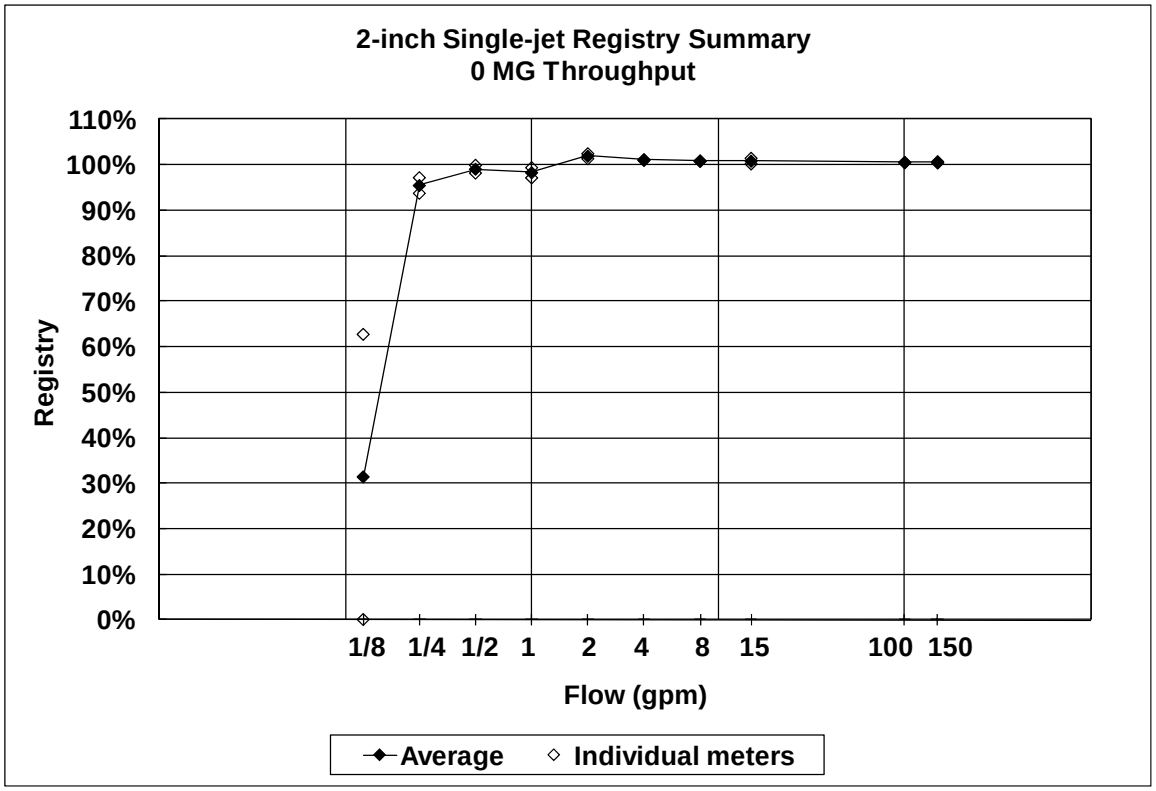

Figure 3.140 2-inch single-jet 0 MG throughput

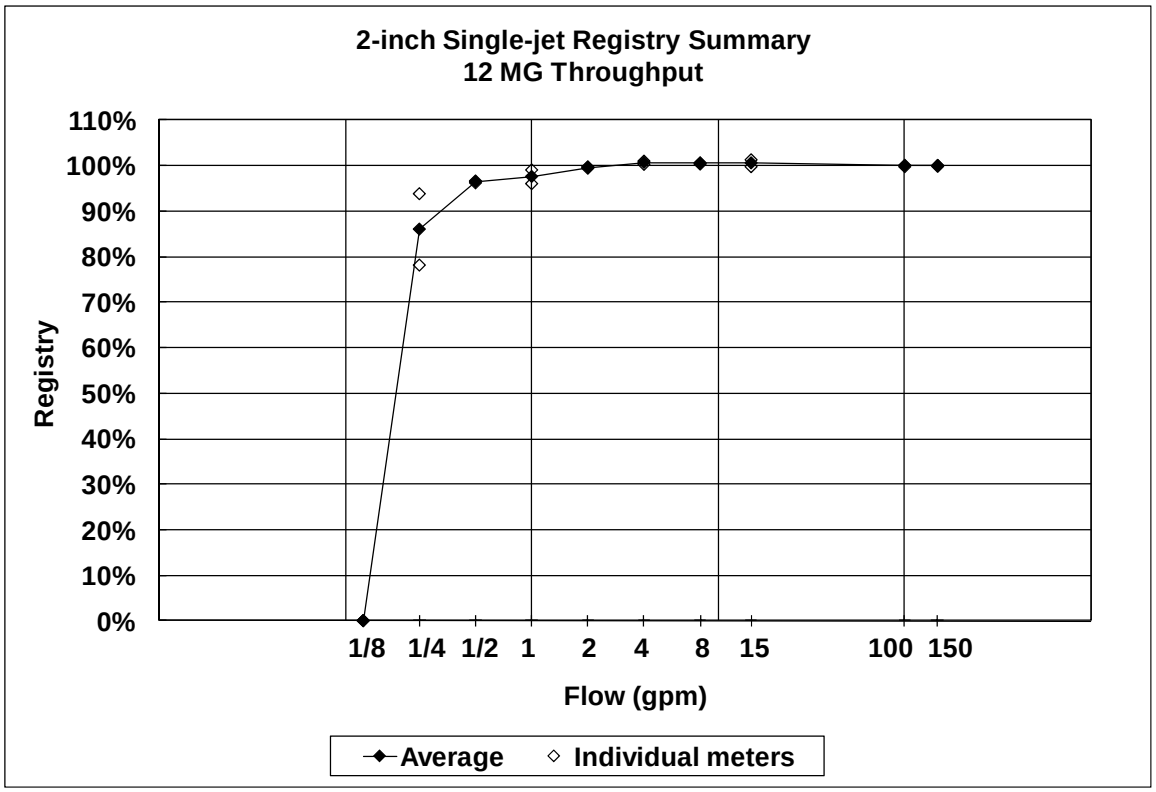

Figure 3.141 2-inch single-jet 12 MG throughput

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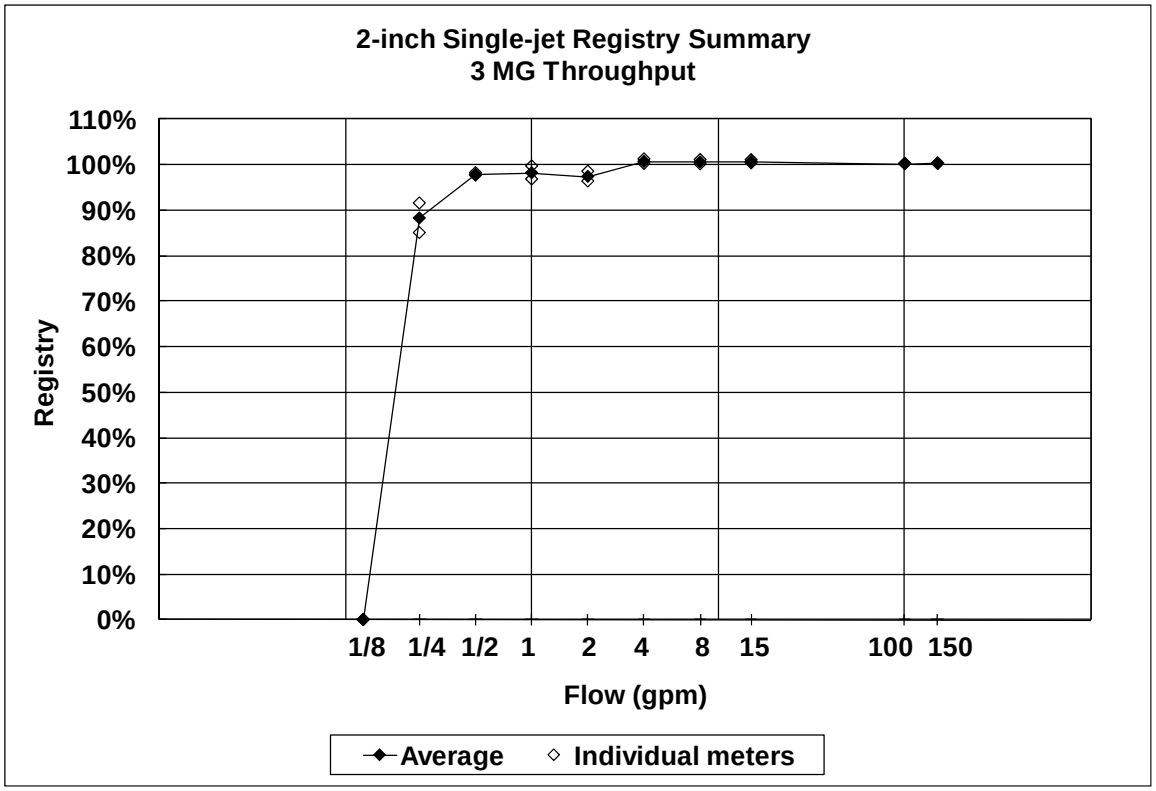

Figure 3.142 2-inch single-jet 3 MG throughput

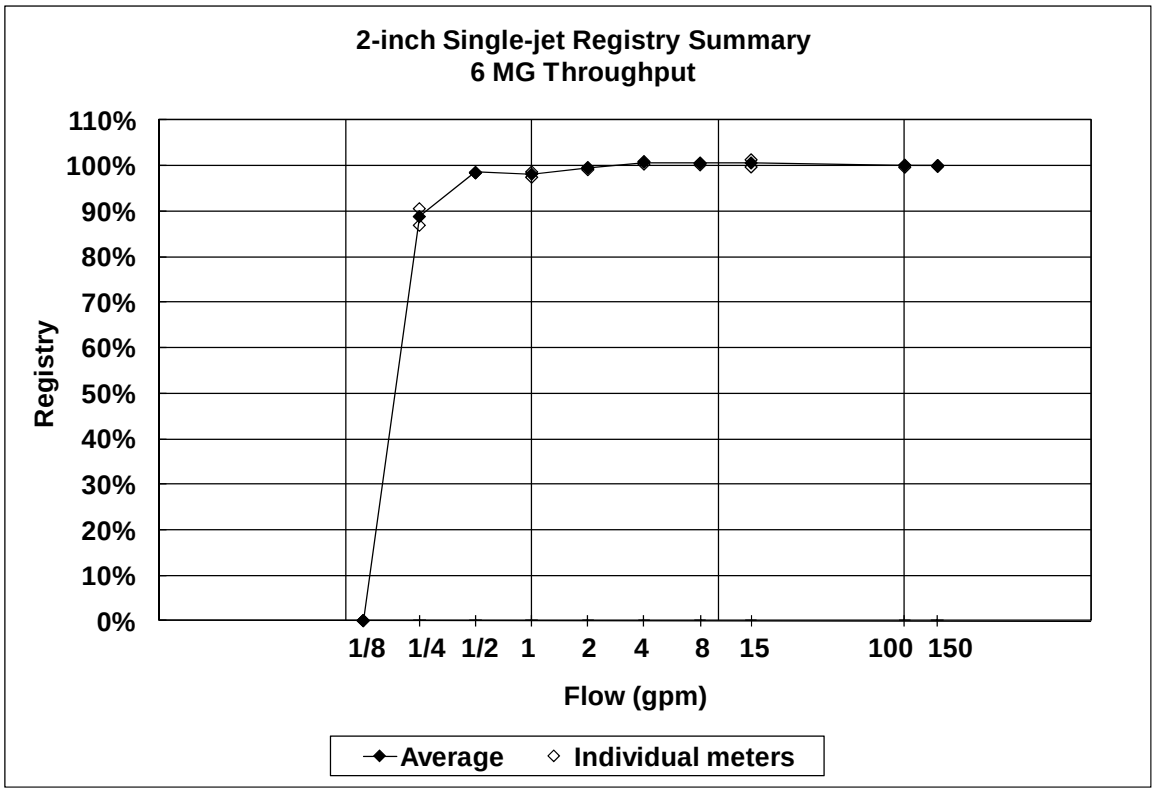

Figure 3.143 2-inch single-jet 6 MG throughput

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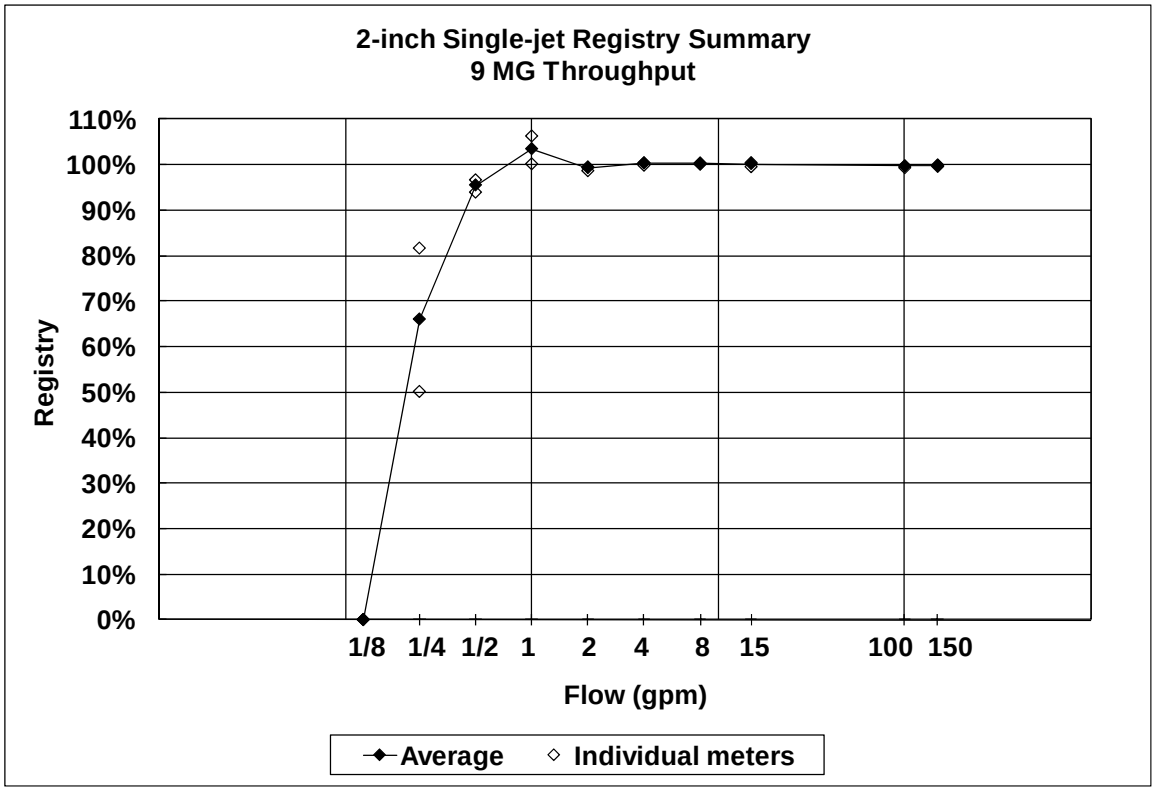

Figure 3.144 2-inch single-jet 9 MG throughput

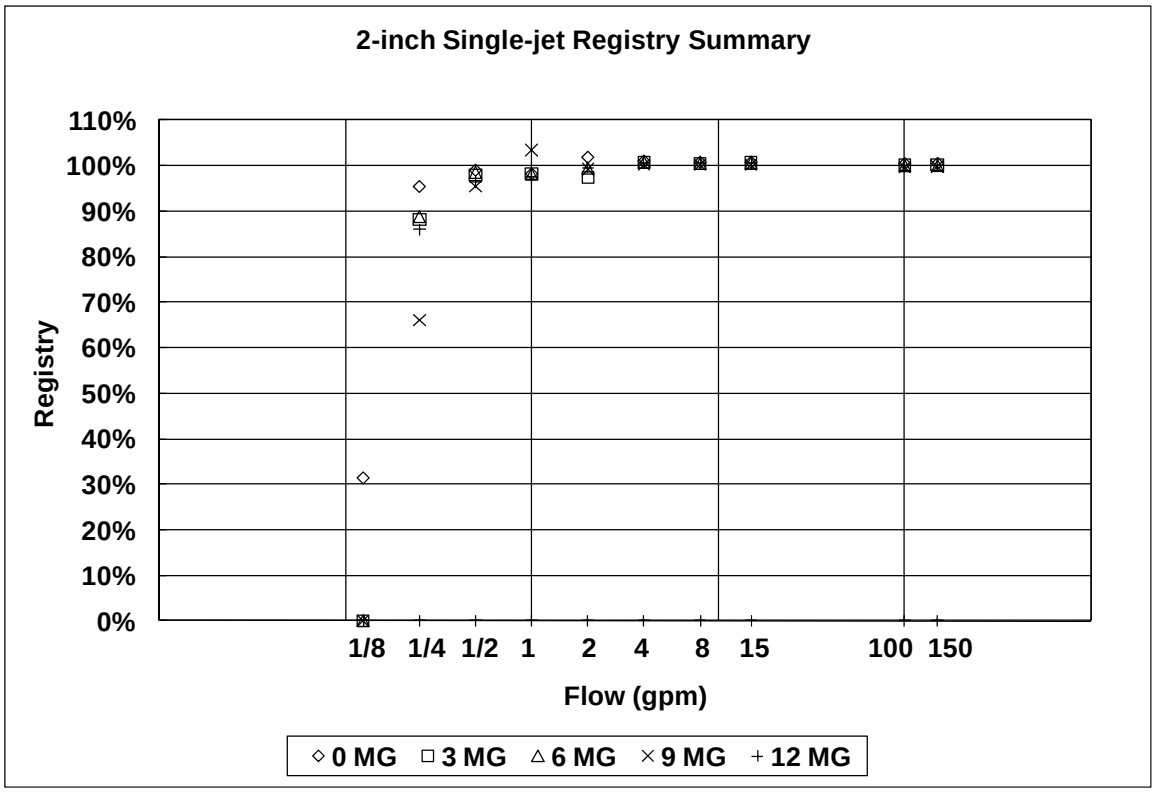

Figure 3.145 2-inch single-jet registry summary

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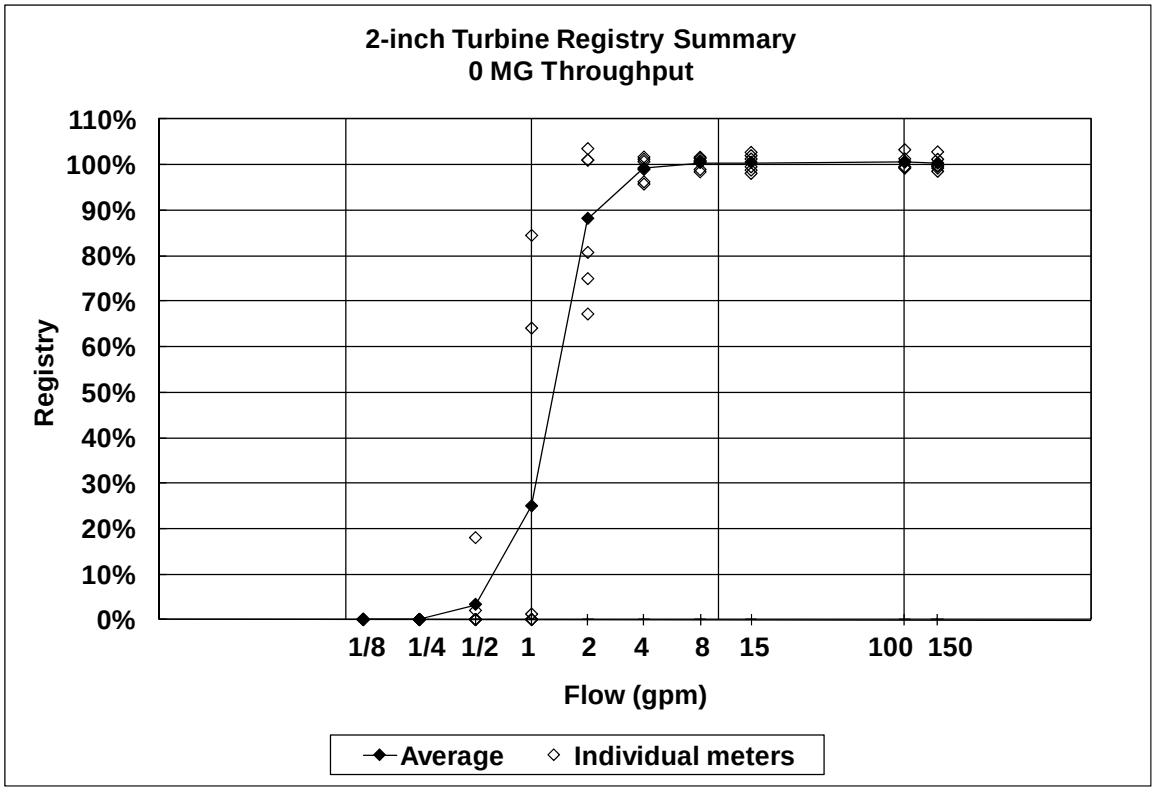

Figure 3.146 2-inch turbine 0 MG throughput

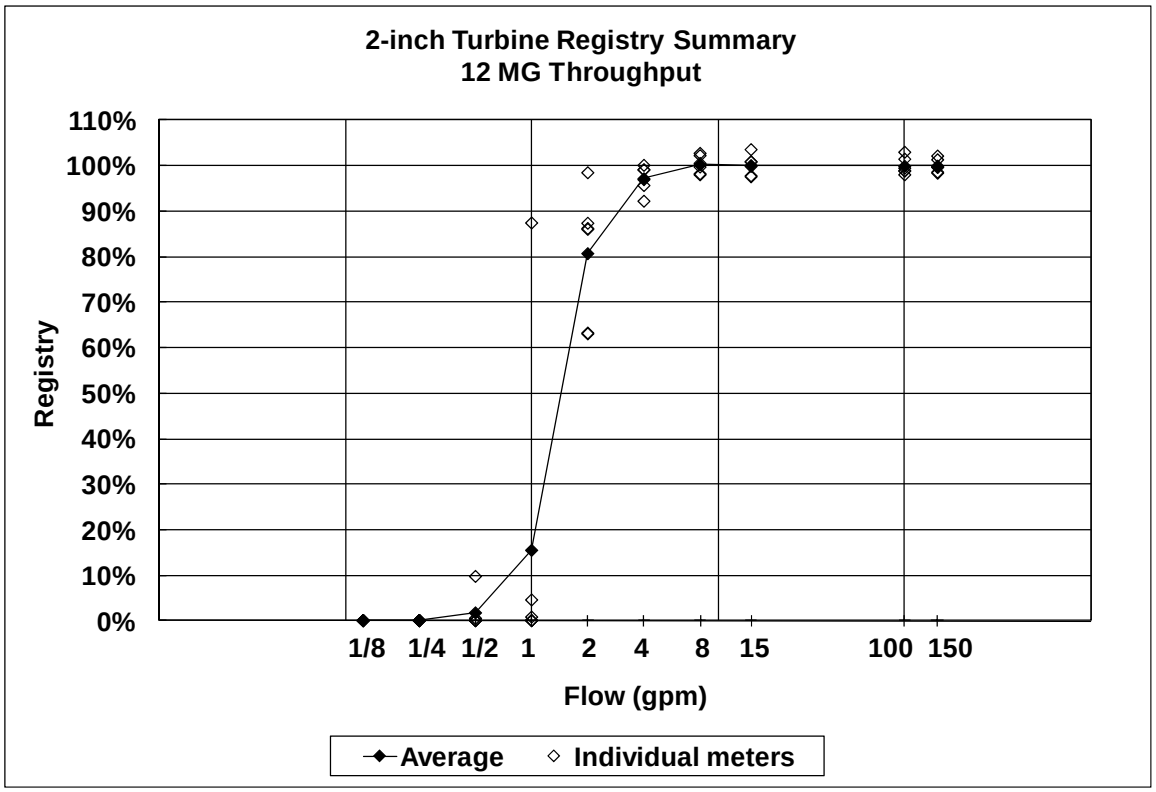

Figure 3.147 2-inch turbine 12 MG throughput

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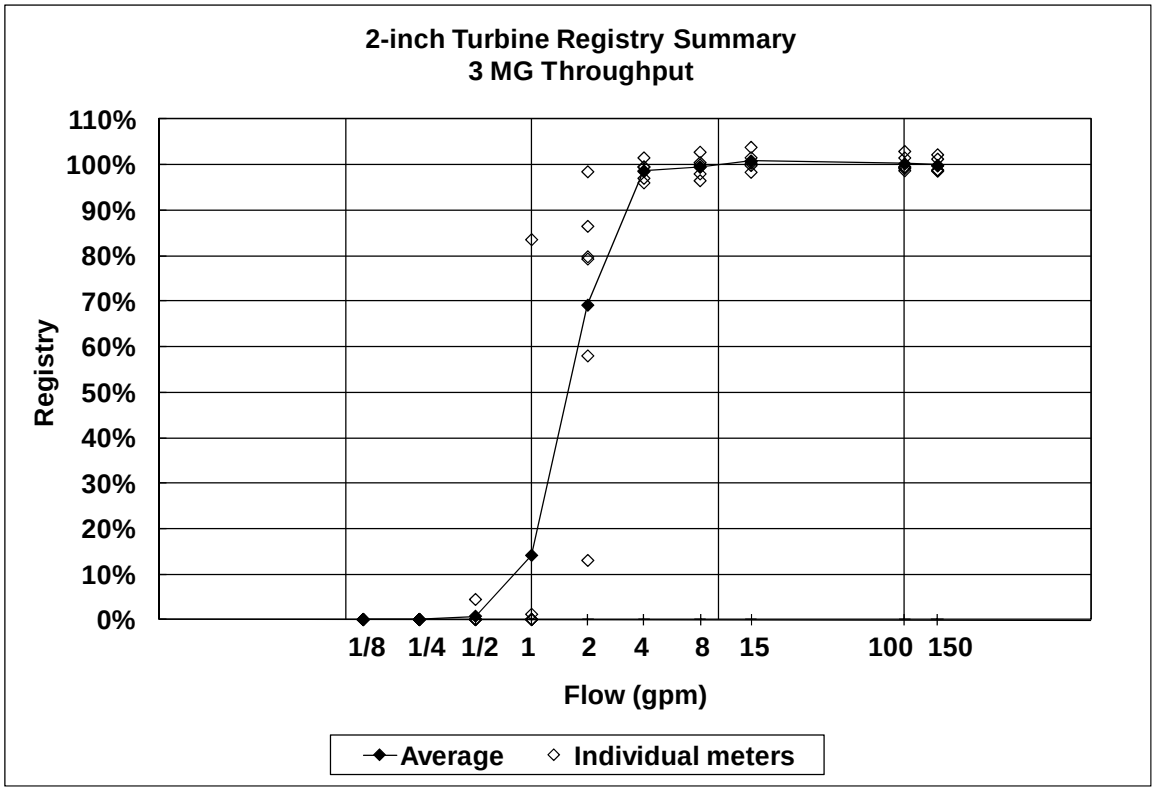

Figure 3.148 2-inch turbine 3 MG throughput

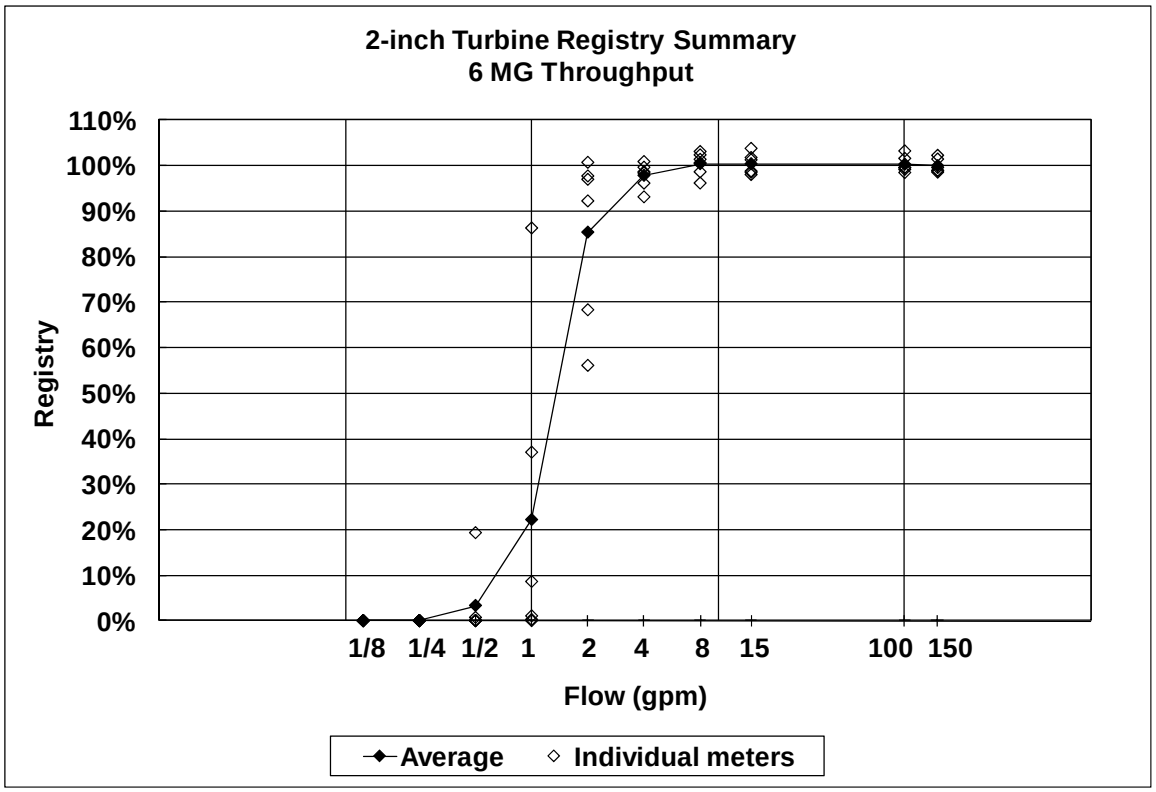

Figure 3.149 2-inch turbine 6 MG throughput

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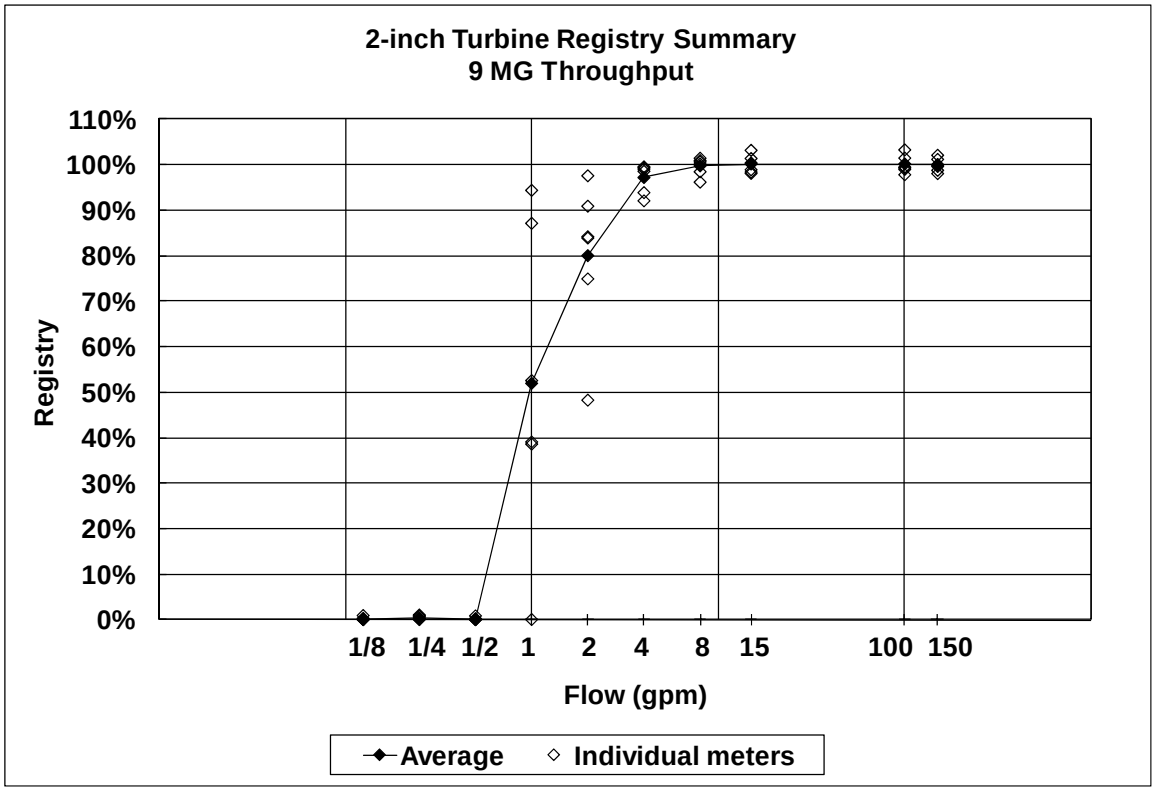

Figure 3.150 2-inch turbine 9 MG throughput

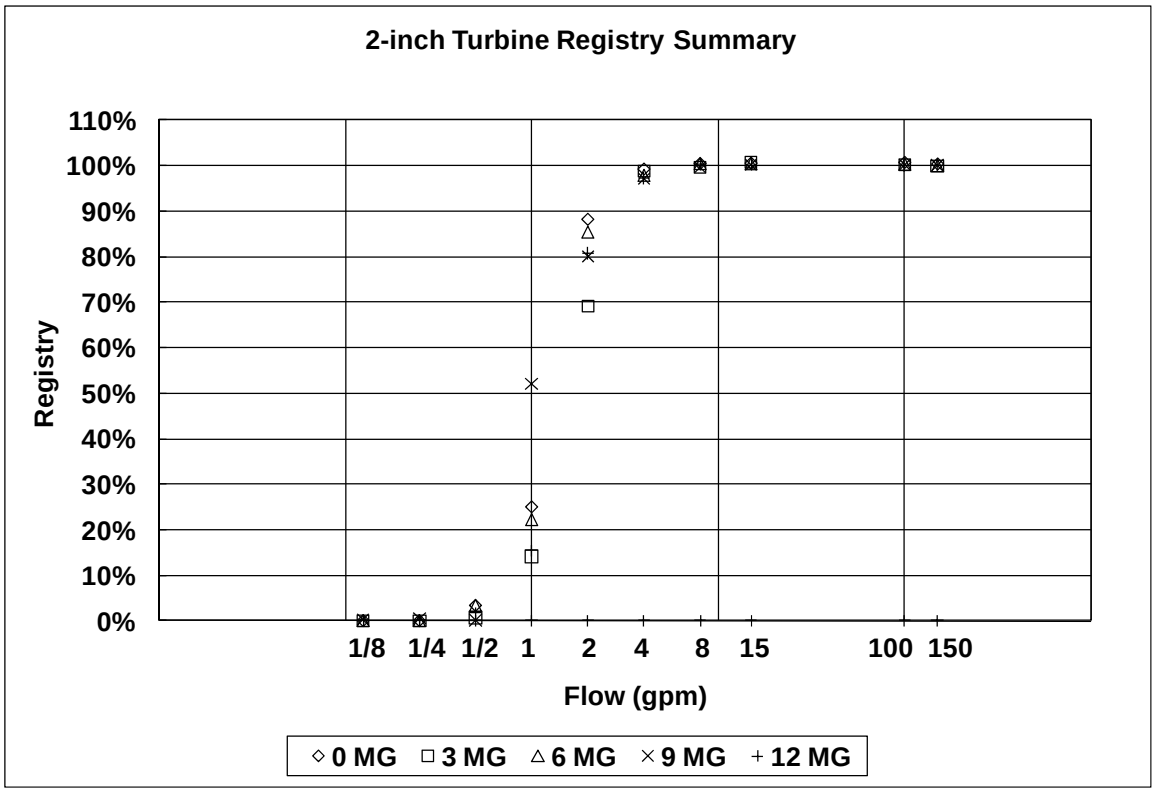

Figure 3.151 2-inch turbine registry summary

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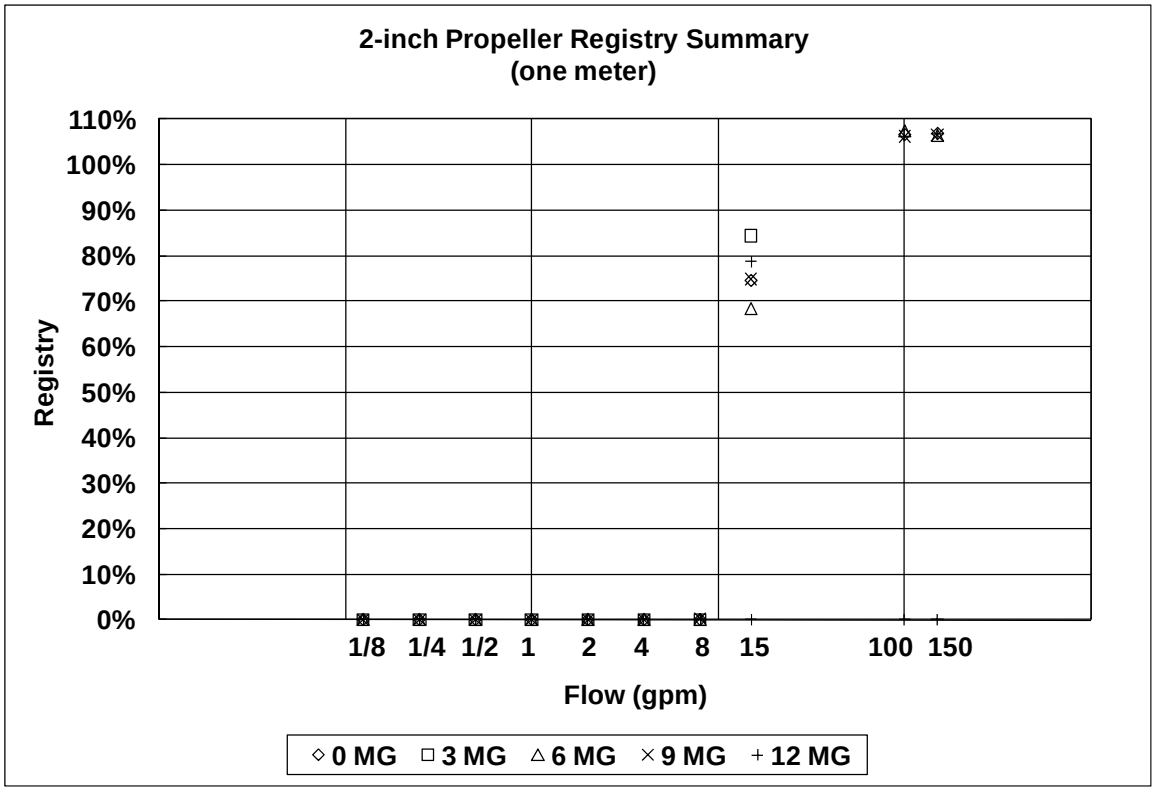

Figure 3.152 2-inch propeller registry summary

PHASE III: PULLED METER TESTS

Five hundred ninety five (595) meters from various utilities around the United States were pulled and tested. Table 3.10 summarizes the number of meters that were donated by meter type. Twelve different manufacturers are represented in Table 3.10. Only piston, nutating disc and multi-jet type meters were donated. The results of the testing are given in the figures that follow. The data are plotted such that the registry is plotted versus throughput, time of service, throughput/time of service, and problem index. The throughput is the meter odometer reading when the meter was pulled and shipped to the laboratory. The time of service is the number of years that the subject meter was in service before it was pulled and shipped to the laboratory. The throughput/time is the ratio of the first two factors, and the problem index is the summated value of 11 different internal metering parameters (range of 0 to 3); including chamber deposits, chamber scarring, magnet condition, upper bearing, lower bearing, meter device condition, disc guide bearing, body debris, body scale, gaskets and leaks. Strainer debris quantity and weight was also measured. Figure 2.21 illustrates the data sheet onto which this information was recorded.

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Table 3.10
Summary of donated meters

Donated Meters	Meter Type
344	DP
211	ND
40	MJ

5/8x3/4-inch Meters

Figures 3.153 through 3.162 show the results for the pulled 5/8x3/4-inch meters tested. The results are presented as registry versus service live, versus throughput, versus throughput divided by service time, and versus the problem index.

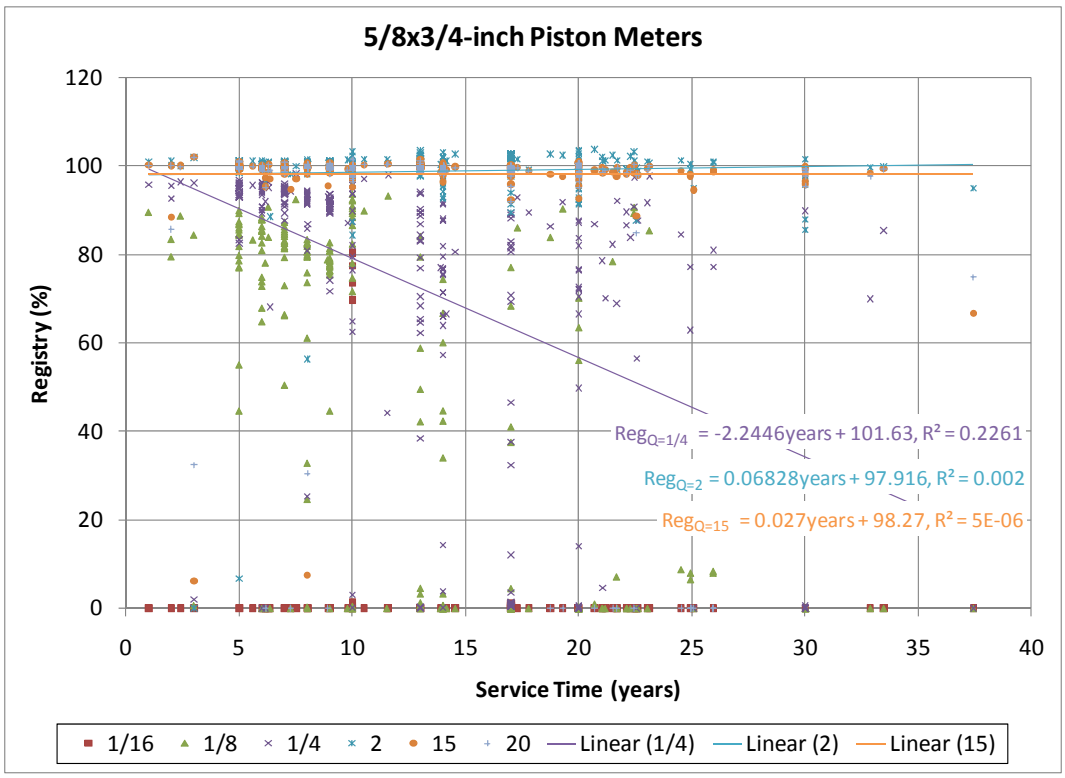

Figure 3.153 Service time versus registry 5/8x3/4-inch piston meters

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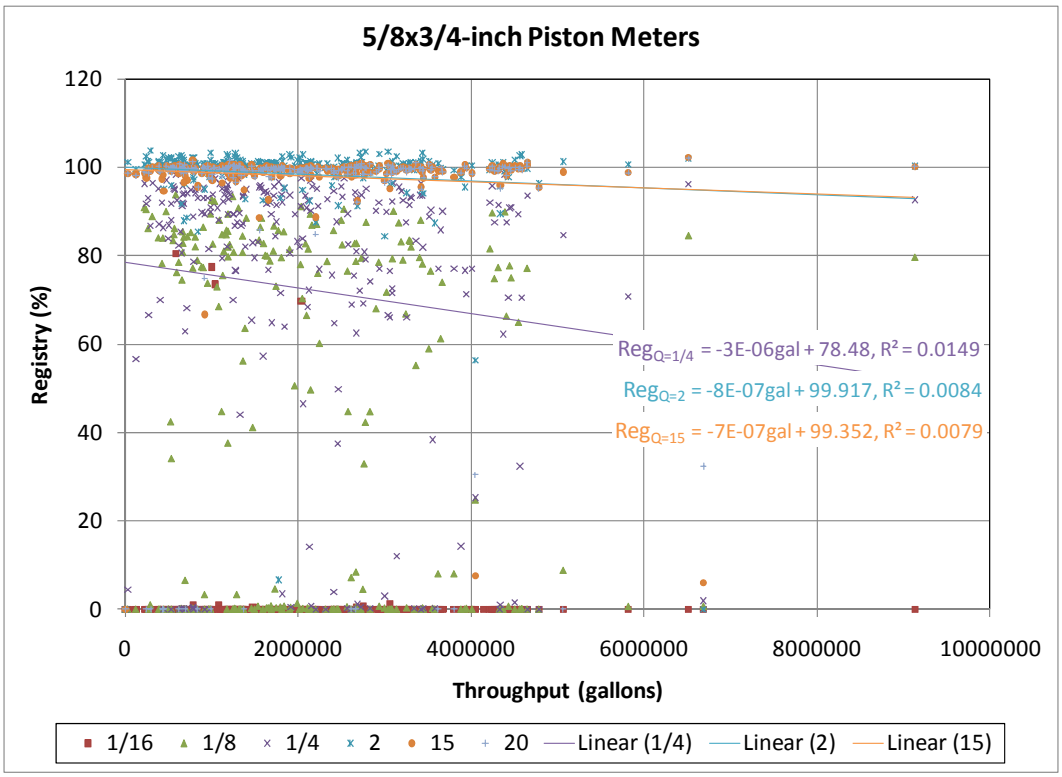

Figure 3.154 Throughput versus registry 5/8x3/4-inch piston meters

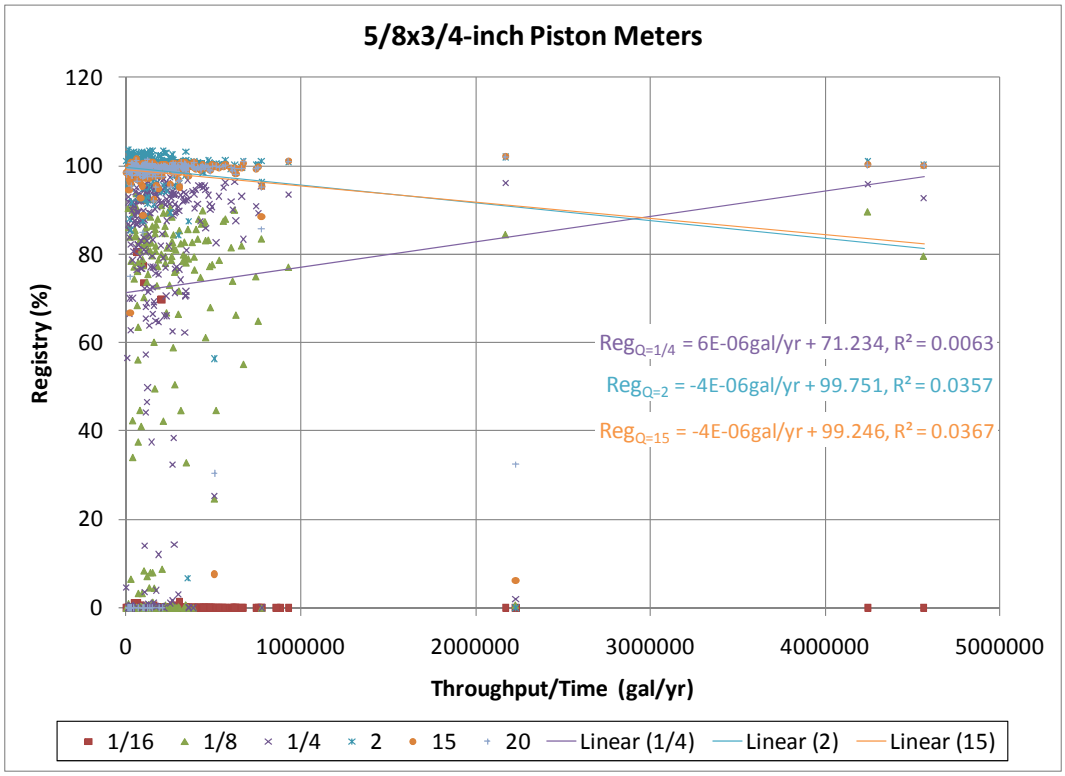

Figure 3.155 Throughput/time versus registry 5/8x3/4-inch piston meters

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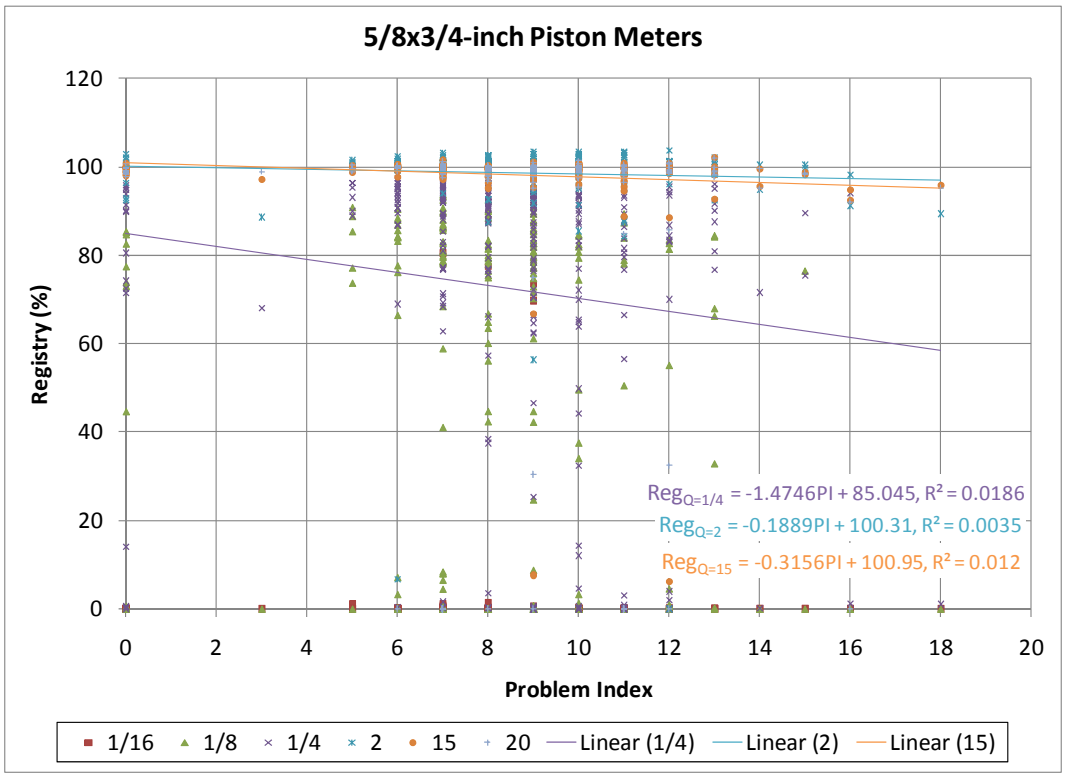

Figure 3.156 Problem index versus registry 5/8x3/4-inch piston meters

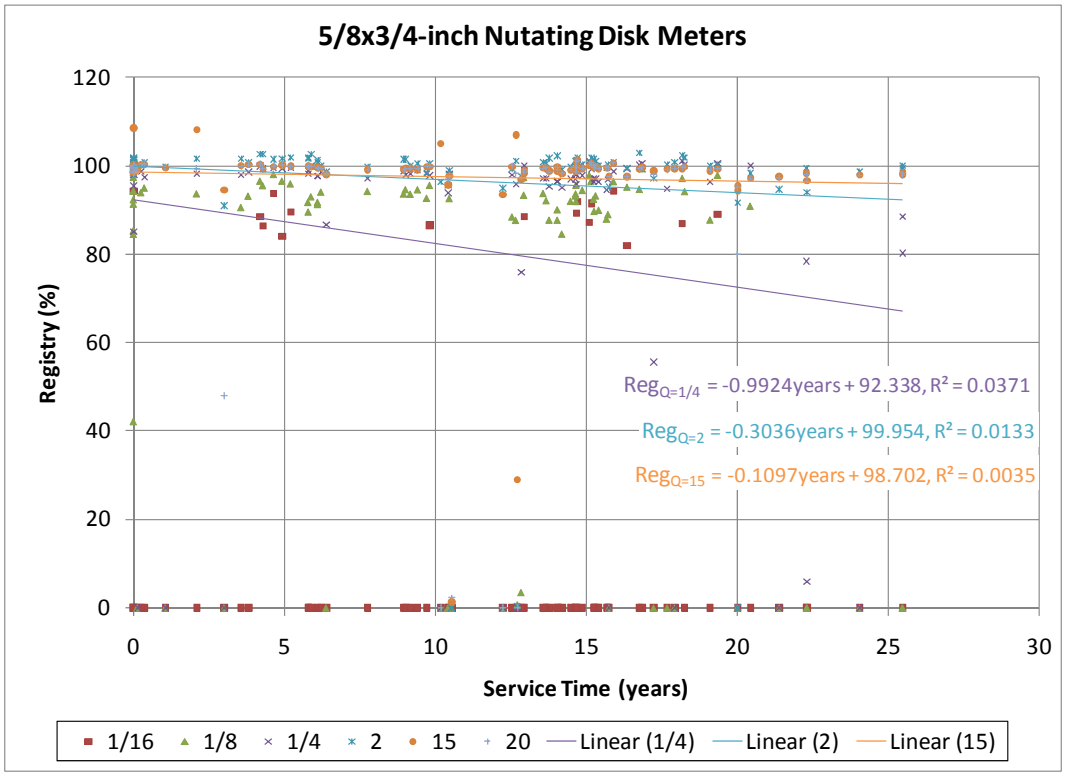

Figure 3.157 Service time versus registry 5/8x3/4-inch nutating disc meters

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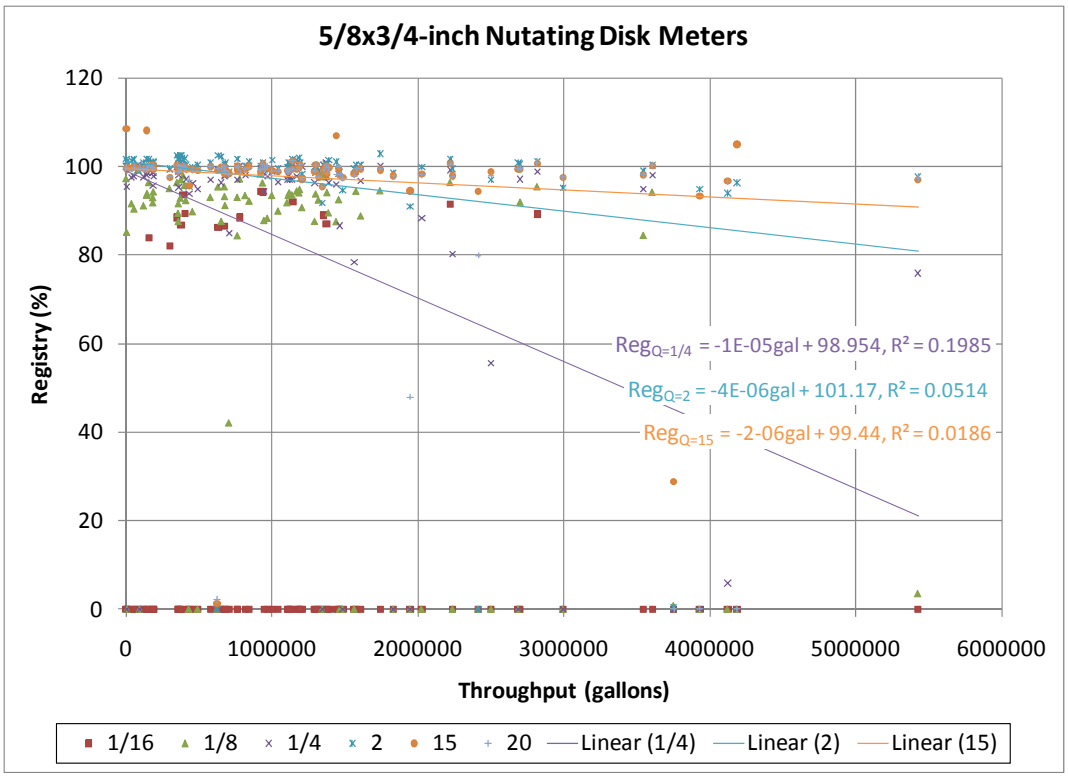

Figure 3.158 Throughput versus registry 5/8x3/4-inch nutating disc meters

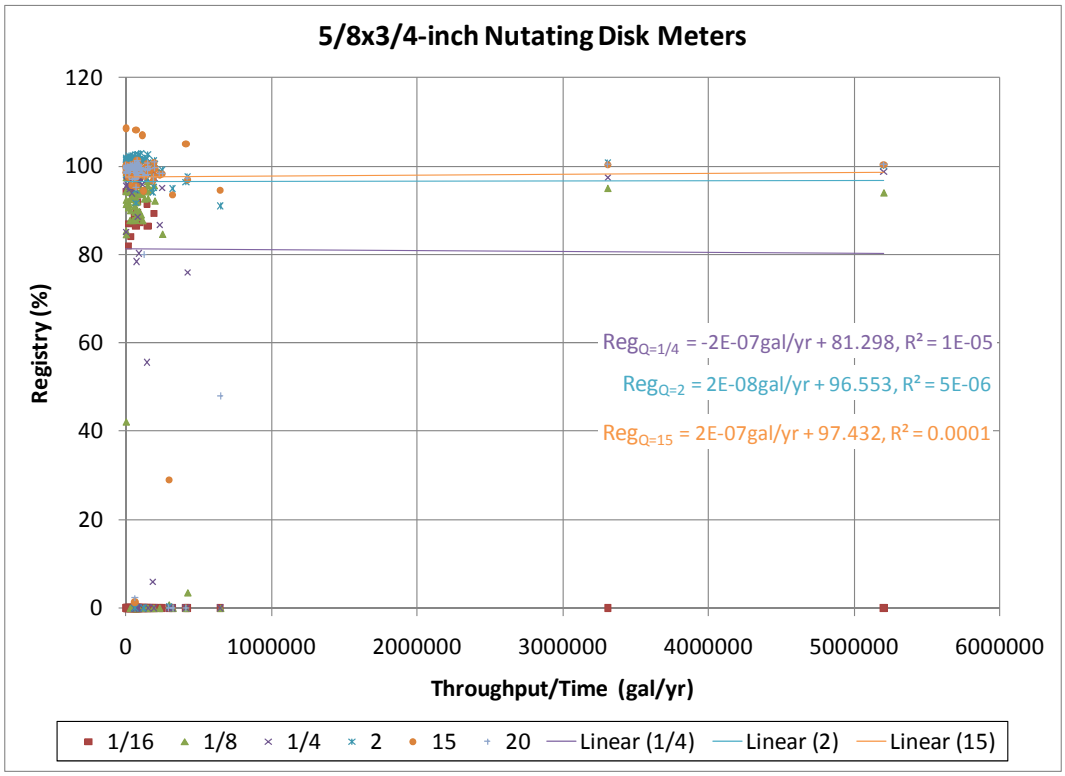

Figure 3.159 Throughput/time versus registry 5/8x3/4-inch nutating disc meters

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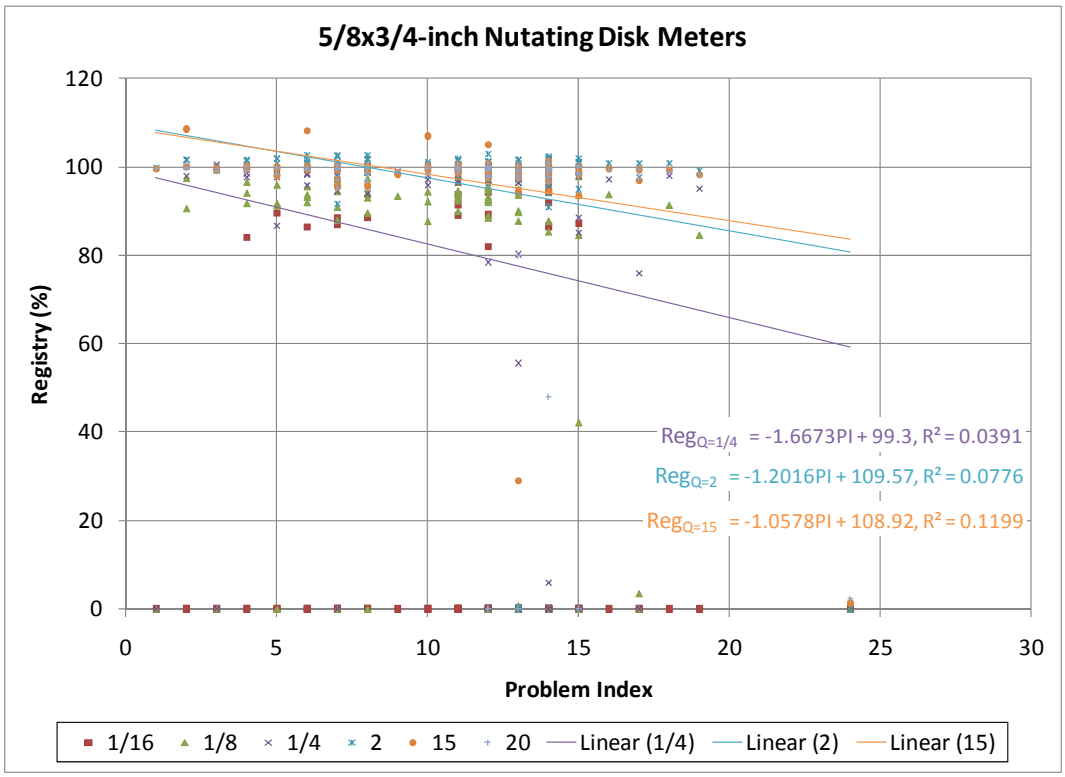

Figure 3.160 Problem index versus registry 5/8x3/4-inch nutating disc meters

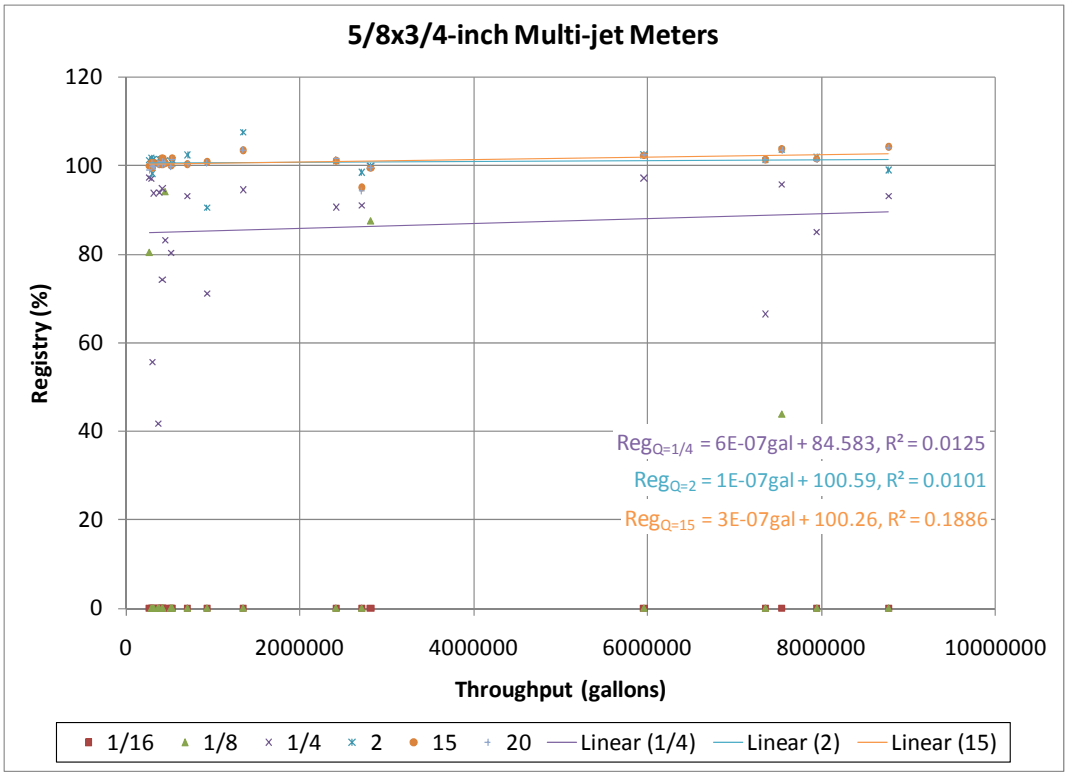

Figure 3.161 Throughput versus registry 5/8x3/4-inch multi-jet meters

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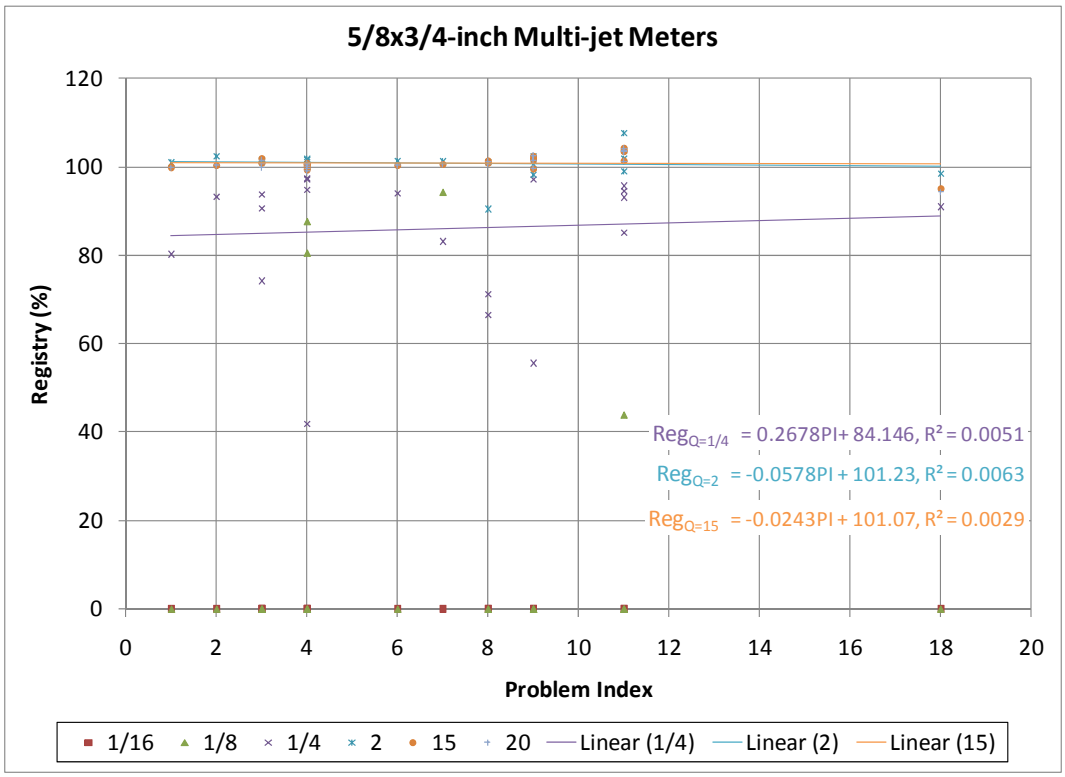

Figure 3.162 Problem index versus registry 5/8x3/4-inch multi-jet meters

3/4-inch Meters

Figures 3.163 through 3.170 show the results for the pulled 3/4-inch meters tested. The results are presented as registry versus service live, versus throughput, versus throughput divided by service time, and versus the problem index.

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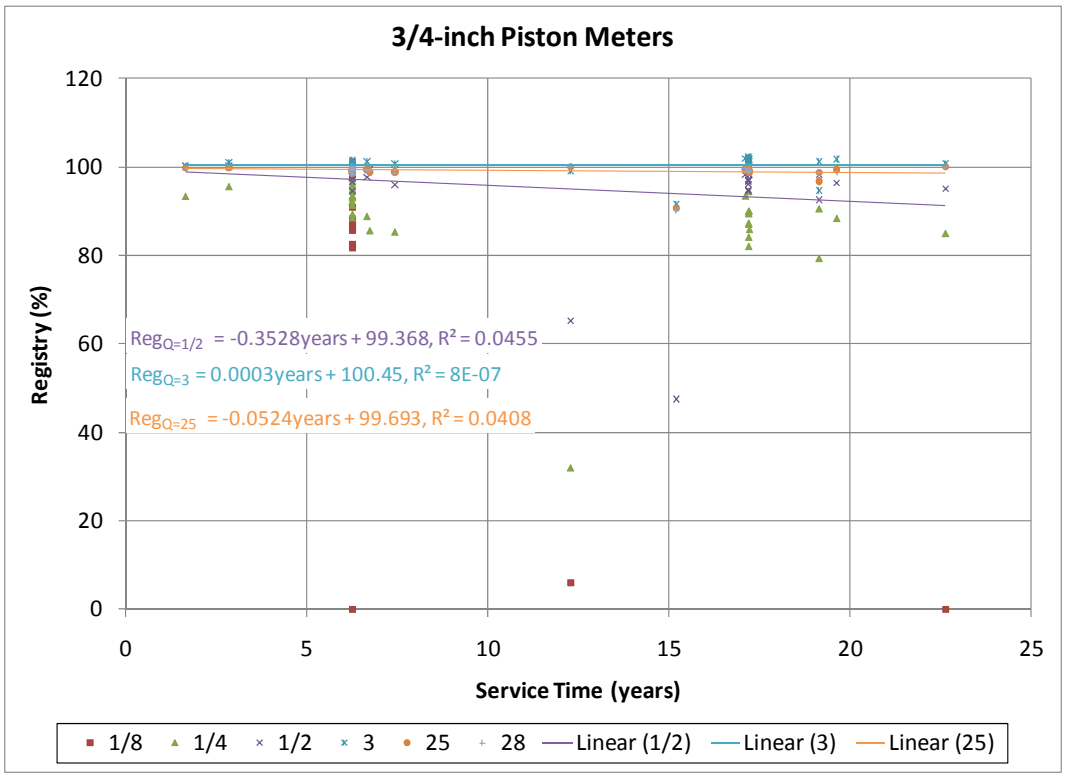

Figure 3.163 Service time versus registry 3/4-inch piston meters

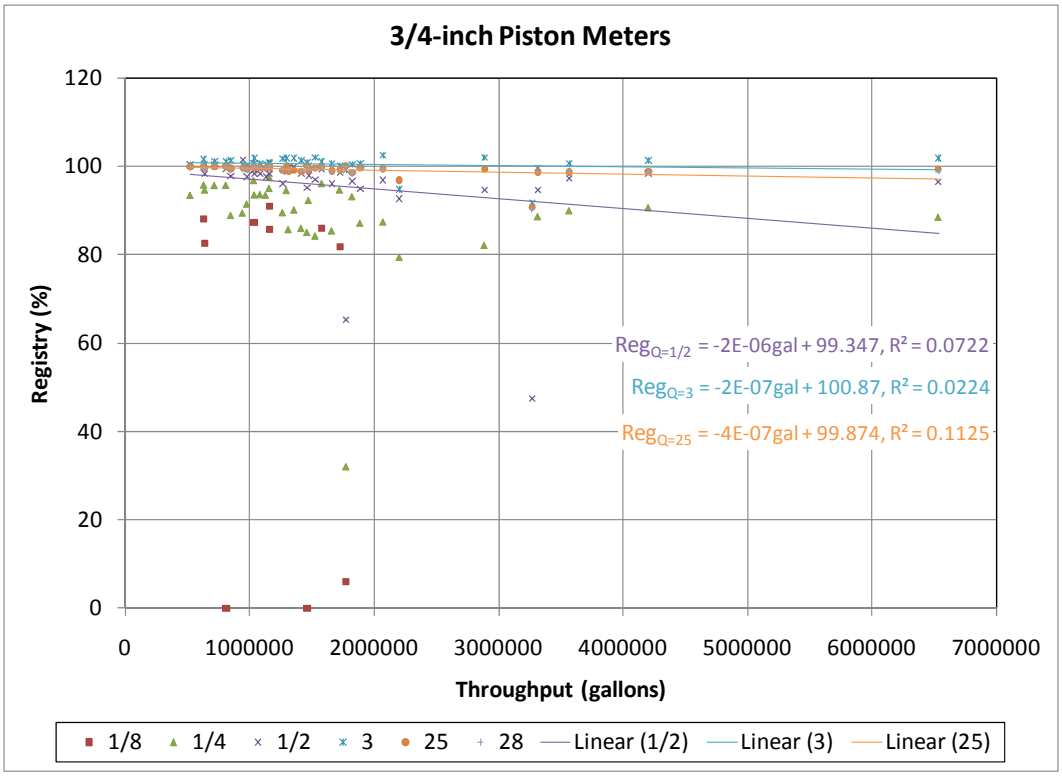

Figure 3.164 Throughput versus registry 3/4-inch piston meters

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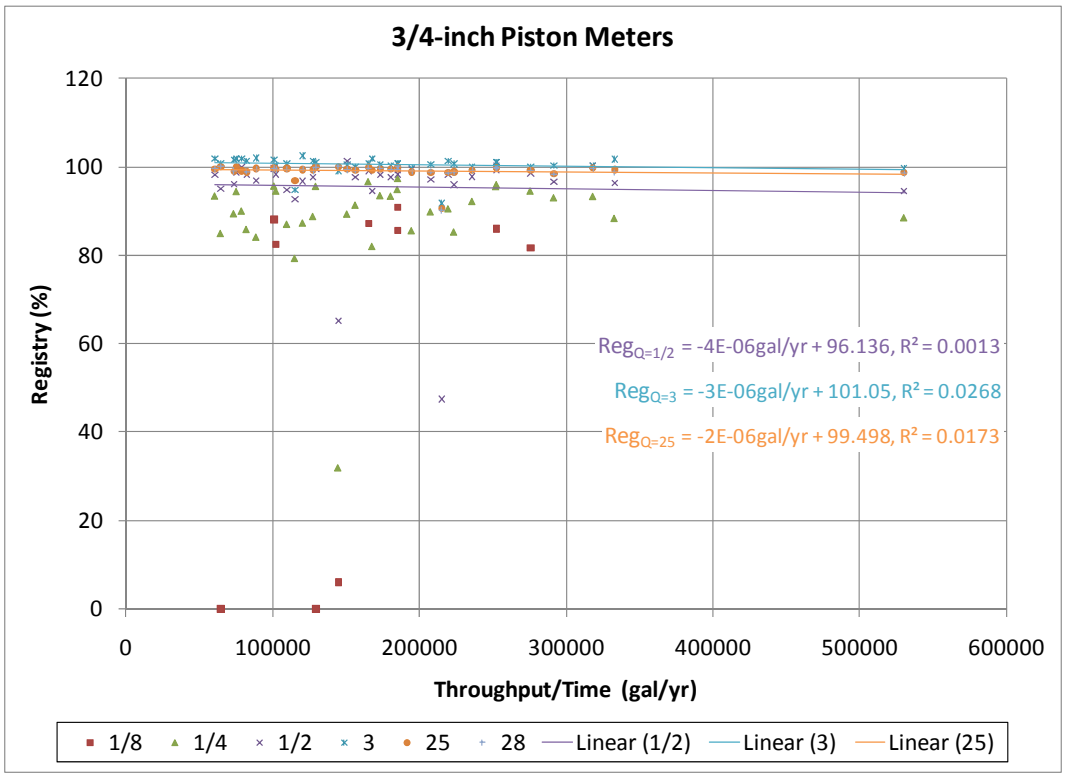

Figure 3.165 Throughput/time versus registry 3/4-inch piston meters

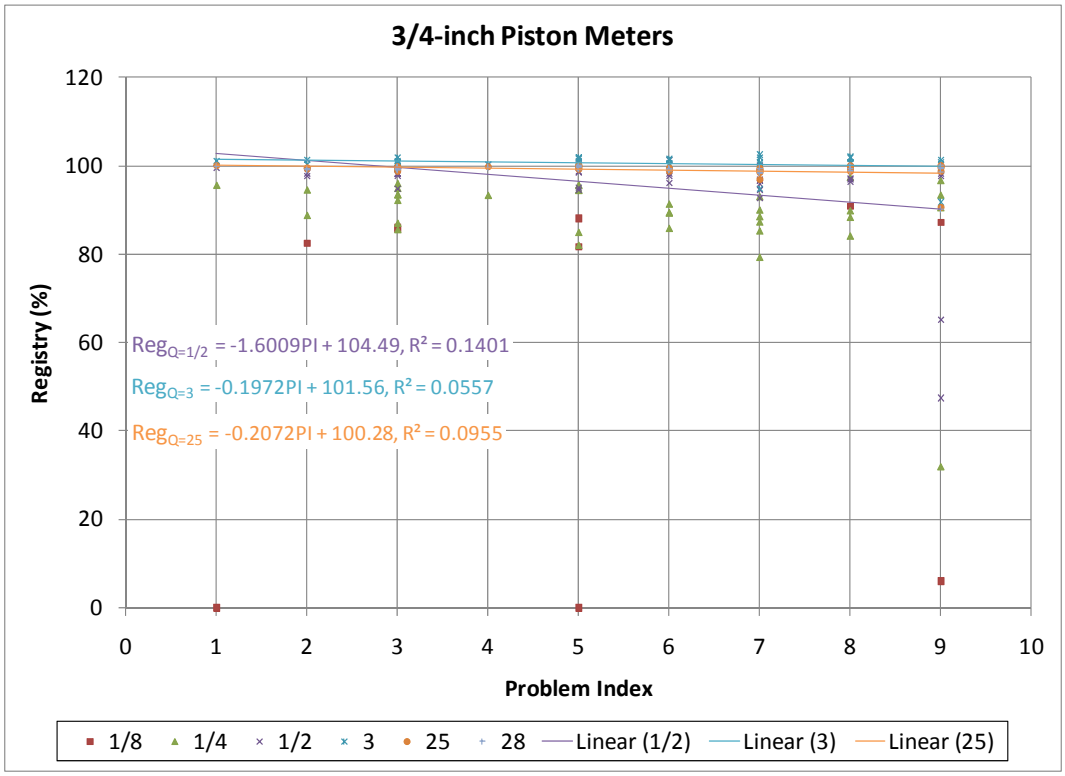

Figure 3.166 Problem index versus registry 3/4-inch piston meters

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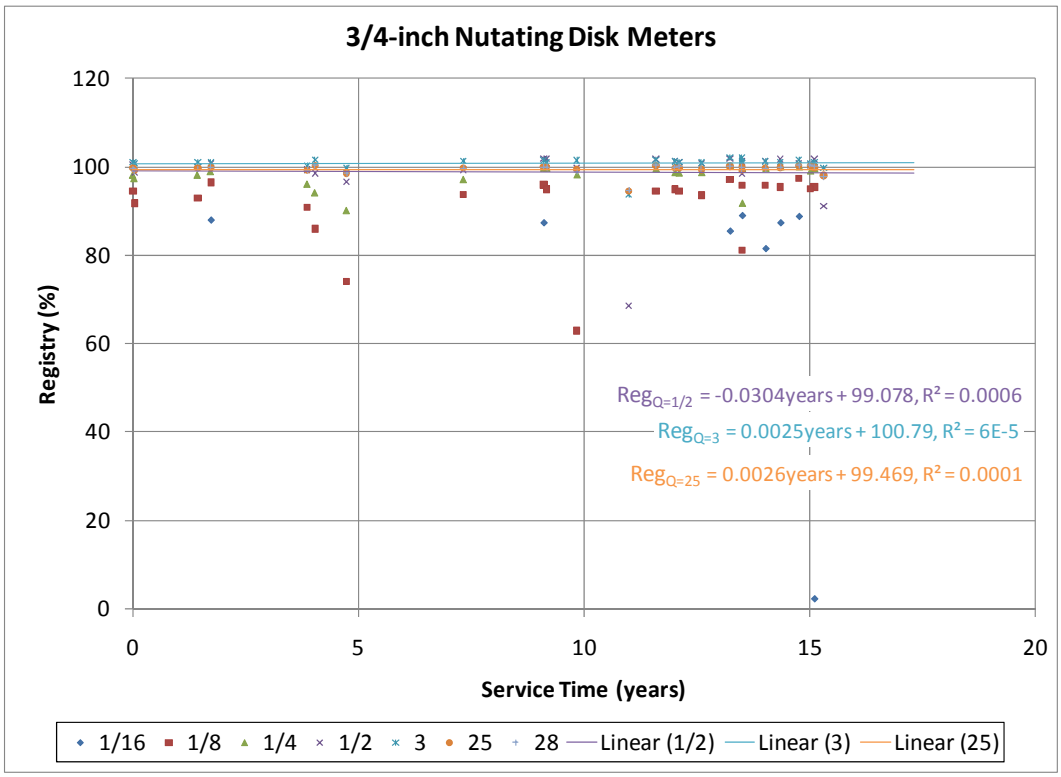

Figure 3.167 Service time versus registry 3/4-inch nutating disc meters

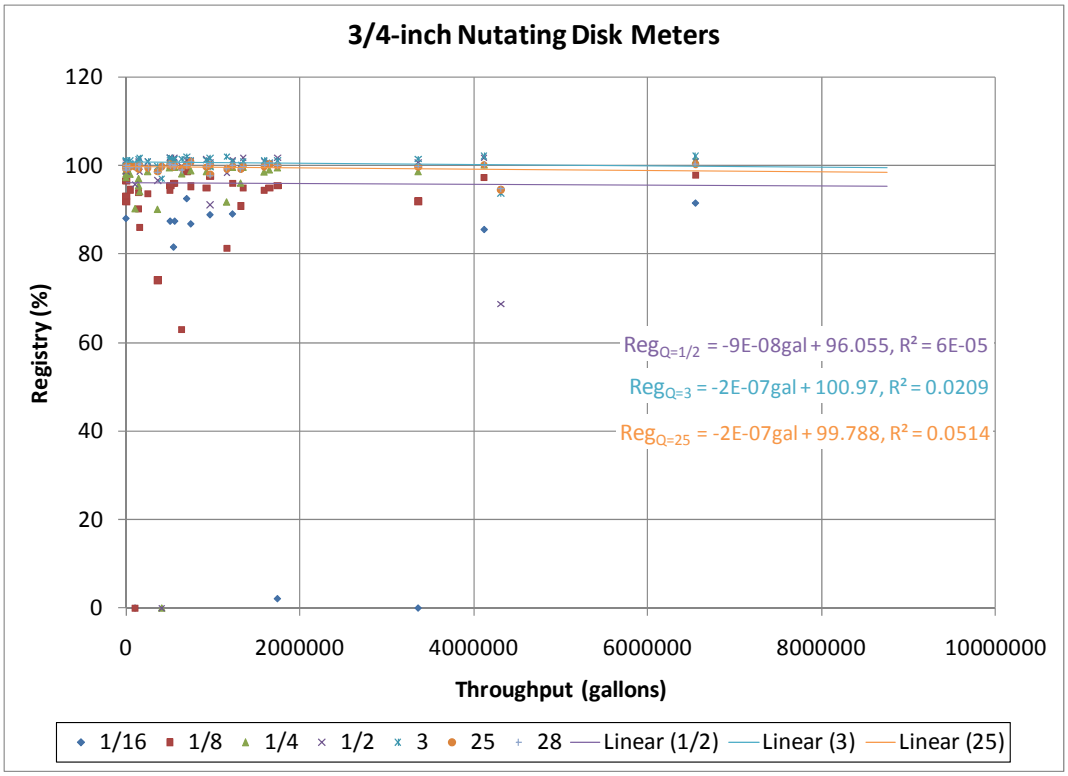

Figure 3.168 Throughput versus registry 3/4-inch nutating disc meters

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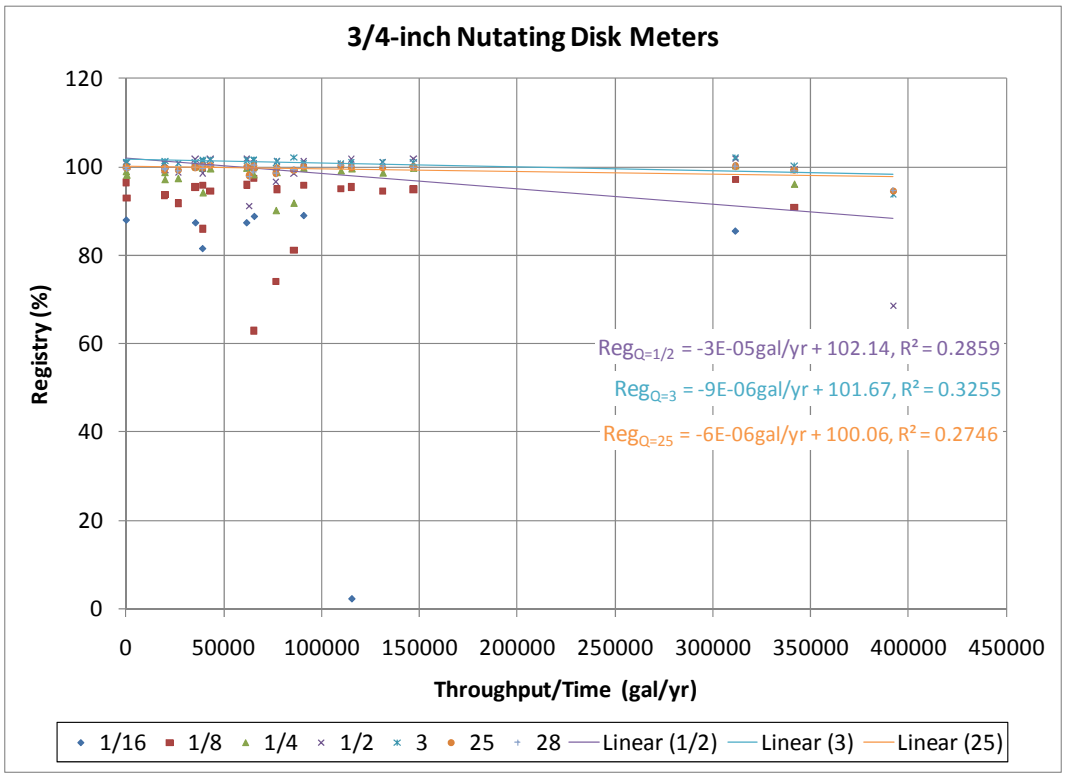

Figure 3.169 Throughput/time versus registry 3/4-inch nutating disc meters

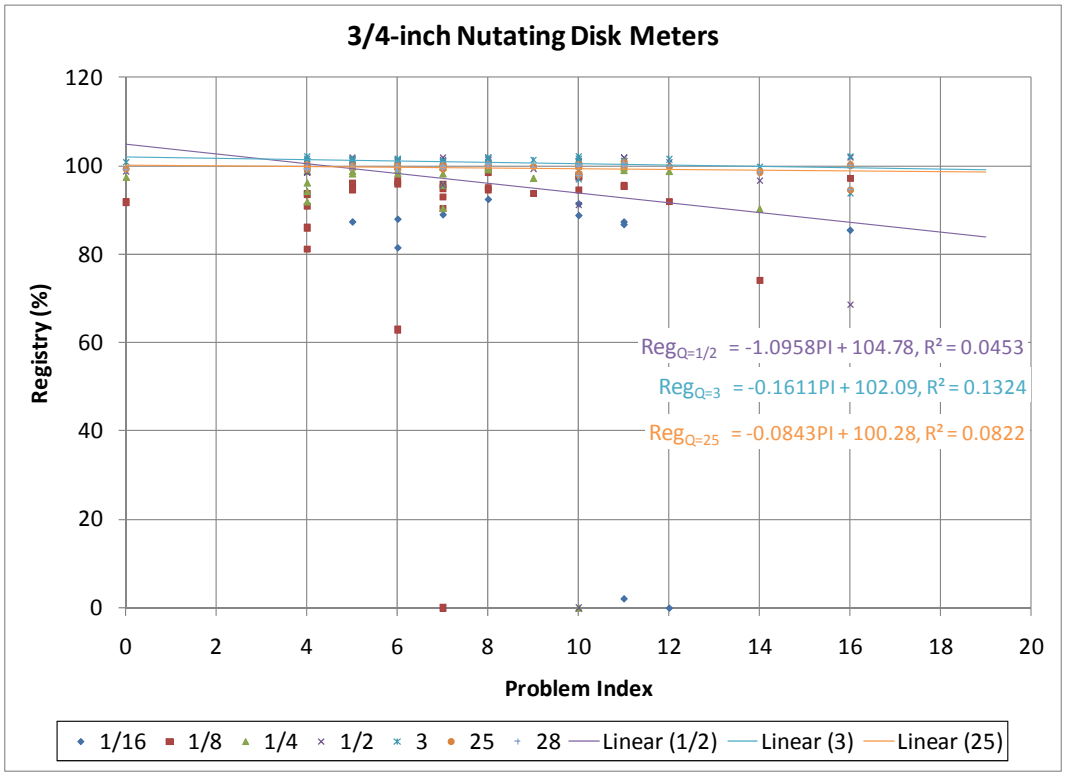

Figure 3.170 Problem index versus registry 3/4-inch nutating disc meters

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1-inch Meters

Figures 3.171 through 3.182 show the results for the pulled 1-inch meters tested. The results are presented as registry versus service live, versus throughput, versus throughput divided by service time, and versus the problem index.

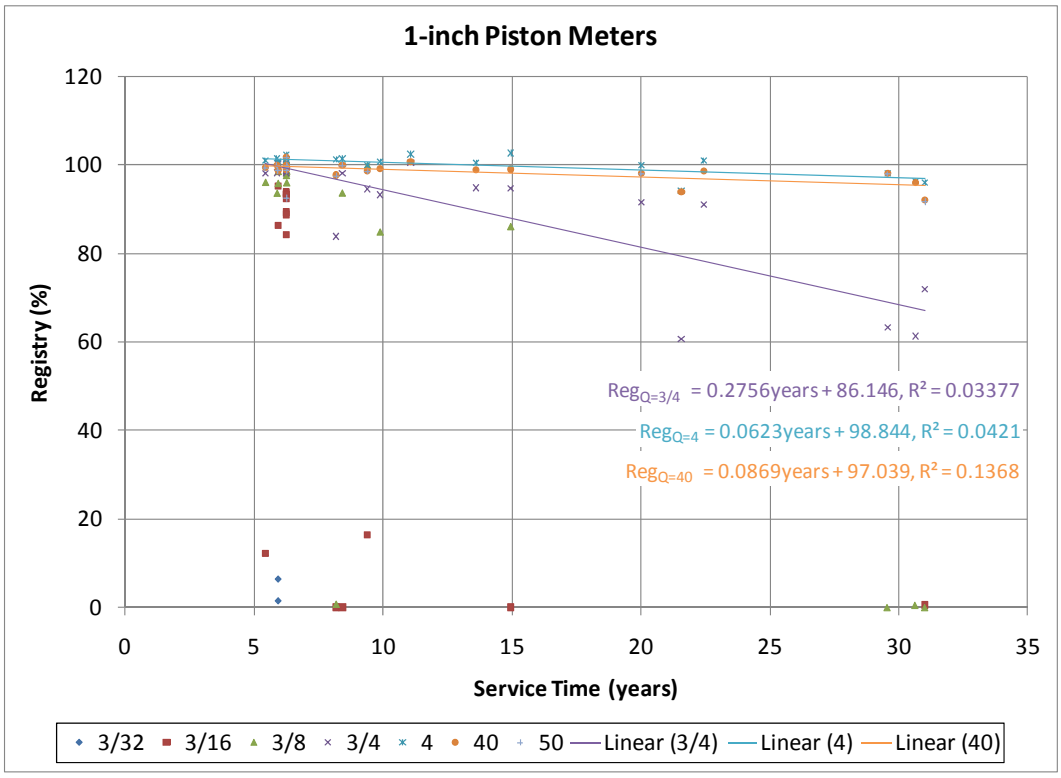

Figure 3.171 Service time versus registry 1-inch piston meters

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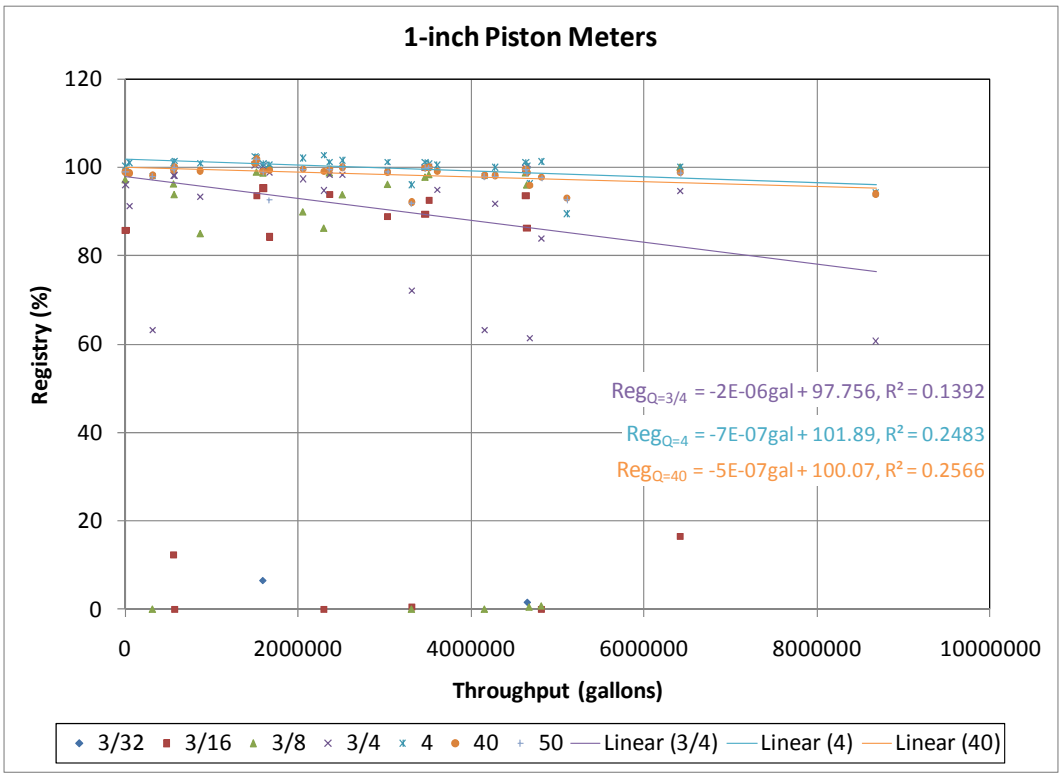

Figure 3.172 Throughput versus registry 1-inch piston meters

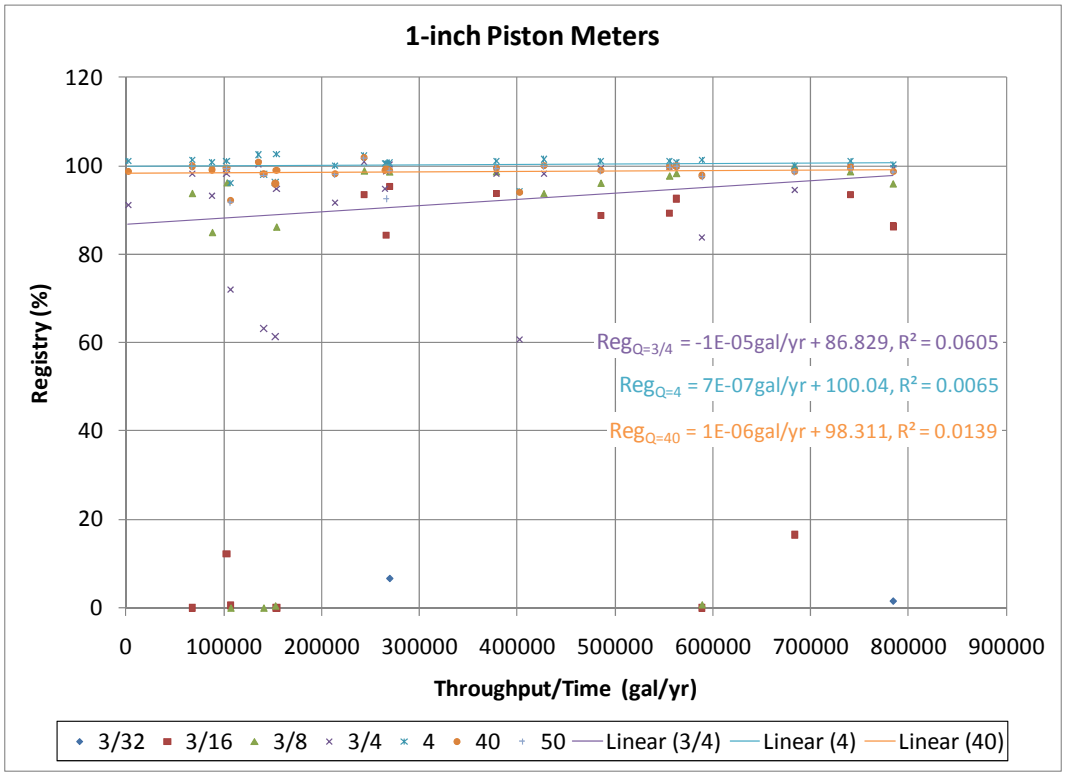

Figure 3.173 Throughput/time versus registry 1-inch piston meters

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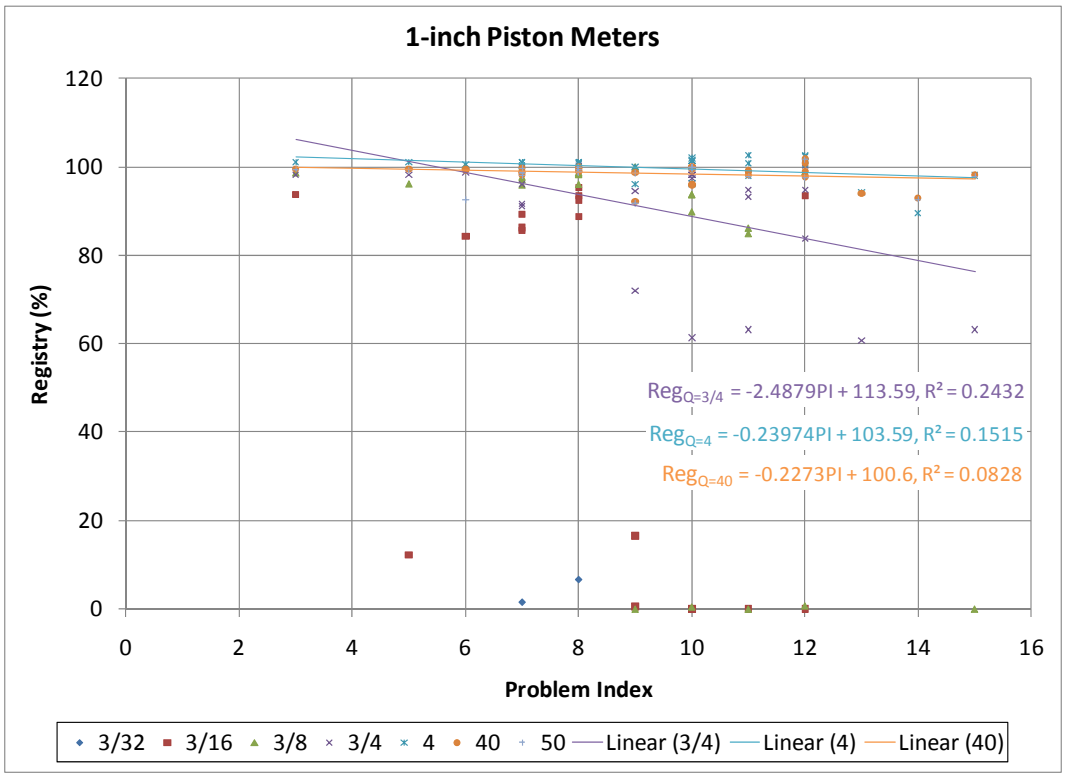

Figure 3.174 Problem index versus registry 1-inch piston meters

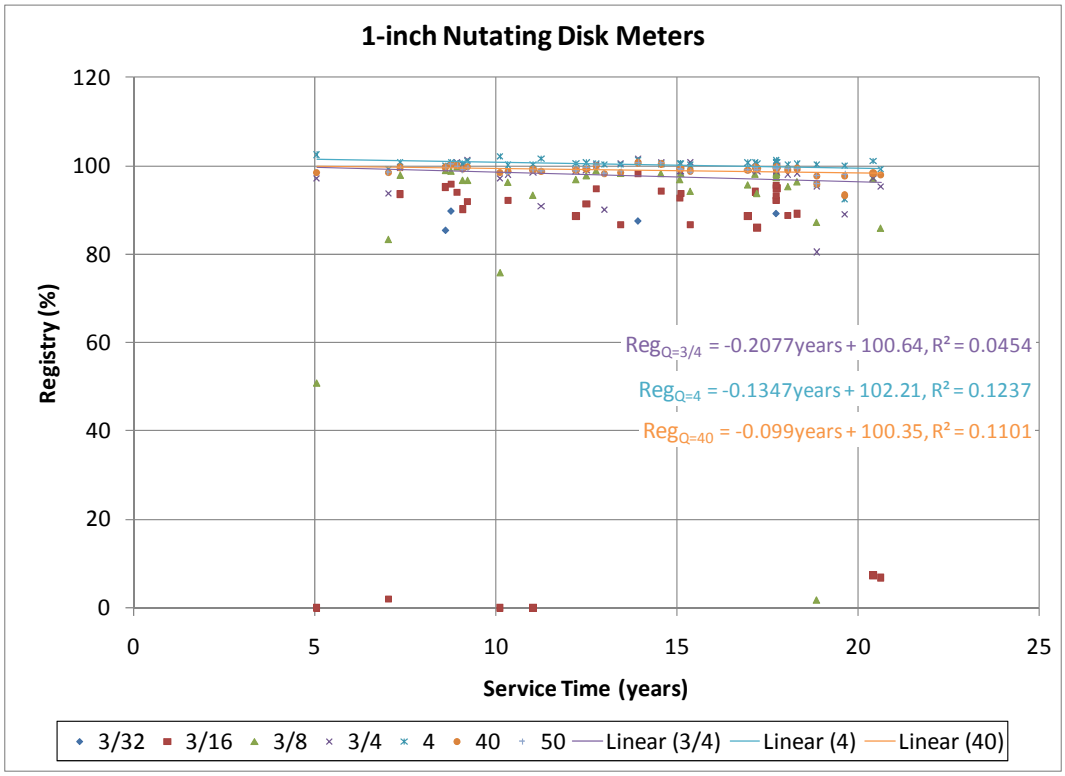

Figure 3.175 Service time versus registry 1-inch nutating disc meters

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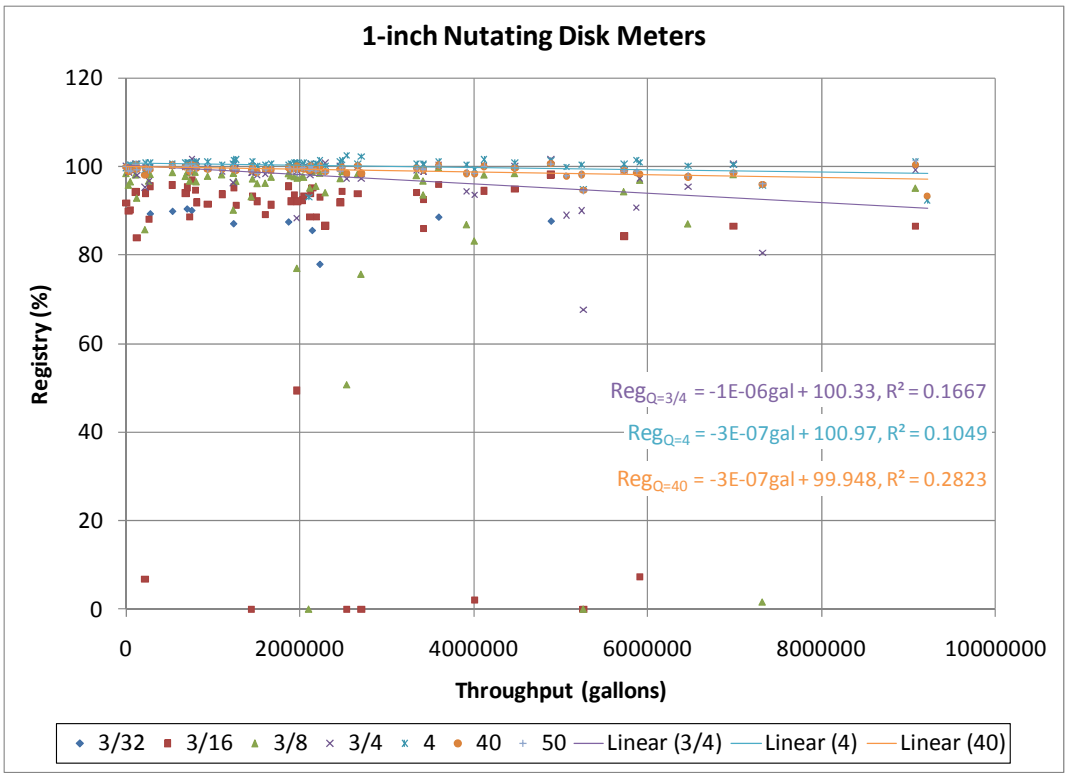

Figure 3.176 Throughput versus registry 1-inch nutating disc meters

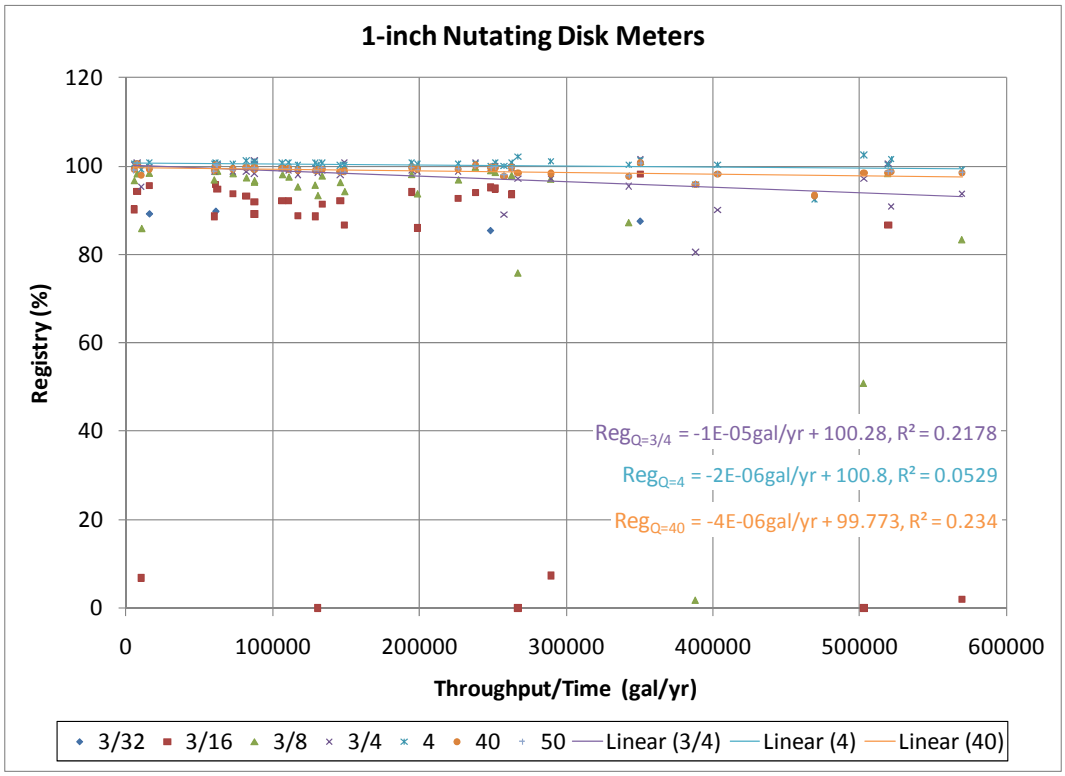

Figure 3.177 Throughput/time versus registry 1-inch nutating disc meters

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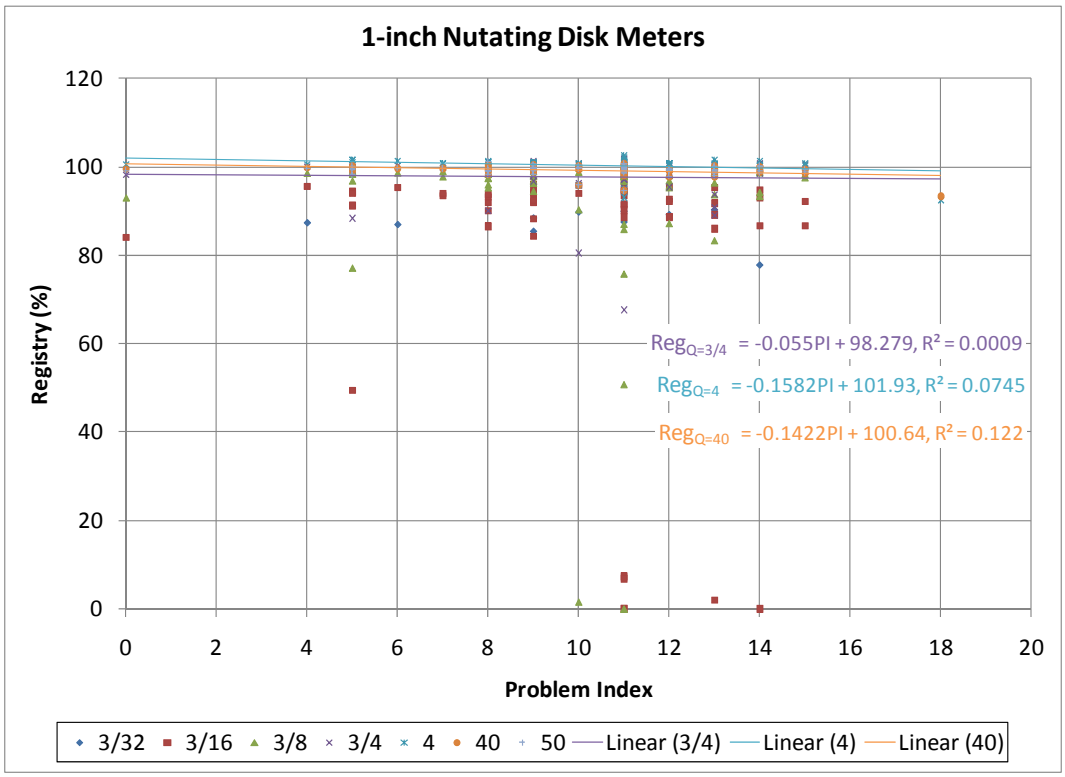

Figure 3.178 Problem index versus registry 1-inch nutating disc meters

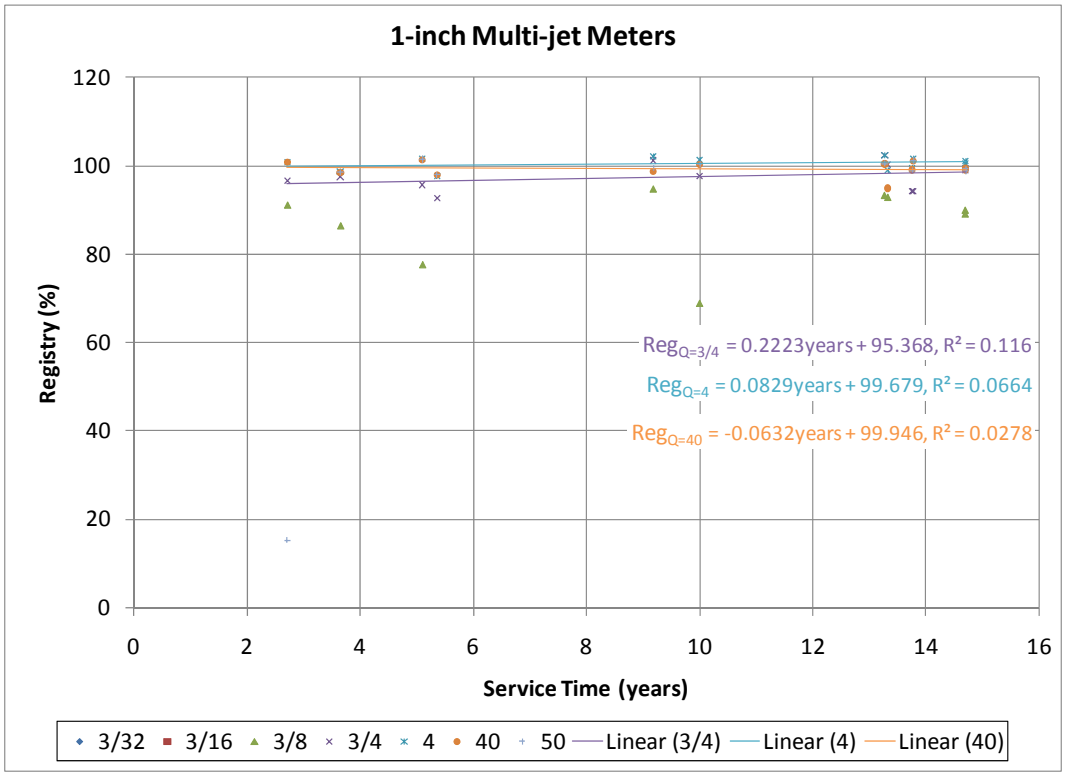

Figure 3.179 Service time versus registry 1-inch multi-jet meters

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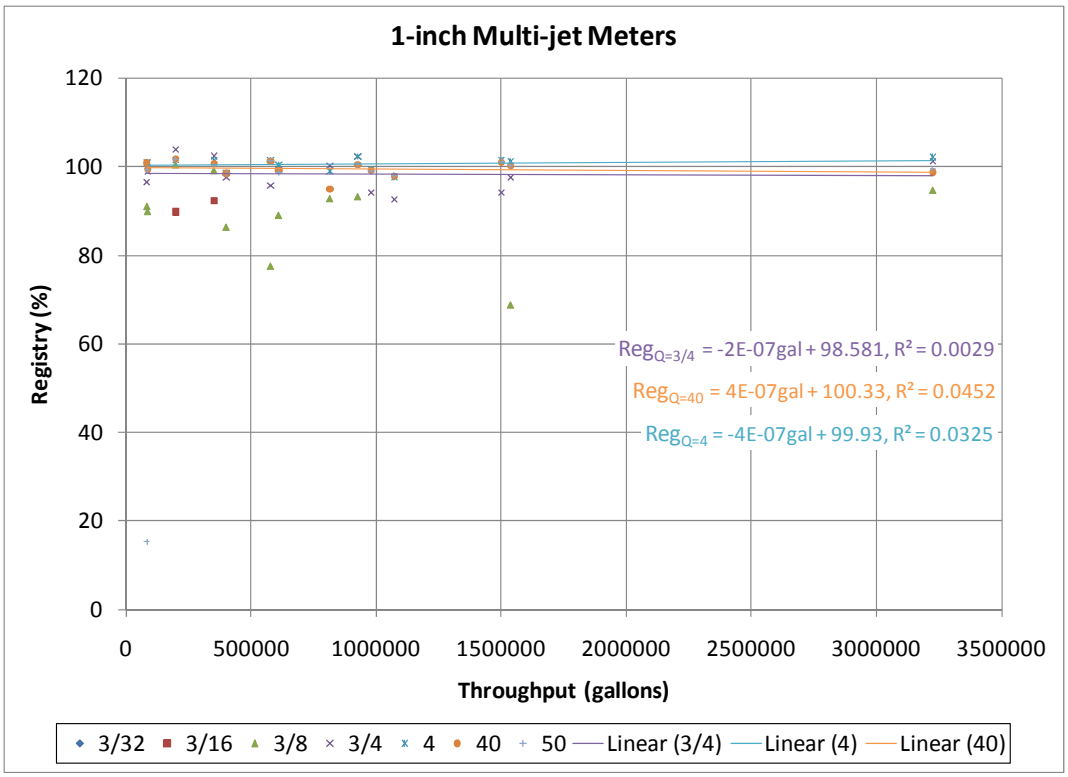

Figure 3.180 Throughput versus registry 1-inch multi-jet meters

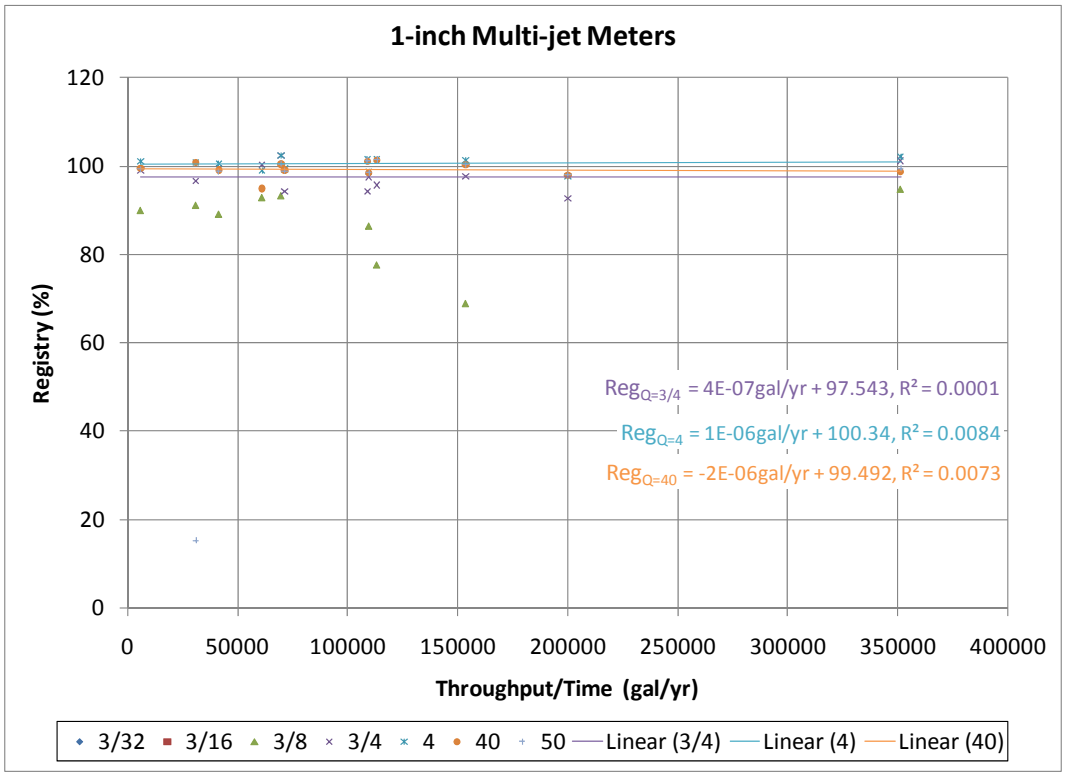

Figure 3.181 Throughput/time versus registry 1-inch multi-jet meters

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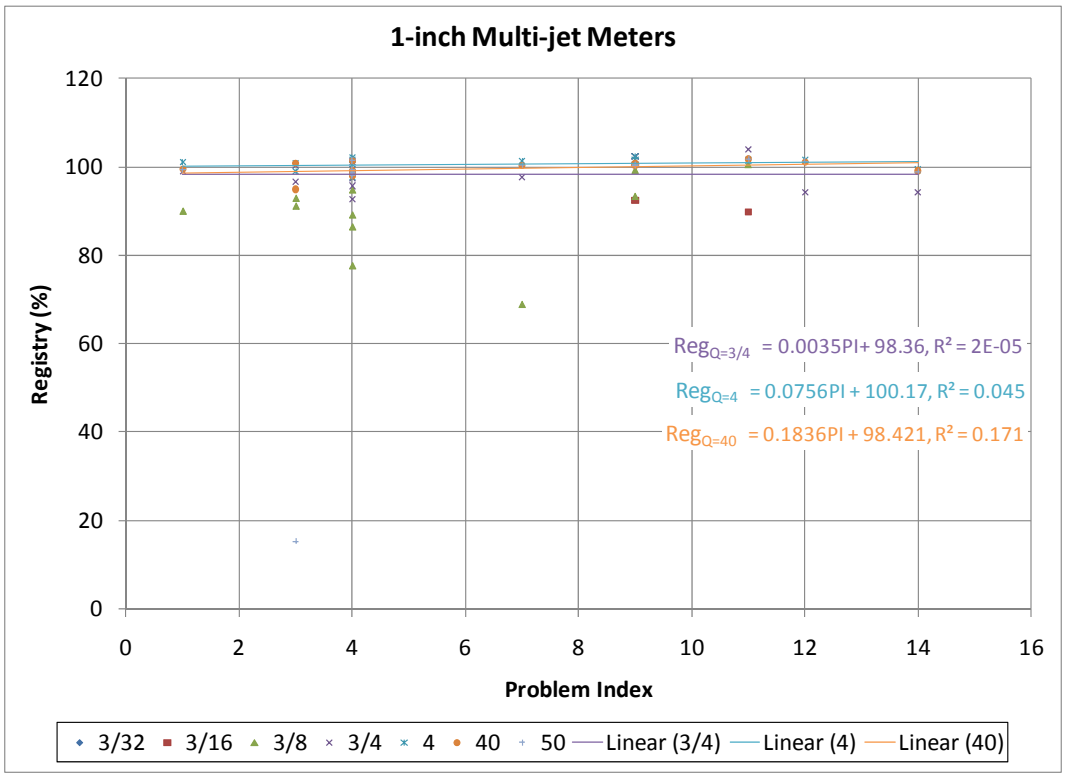

Figure 3.182 Problem index versus registry 1-inch multi-jet meters

1 1/2-inch Meters

Figures 3.183 through 3.194 show the results for the pulled 1 1/2-inch meters tested. The results are presented as registry versus service live, versus throughput, versus throughput divided by service time, and versus the problem index.

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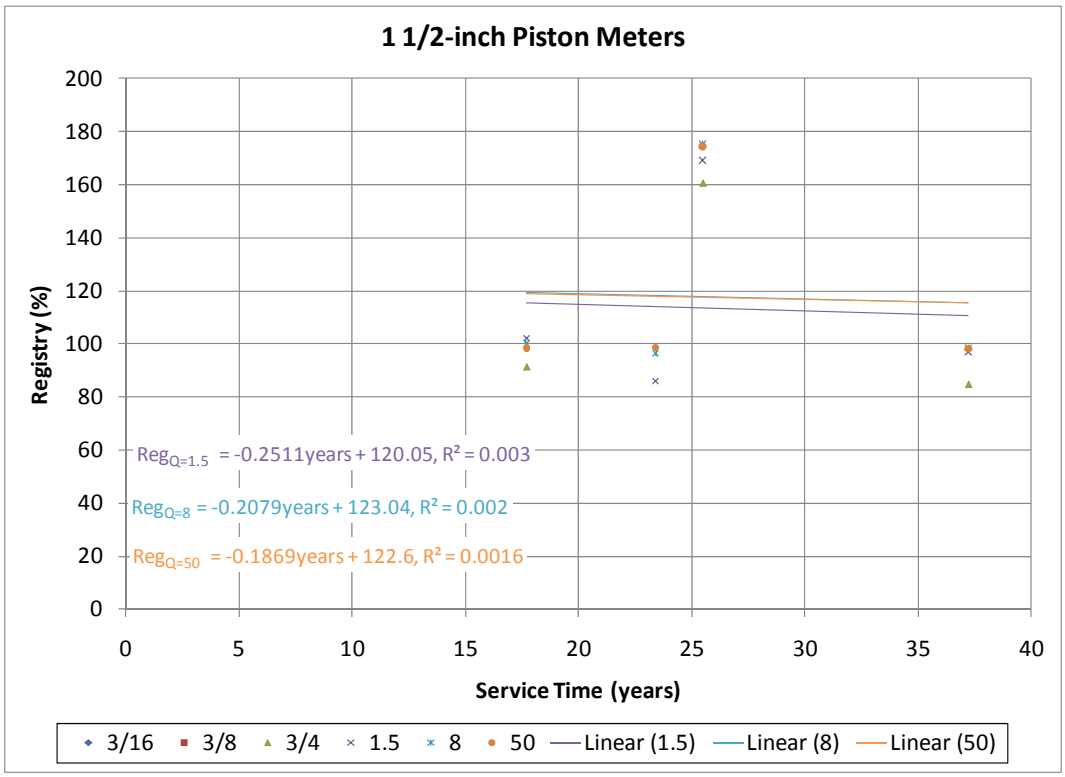

Figure 3.183 Service time versus registry 1 1/2-inch piston meters

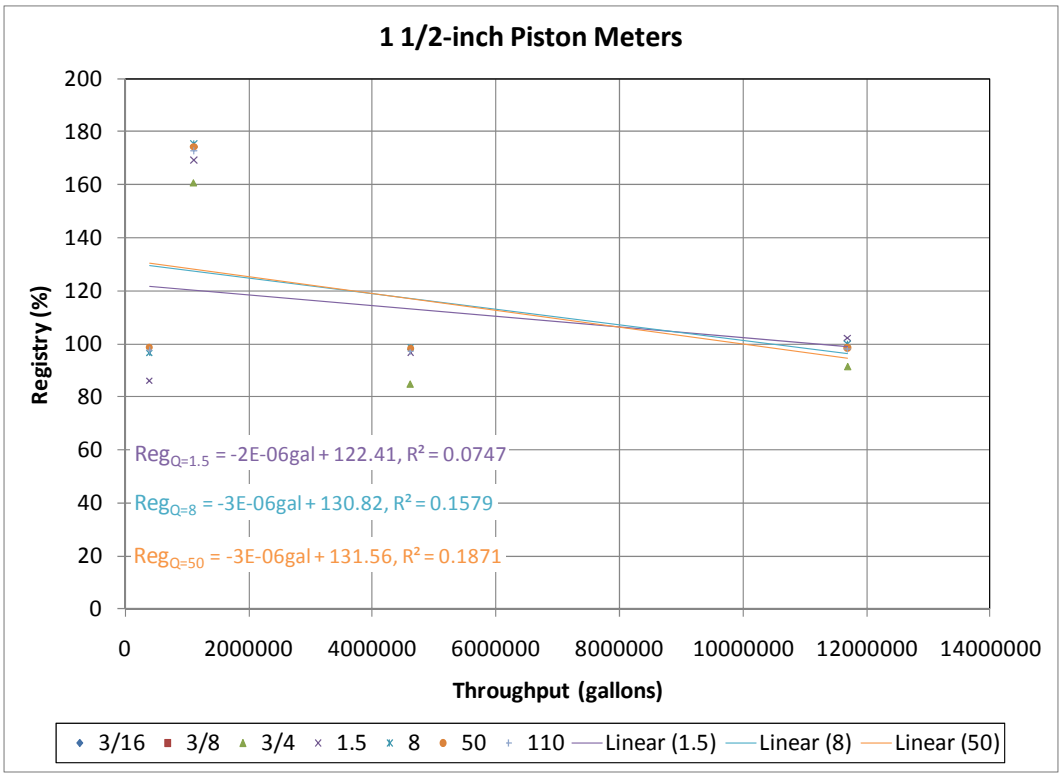

Figure 3.184 Throughput versus registry 1 1/2-inch piston meters

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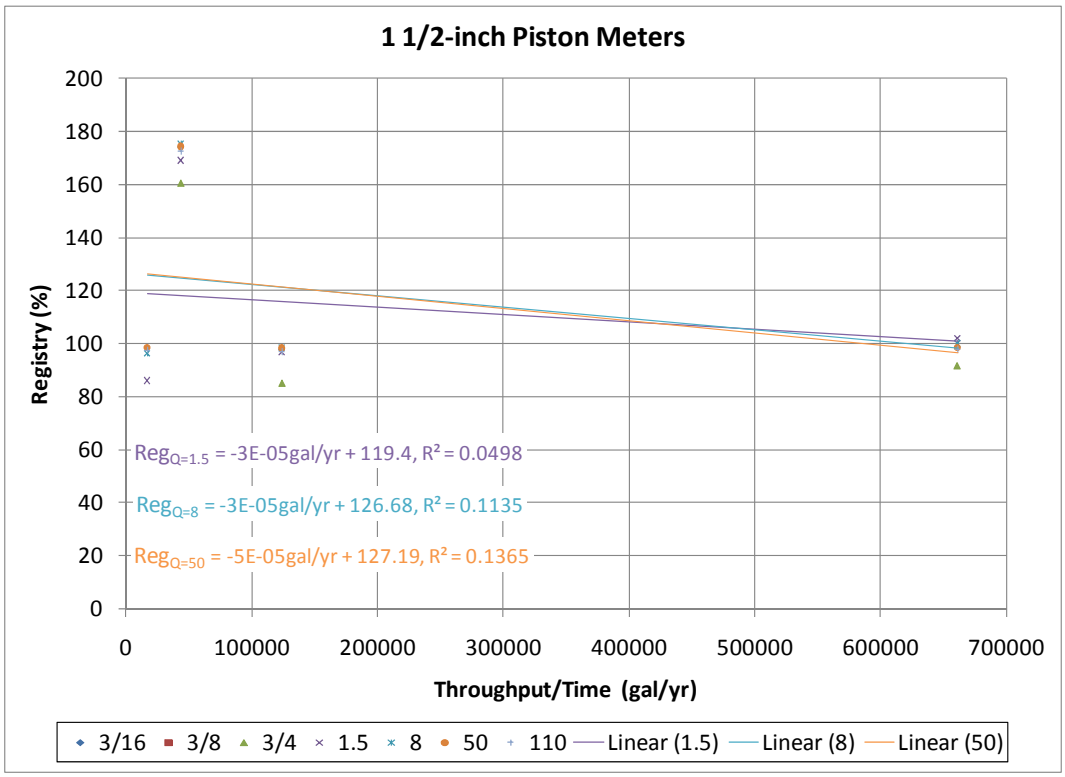

Figure 3.185 Throughput/time versus registry 1 1/2-inch piston meters

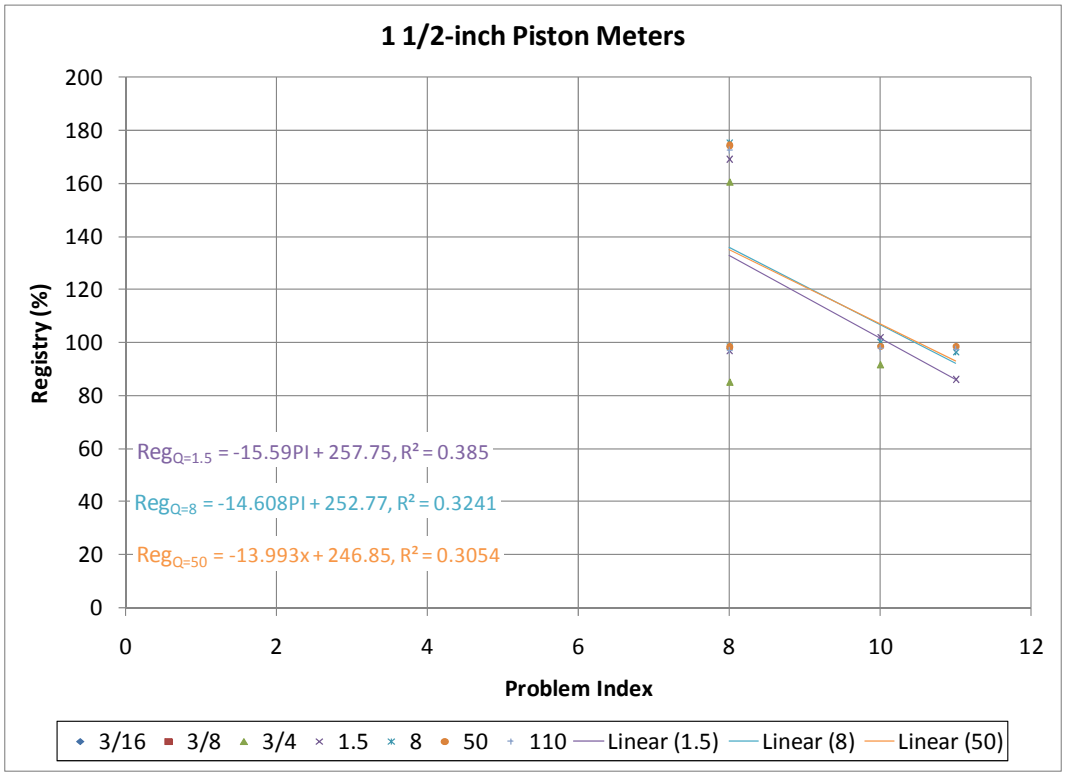

Figure 3.186 Problem index versus registry 1 1/2-inch piston meters

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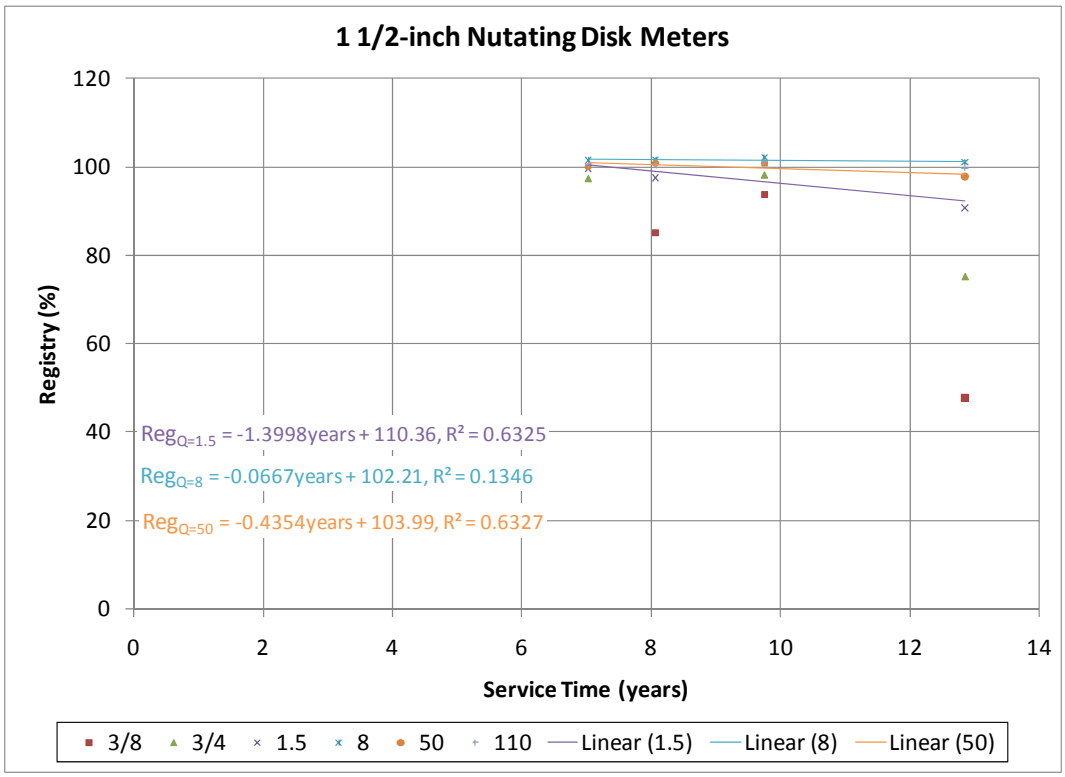

Figure 3.187 Service time versus registry 1 1/2-inch nutating disc meters

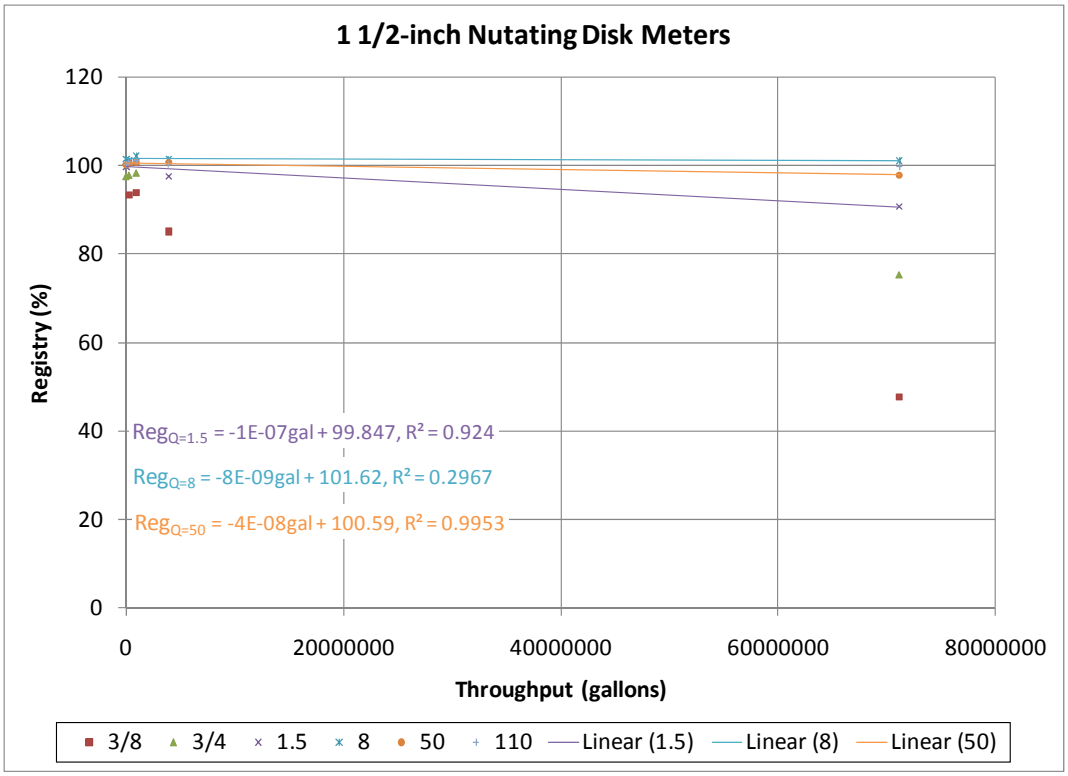

Figure 3.188 Throughput versus registry 1 1/2-inch nutating disc meters

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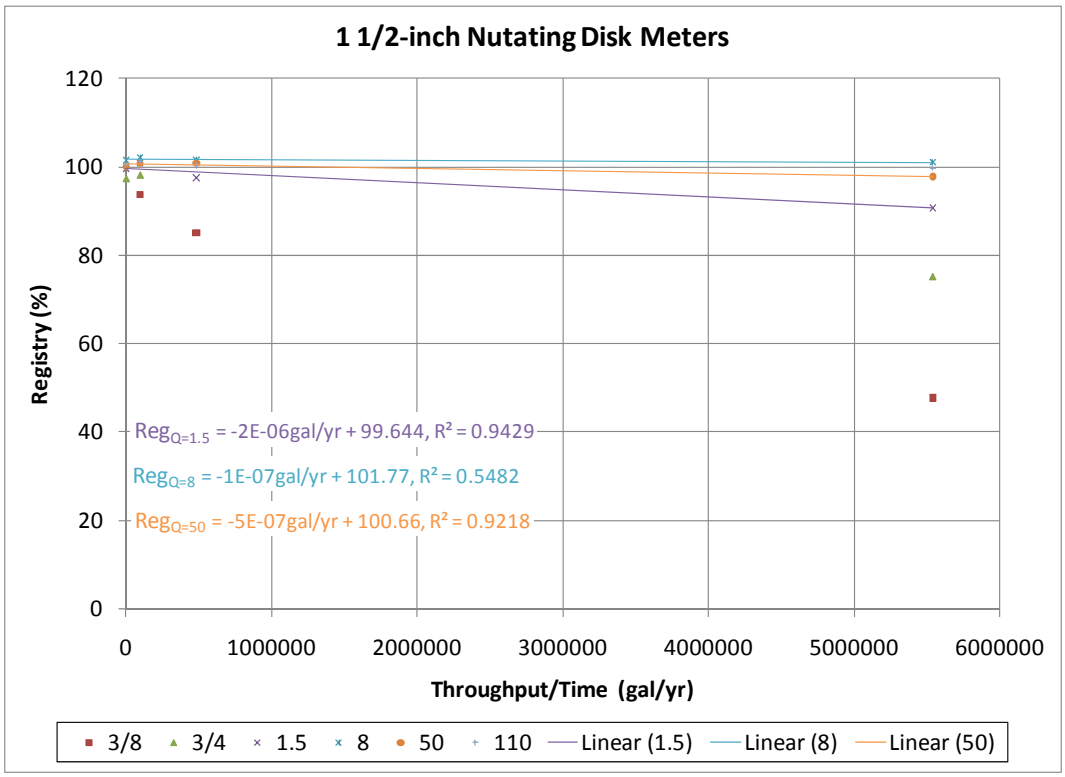

Figure 3.189 Throughput/time versus registry 1 1/2-inch nutating disc meters

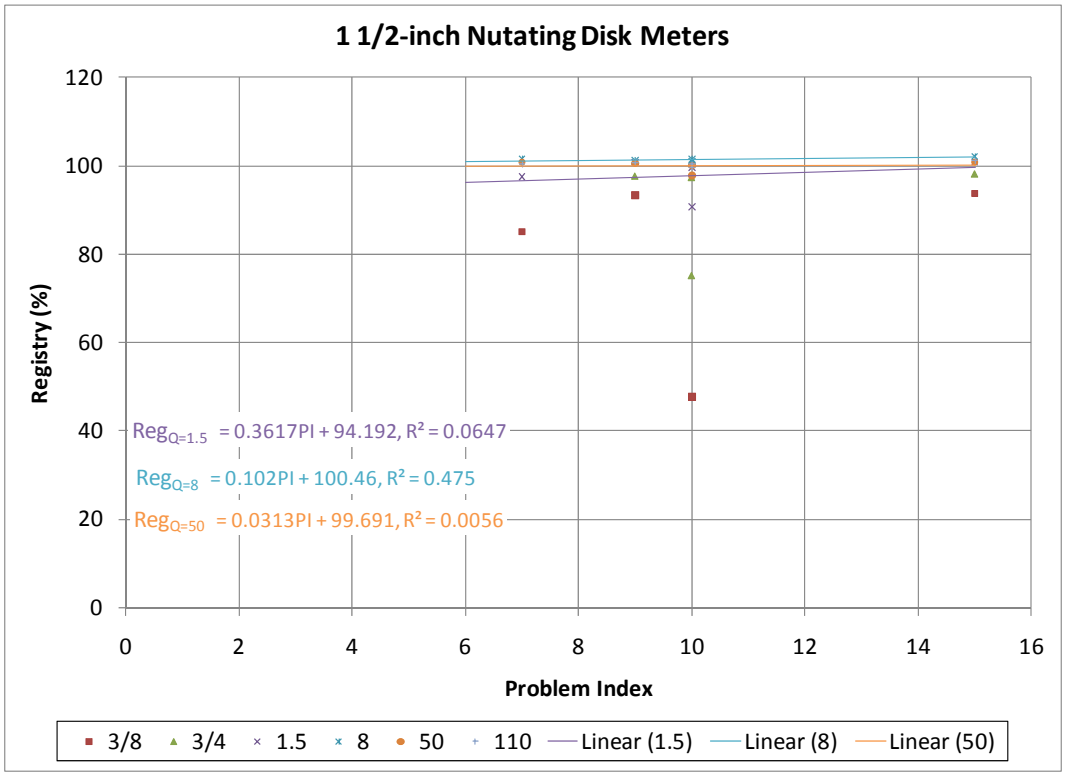

Figure 3.190 Problem index versus registry 1 1/2-inch nutating disc meters

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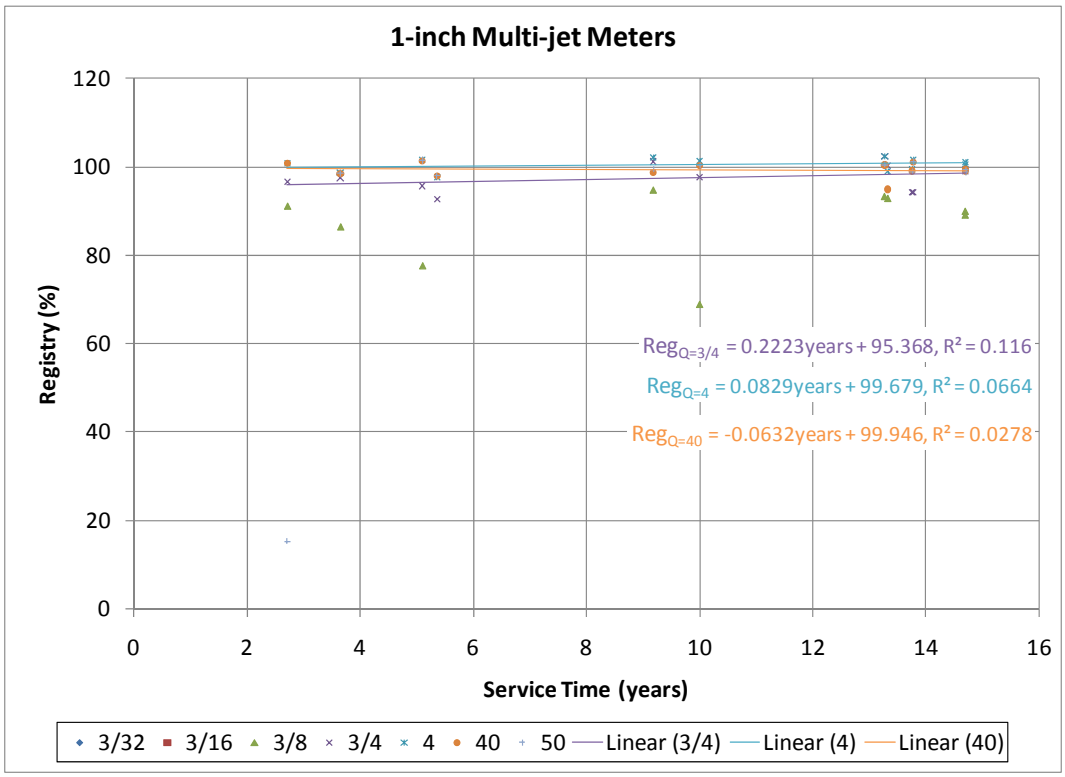

Figure 3.191 Service time versus registry 1 1/2-inch multi-jet meters

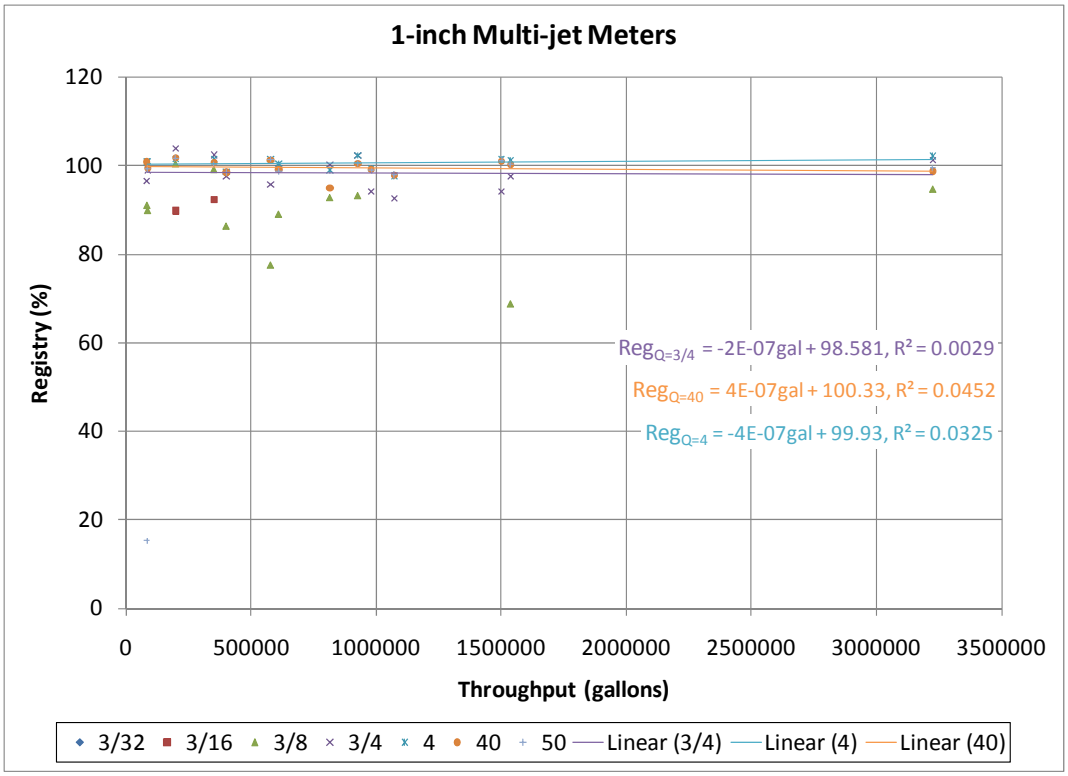

Figure 3.192 Throughput versus registry 1 1/2-inch multi-jet meters

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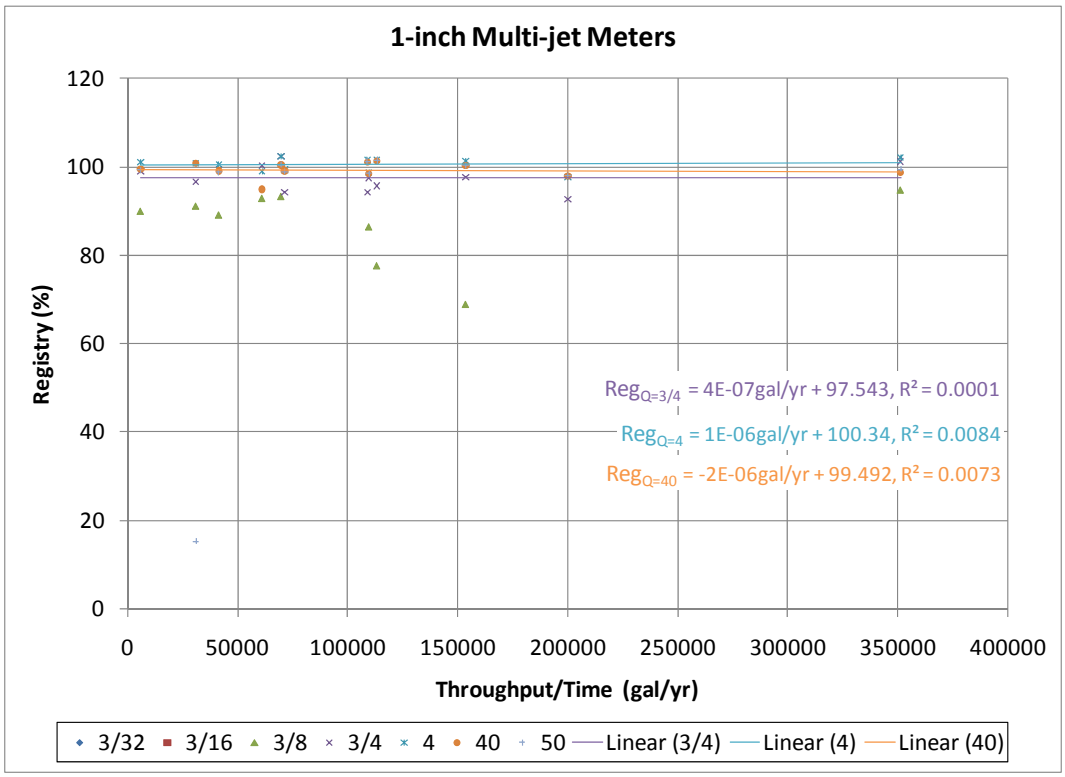

Figure 3.193 Throughput/time versus registry 1 1/2-inch multi-jet meters

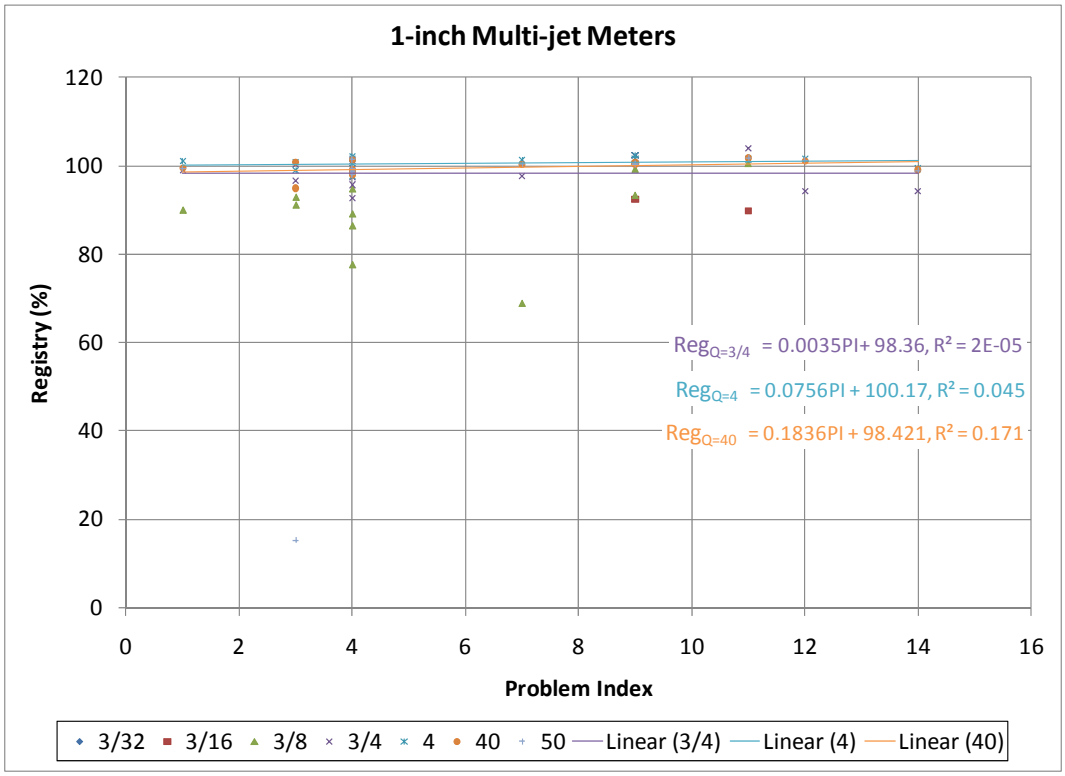

Figure 3.194 Problem index versus registry 1 1/2-inch multi-jet meters

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2-inch Meters

Figure 3.195 through Figure 3.198 show the results for the pulled 2-inch meters. The results are presented as registry versus service live, versus throughput, versus throughput divided by service time, and versus the problem index.

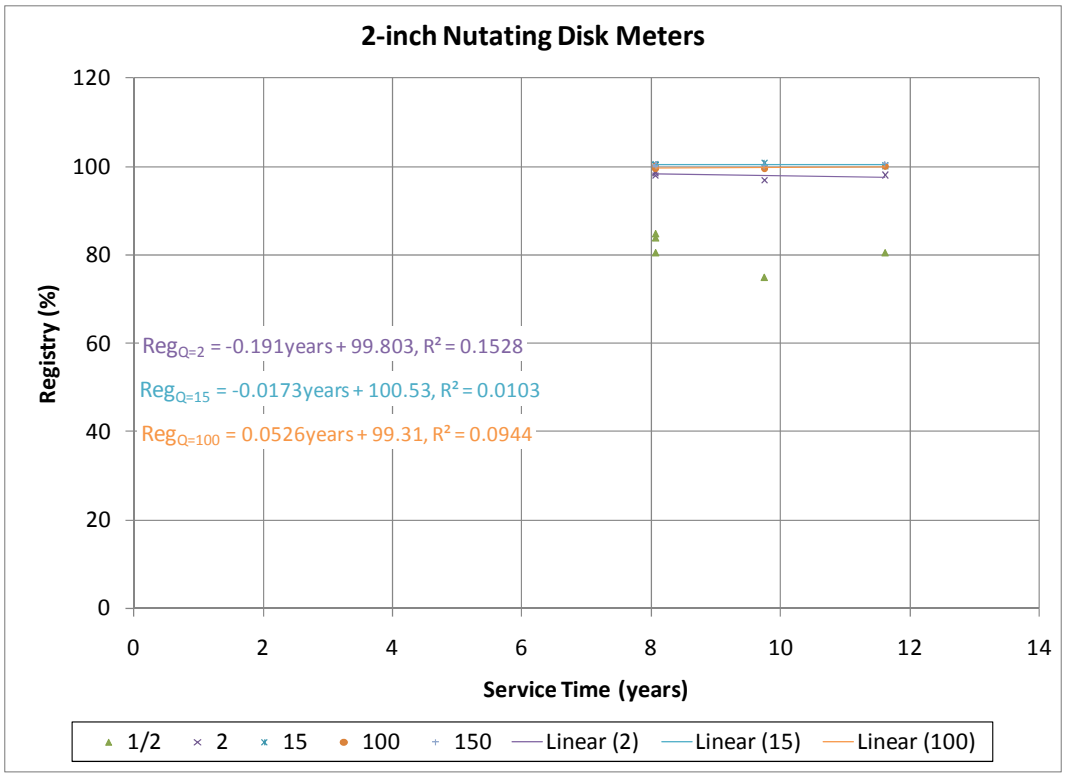

Figure 3.195 Service time versus registry 2-inch nutating disc meters

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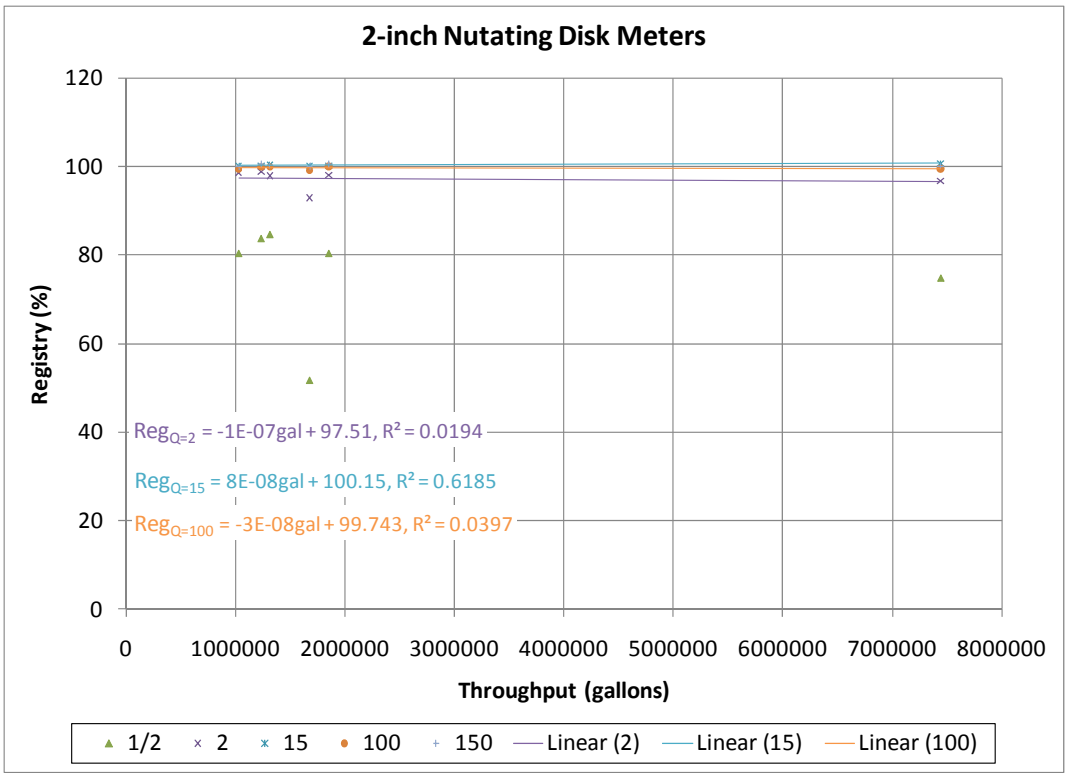

Figure 3.196 Throughput versus registry 2-inch nutating disc meters

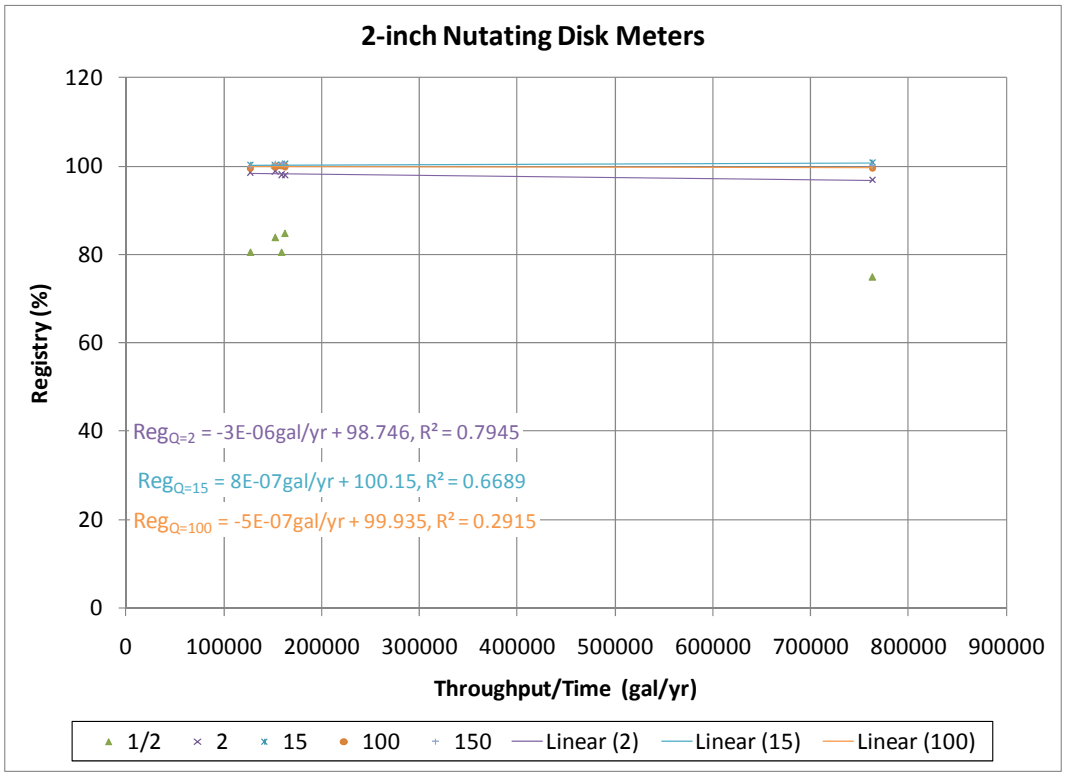

Figure 3.197 Throughput/time versus registry 2-inch nutating disc meters

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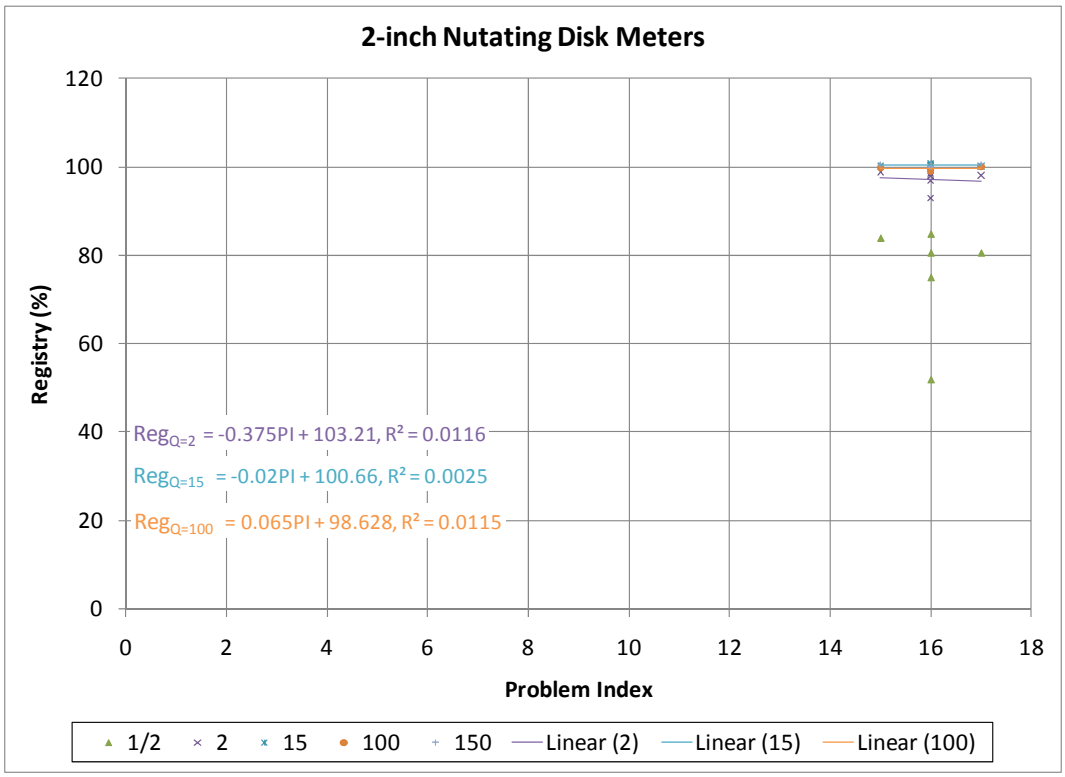

Figure 3.198 Problem index versus registry 2-inch nutating disc meters

PHASE III: PARTICULATE TESTING

As was done with the initial accuracy and endurance, the data for the particulate testing will be presented in a similar manner.

5/8x3/4-inch Meters

Figure 3.199 through Figure 3.233 show the results for the seventy-five 5/8x3/4-inch meters tested in the new condition, and after sand introduction, and their registry at various levels of throughput.

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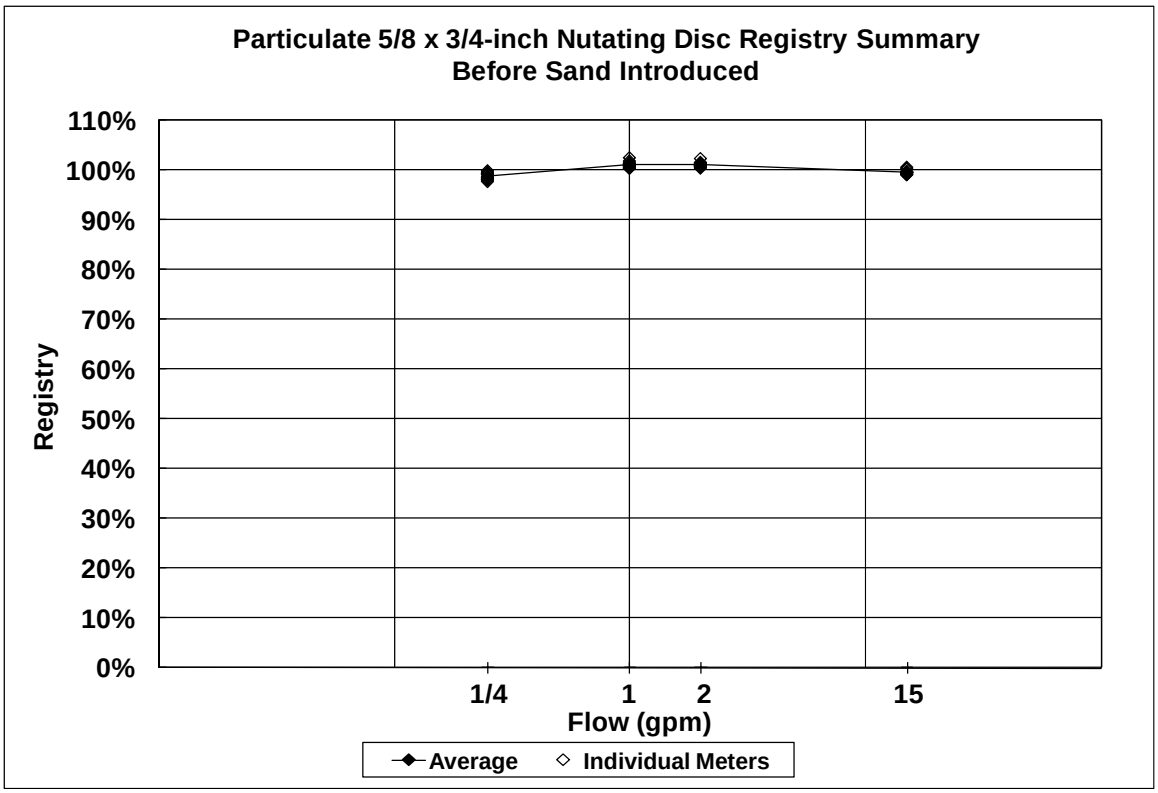

Figure 3.199 5/8x3/4–inch nutating disc 0 MG throughput before sand introduction

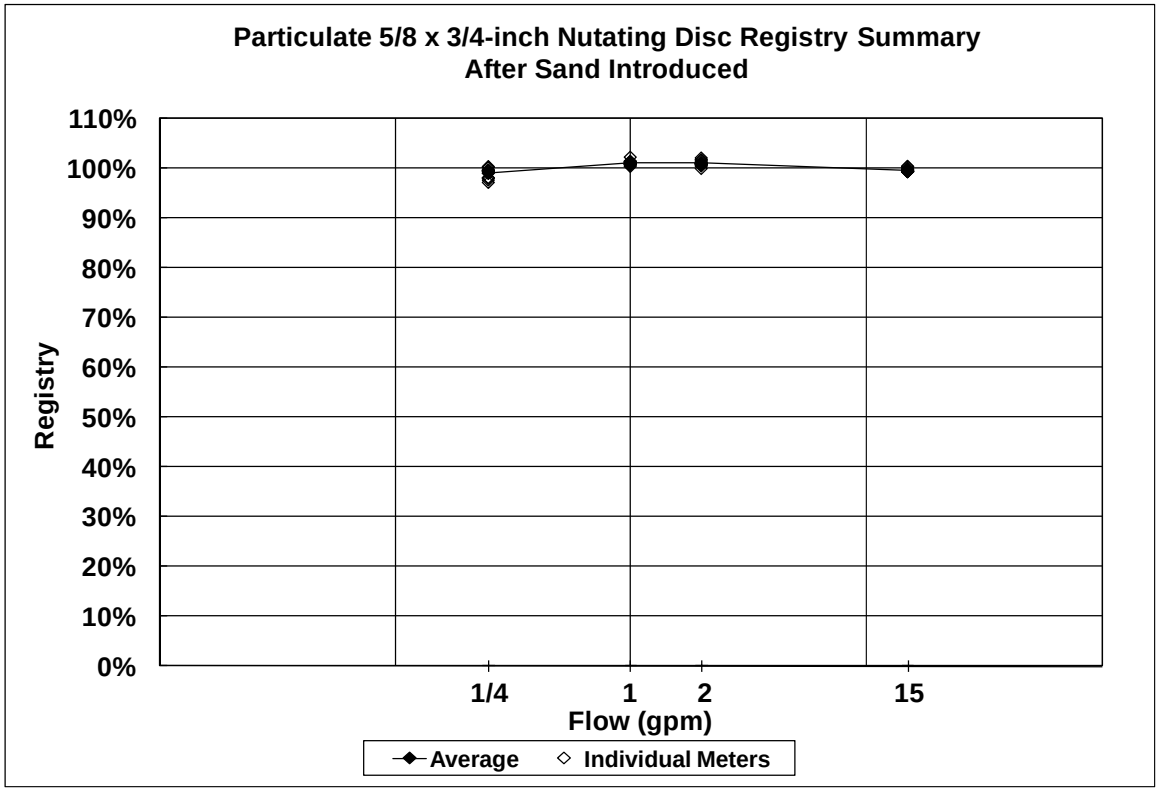

Figure 3.200 5/8x3/4–inch nutating disc 0 MG throughput after sand introduction

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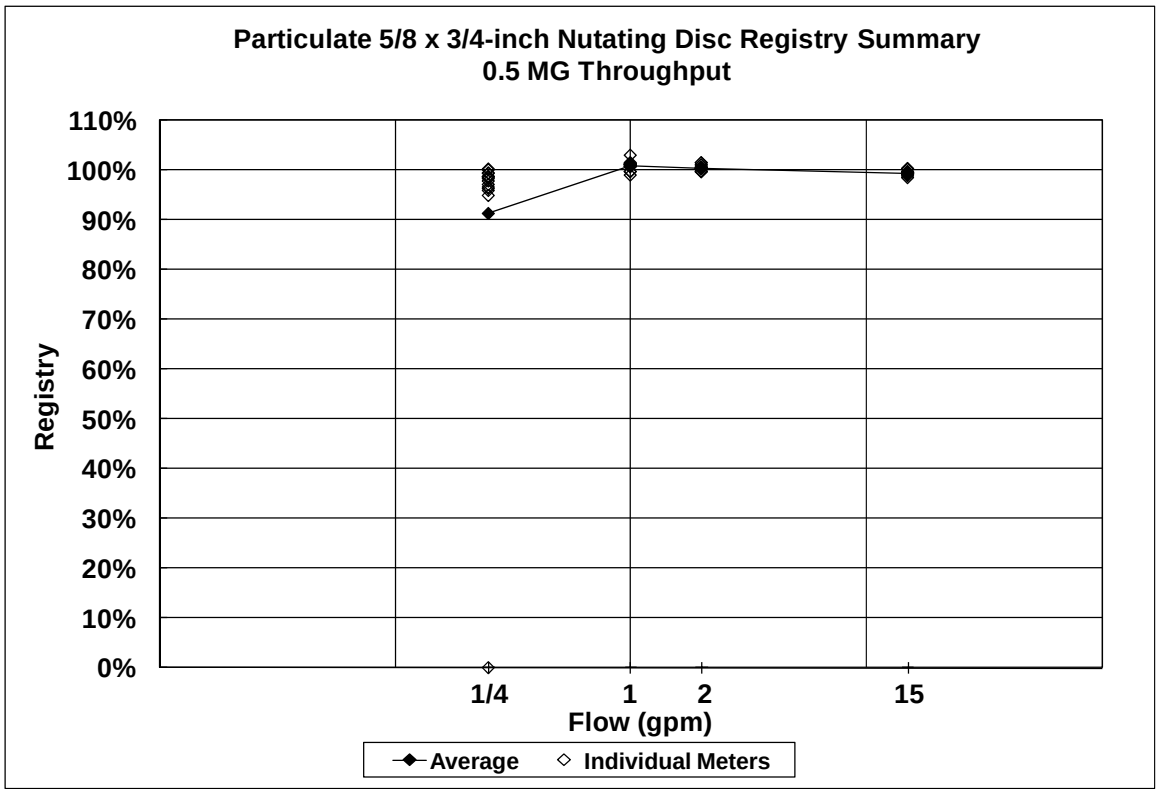

Figure 3.201 5/8x3/4–inch nutating disc 0.5 MG throughput (particulate)

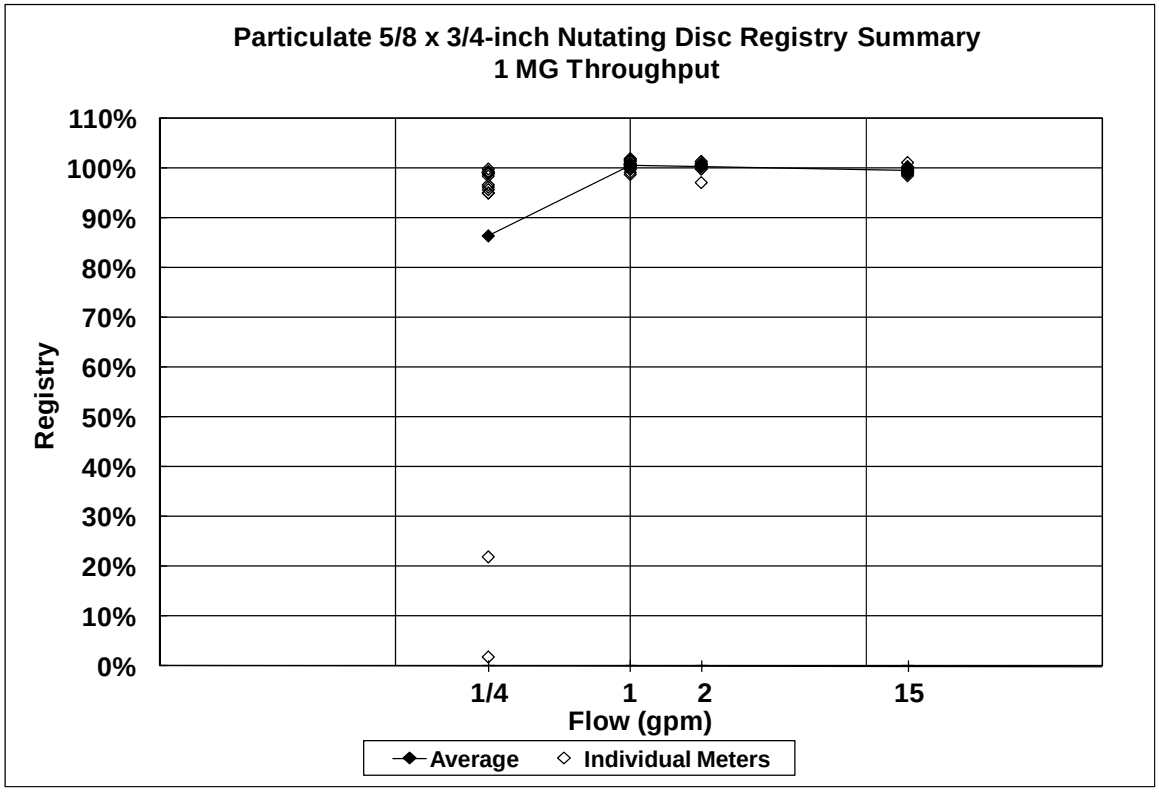

Figure 3.202 5/8x3/4–inch nutating disc 1 MG throughput (particulate)

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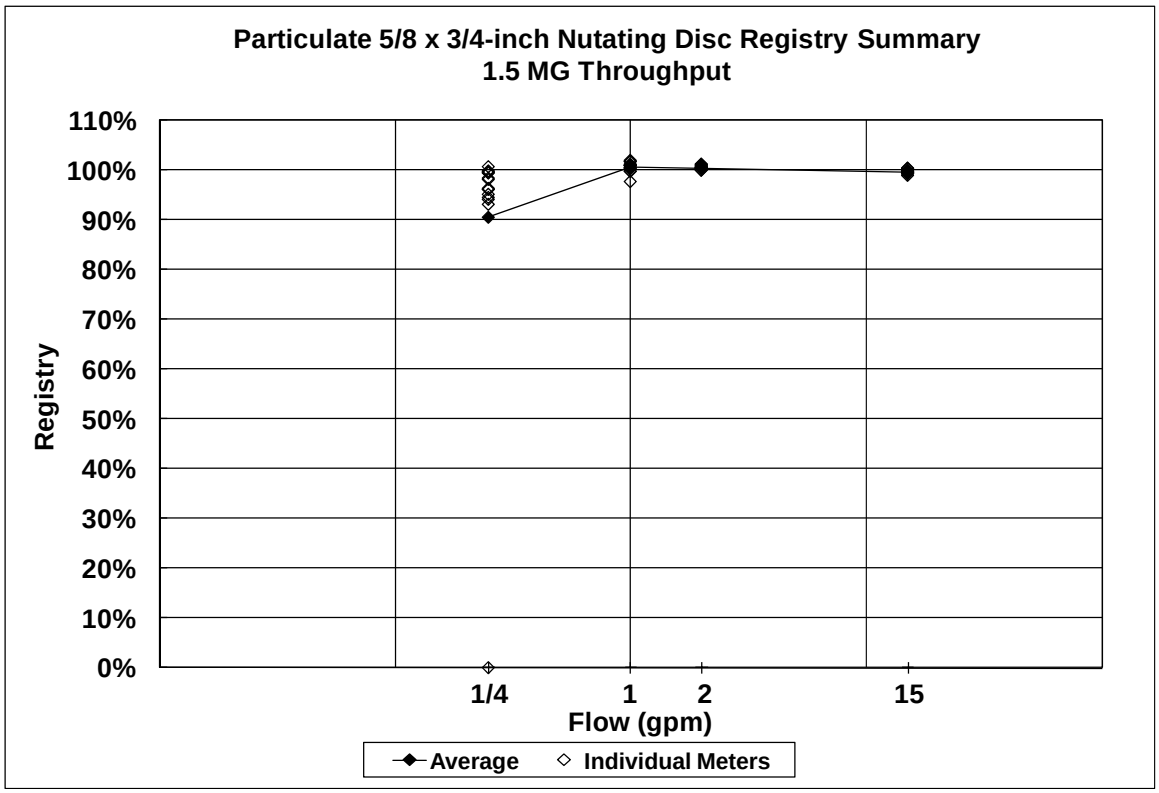

Figure 3.203 5/8x3/4–inch nutating disc 1.5 MG throughput (particulate)

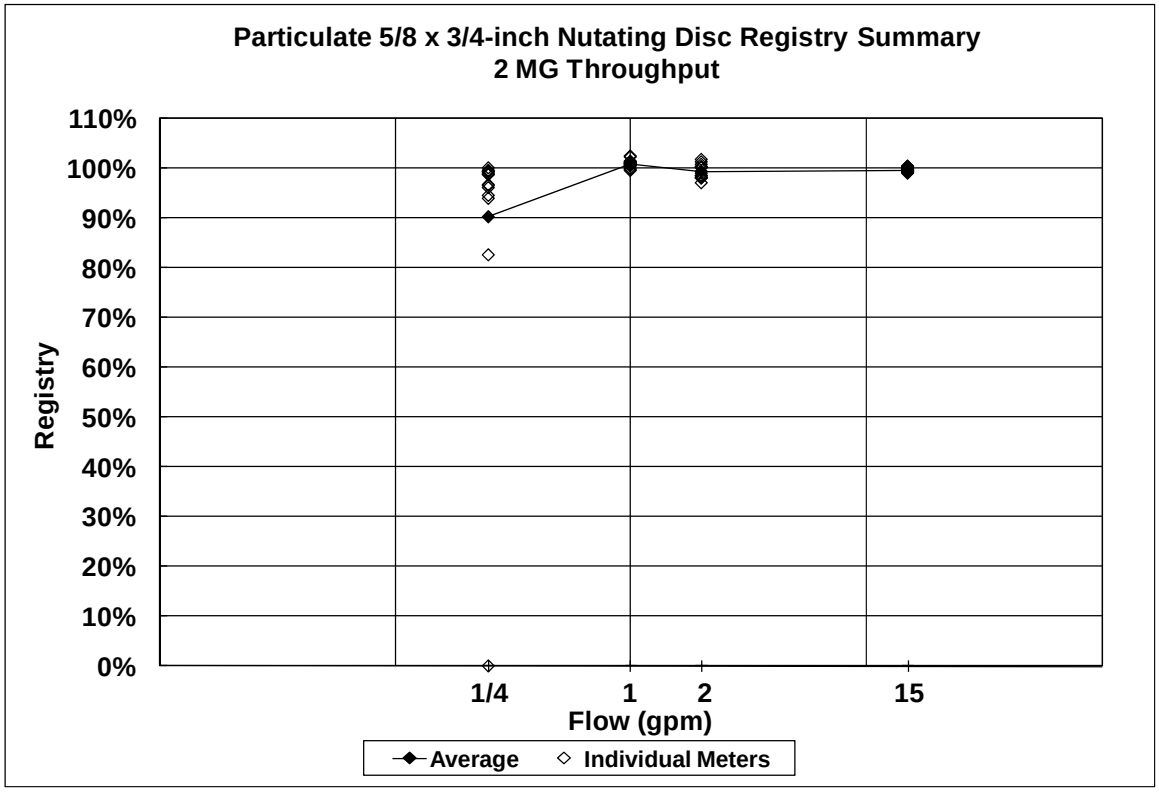

Figure 3.204 5/8x3/4–inch nutating disc 2 MG throughput (particulate)

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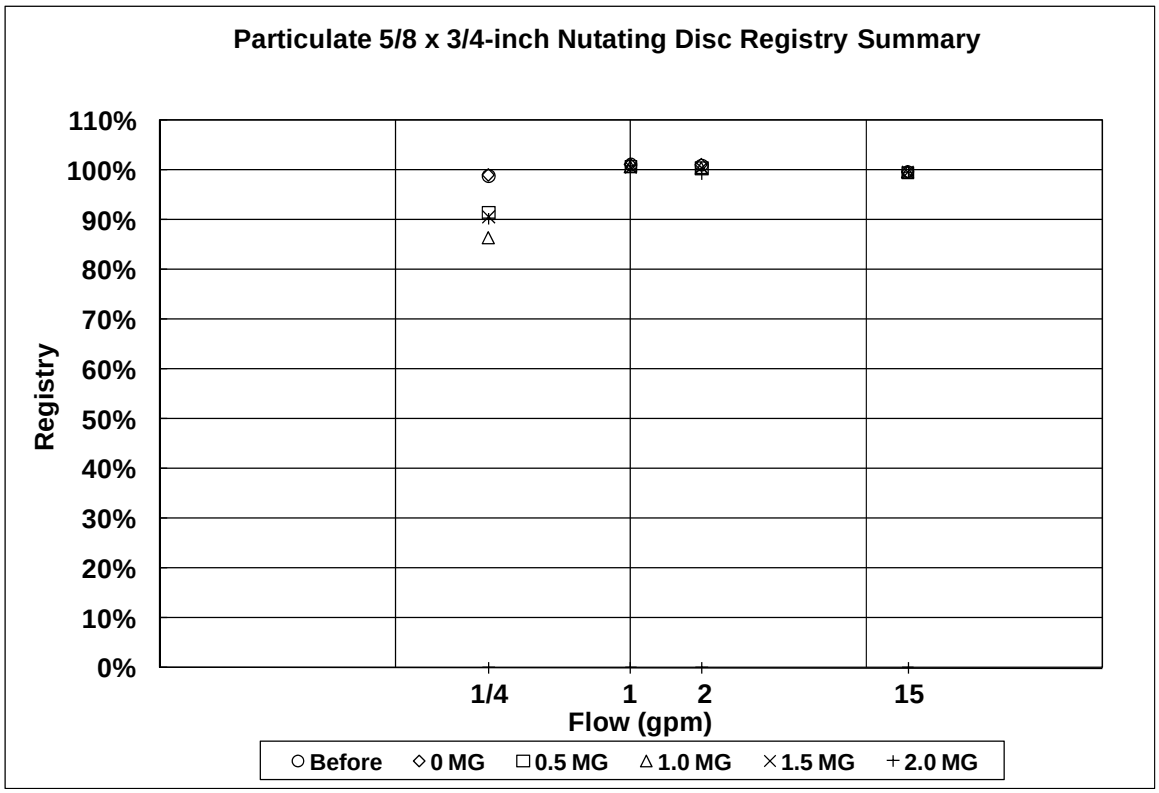

Figure 3.205 5/8x3/4-inch nutating disc registry summary (particulate)

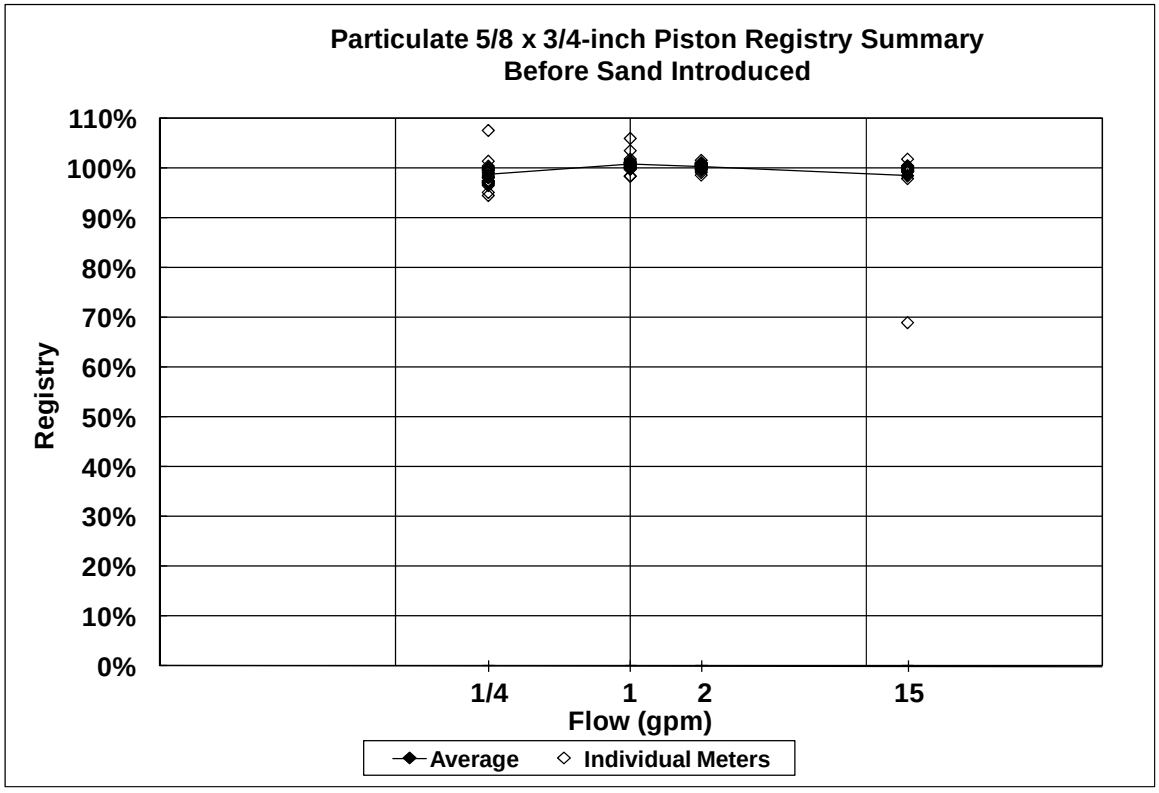

Figure 3.206 5/8x3/4–inch piston 0 MG throughput before sand introduction

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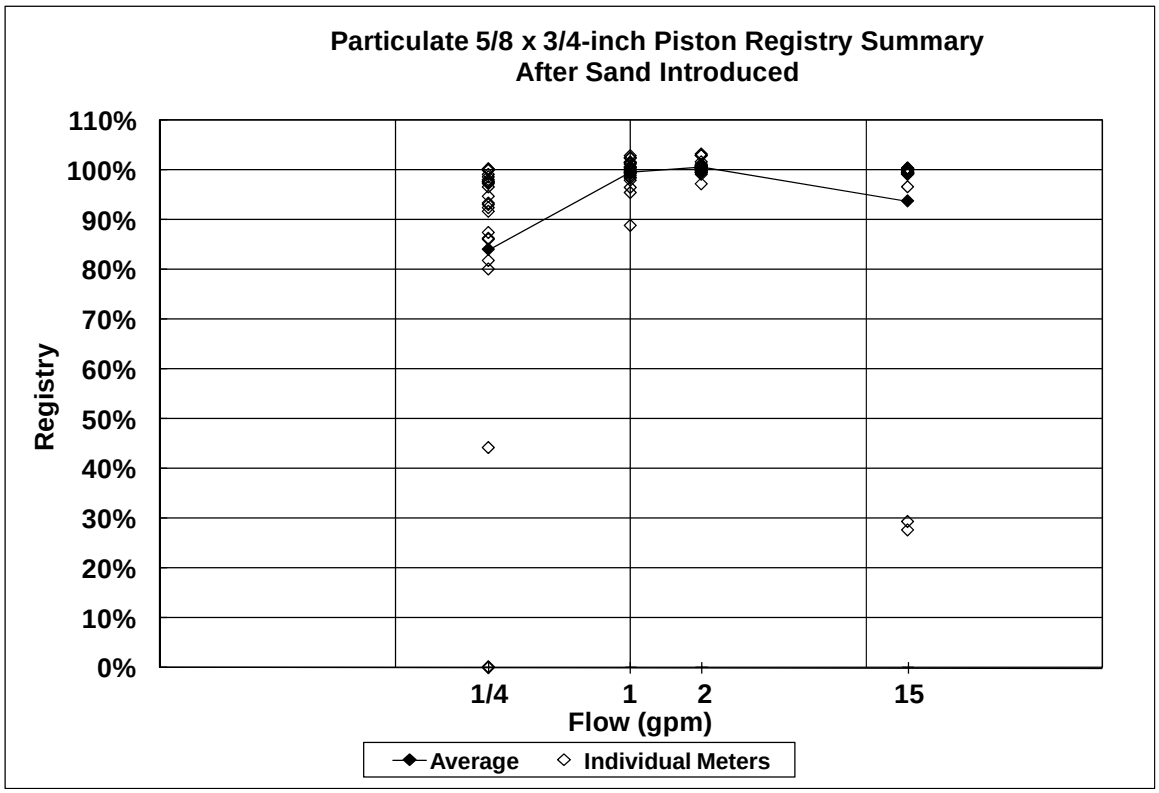

Figure 3.207 5/8x3/4–inch piston 0 MG throughput after sand introduction

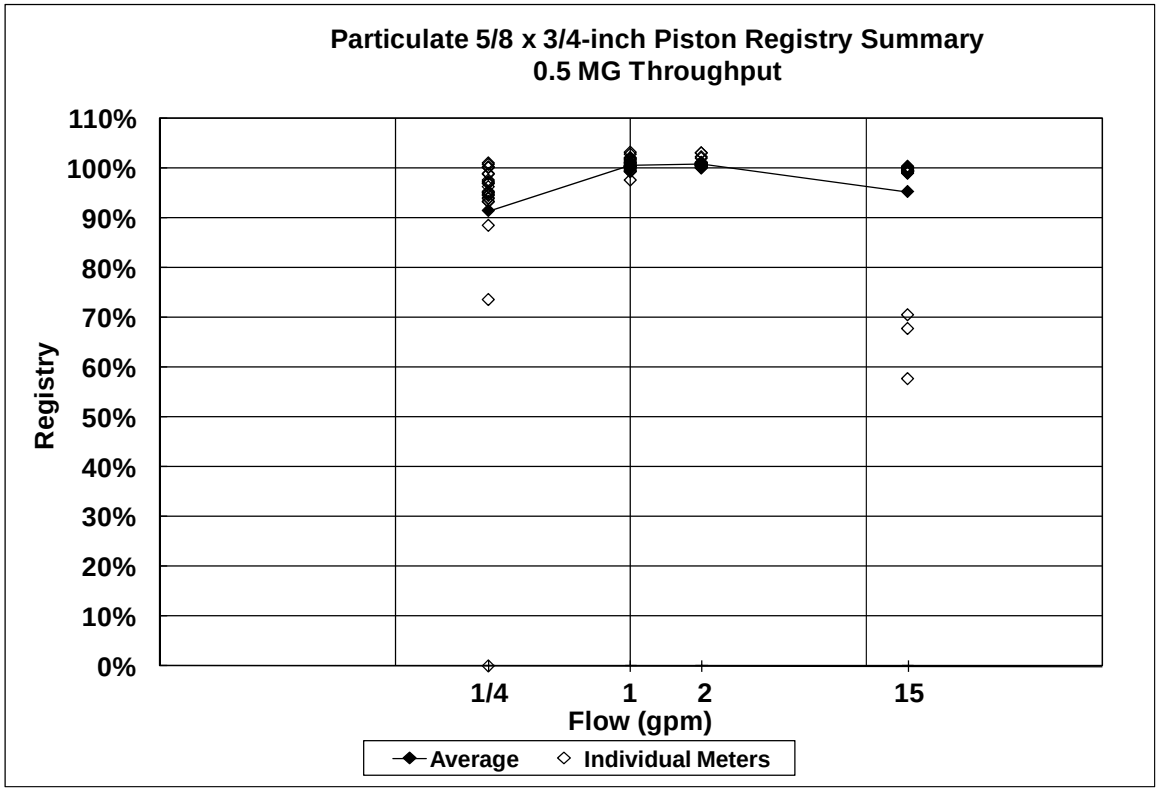

Figure 3.208 5/8x3/4–inch piston 0.5 MG throughput (particulate)

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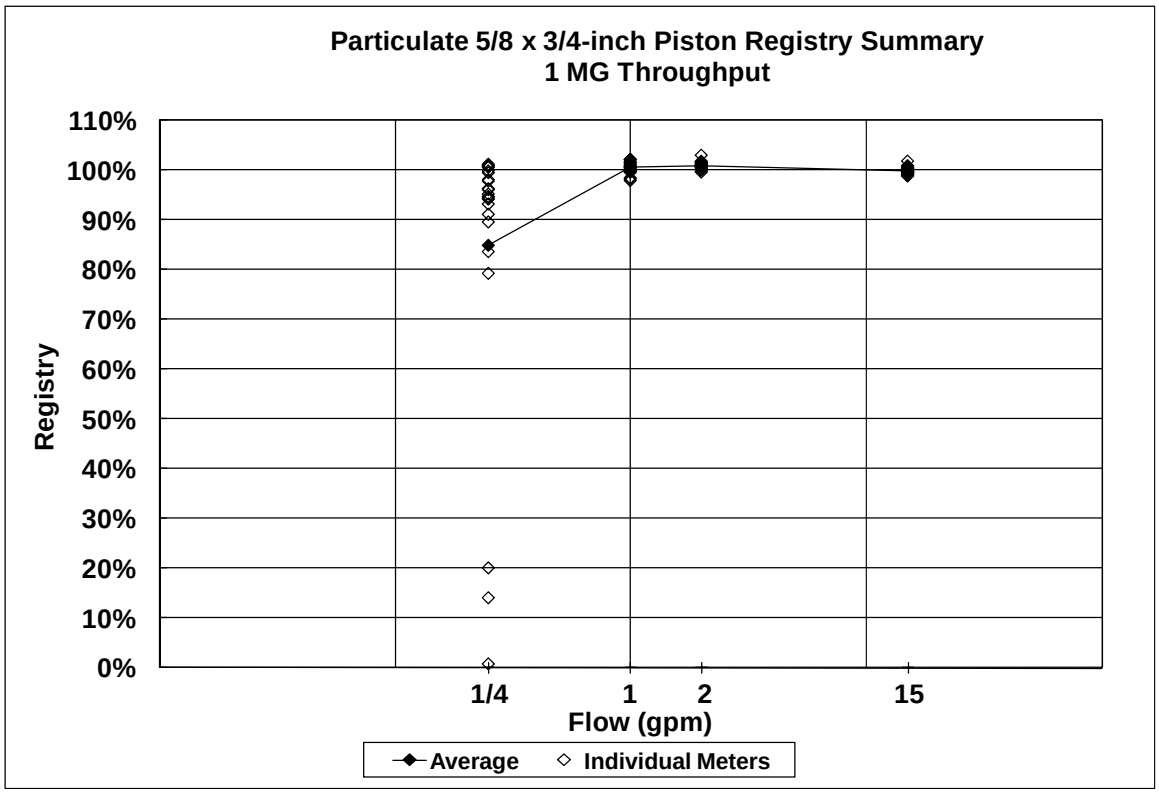

Figure 3.209 5/8x3/4–inch piston 1 MG throughput (particulate)

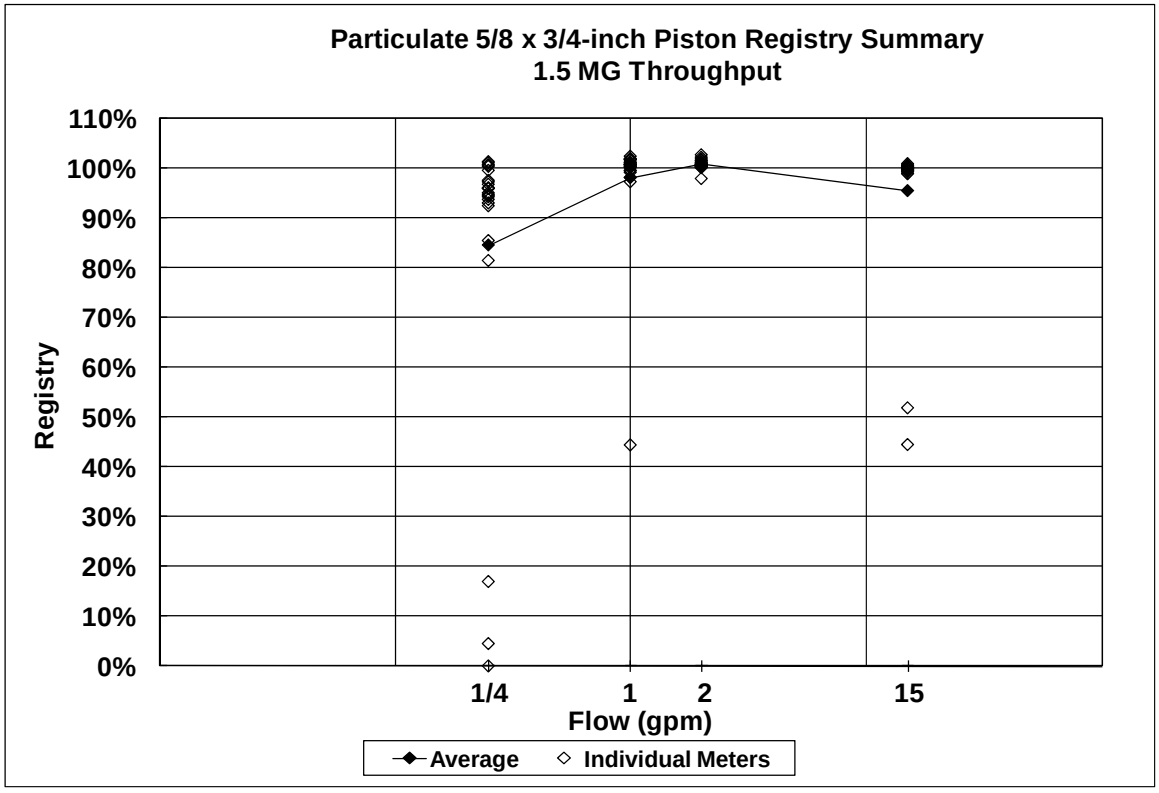

Figure 3.210 5/8x3/4–inch piston 1.5 MG throughput (particulate)

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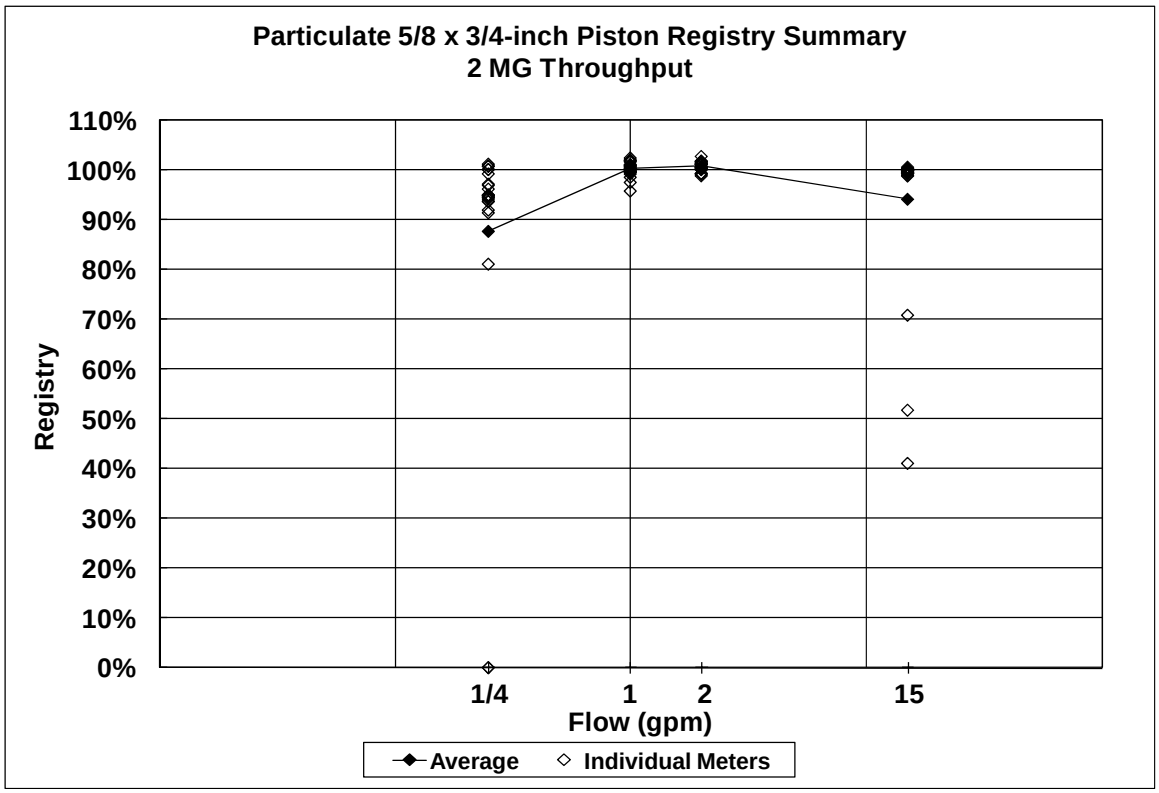

Figure 3.211 5/8x3/4–inch piston 2 MG throughput (particulate)

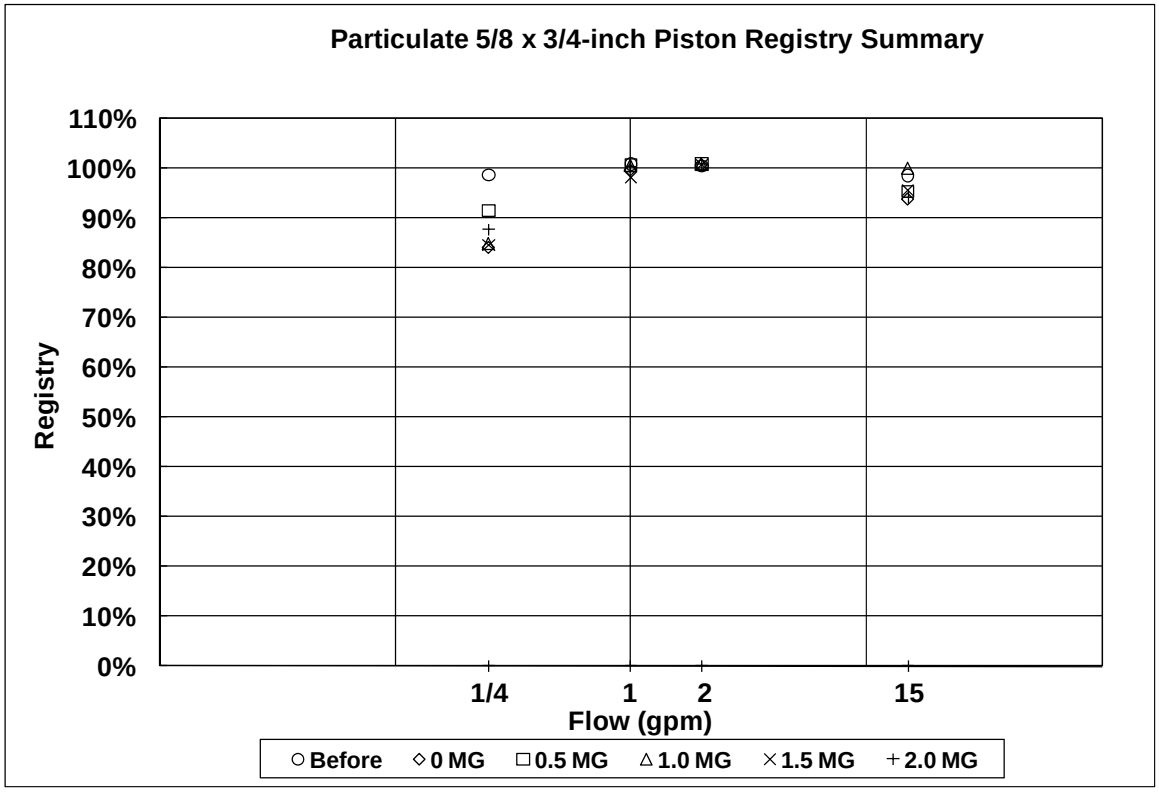

Figure 3.212 5/8x3/4-inch piston registry summary (particulate)

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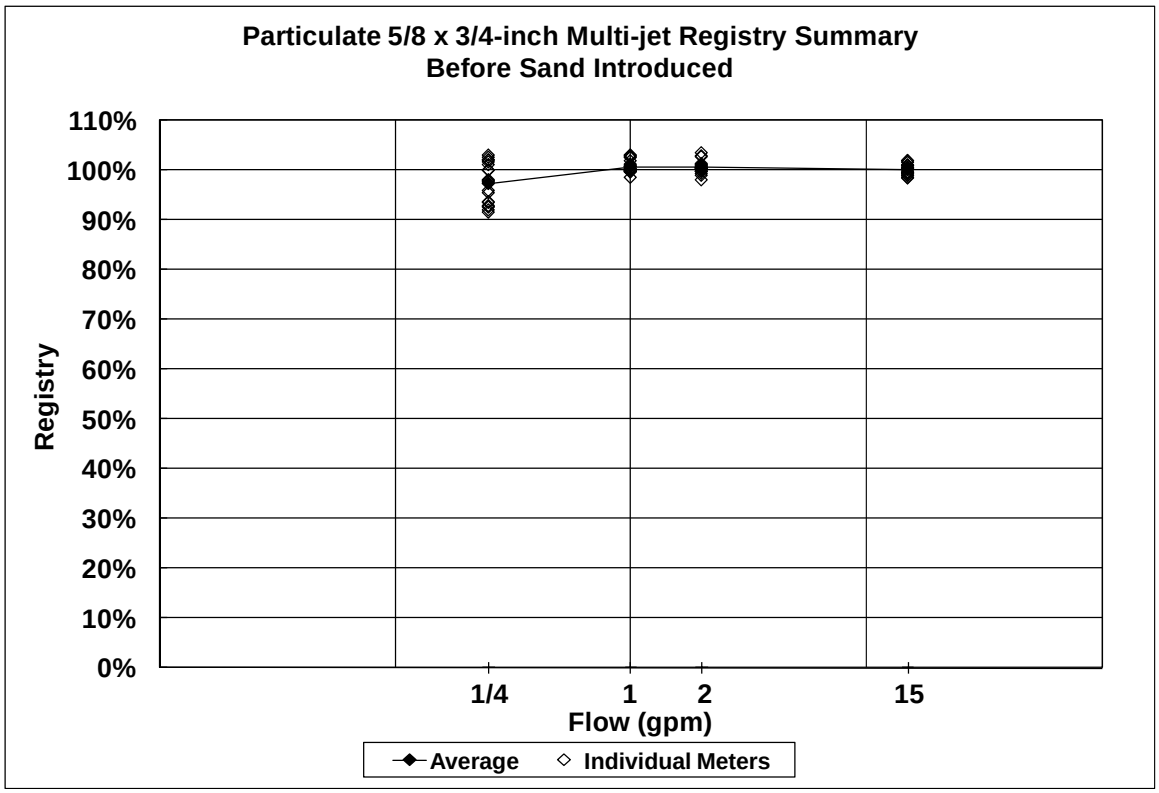

Figure 3.213 5/8x3/4–inch multi-jet 0 MG throughput before sand introduction

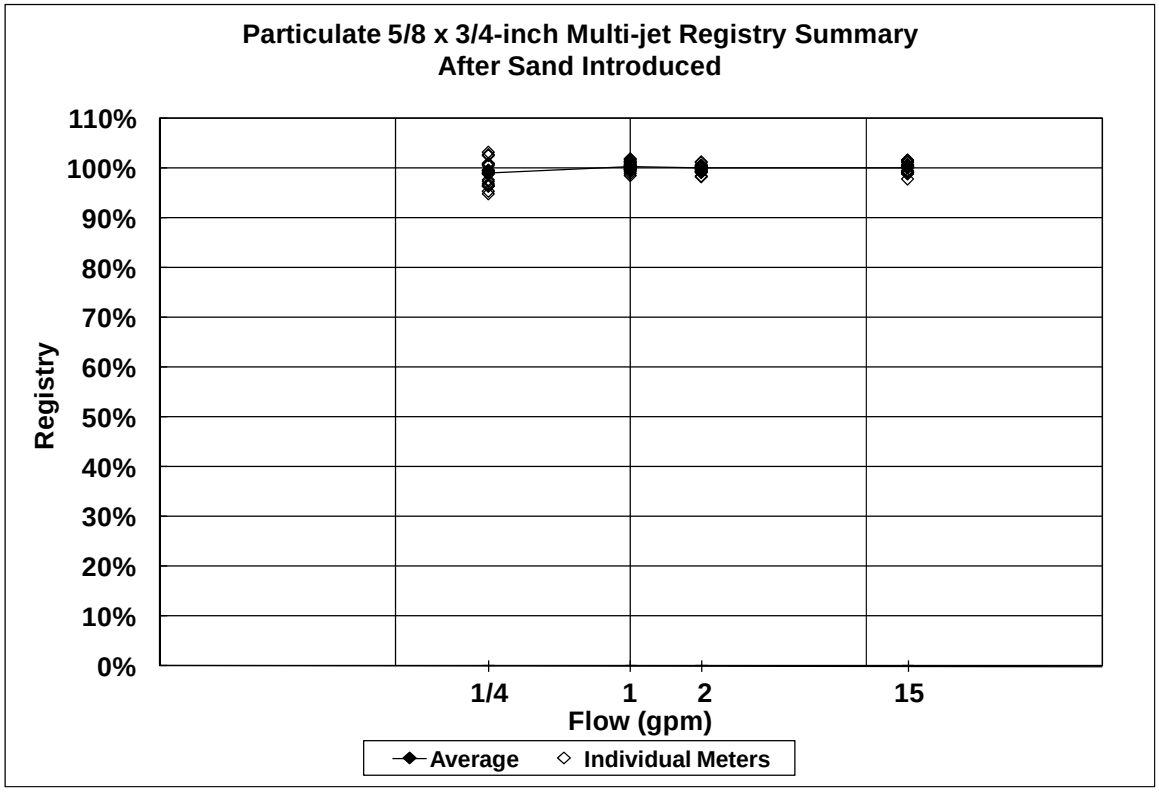

Figure 3.214 5/8x3/4–inch multi-jet 0 MG throughput after sand introduction

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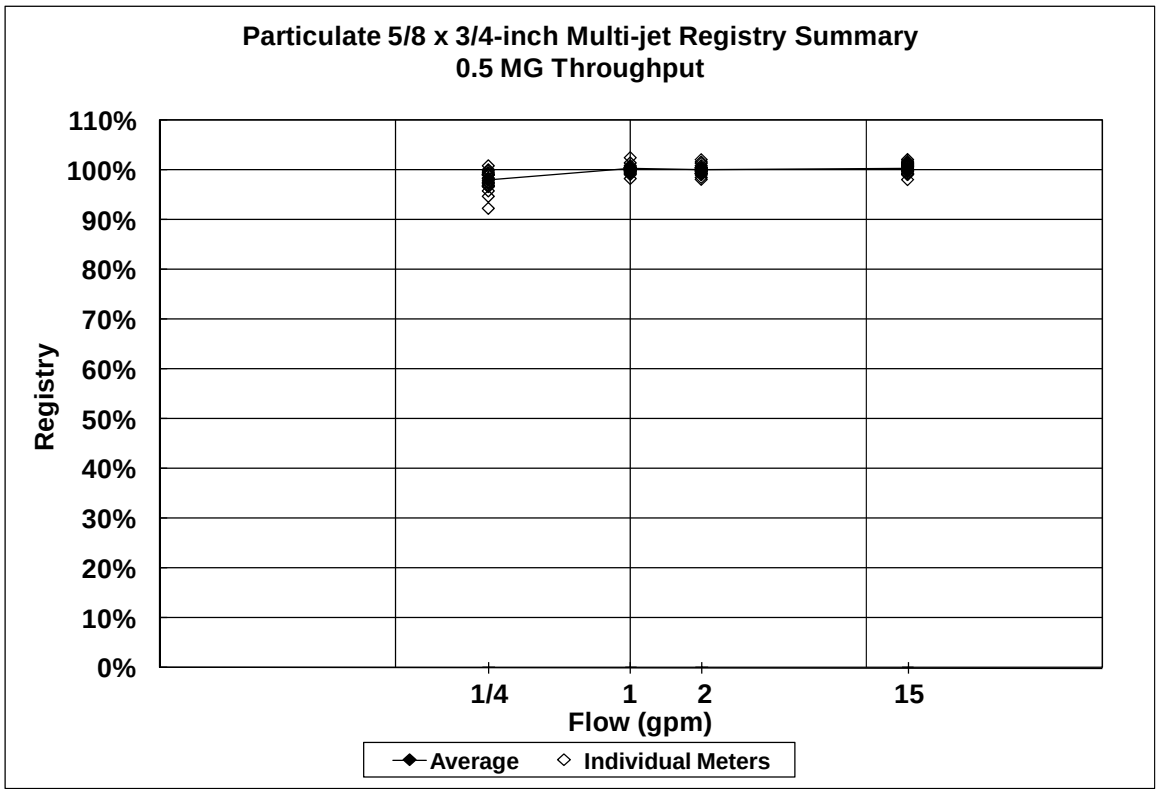

Figure 3.215 5/8x3/4–inch multi-jet 0.5 MG throughput (particulate)

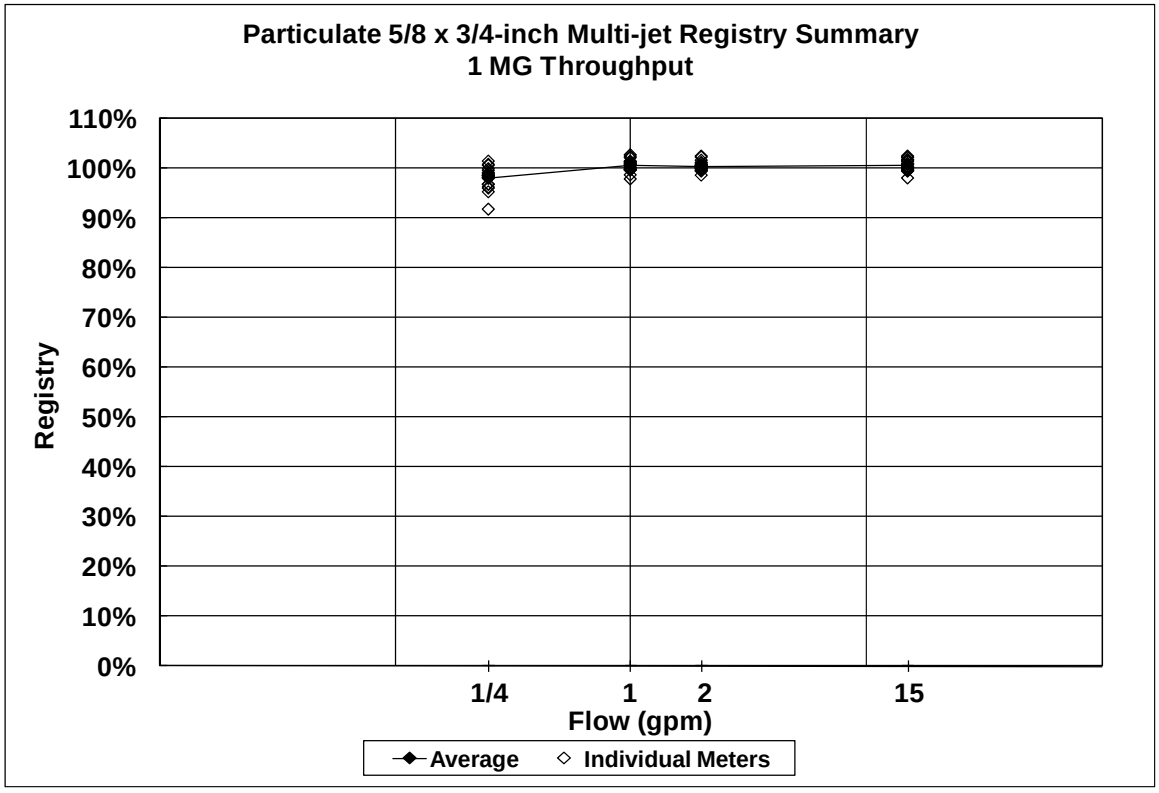

Figure 3.216 5/8x3/4–inch multi-jet 1 MG throughput (particulate)

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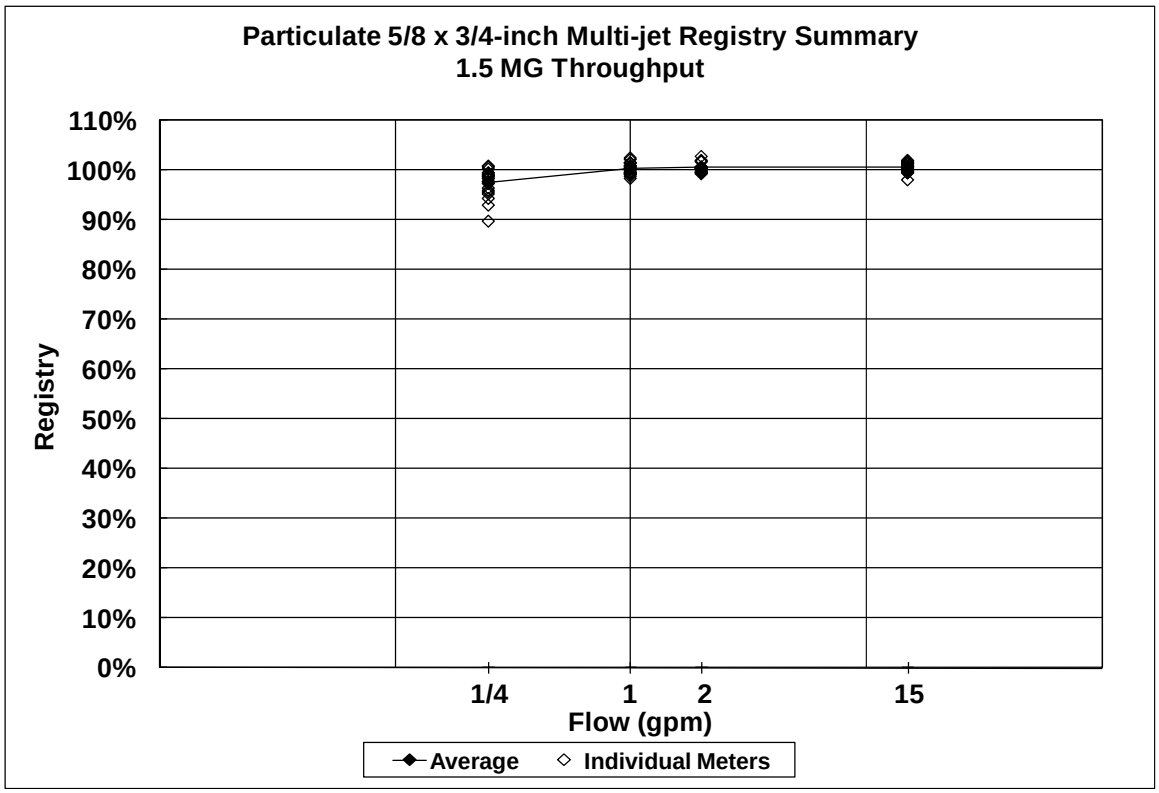

Figure 3.217 5/8x3/4–inch multi-jet 1.5 MG throughput (particulate)

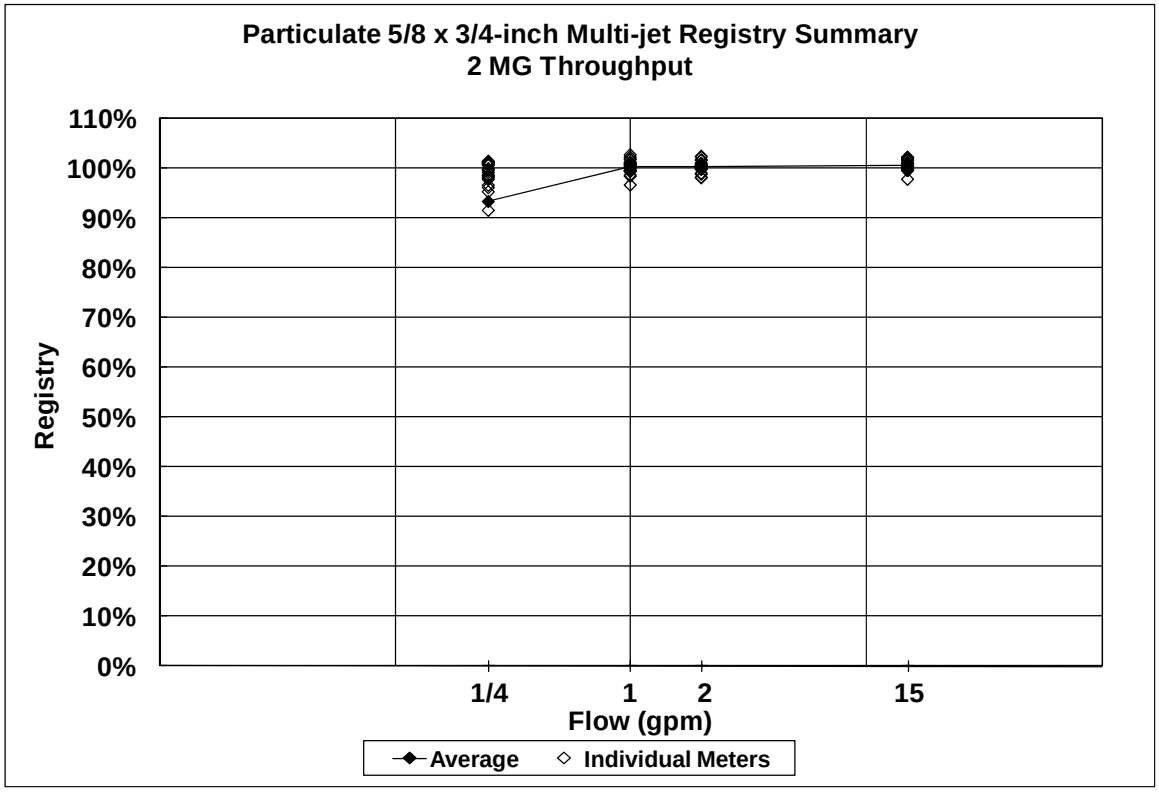

Figure 3.218 5/8x3/4–inch multi-jet 2 MG throughput (particulate)

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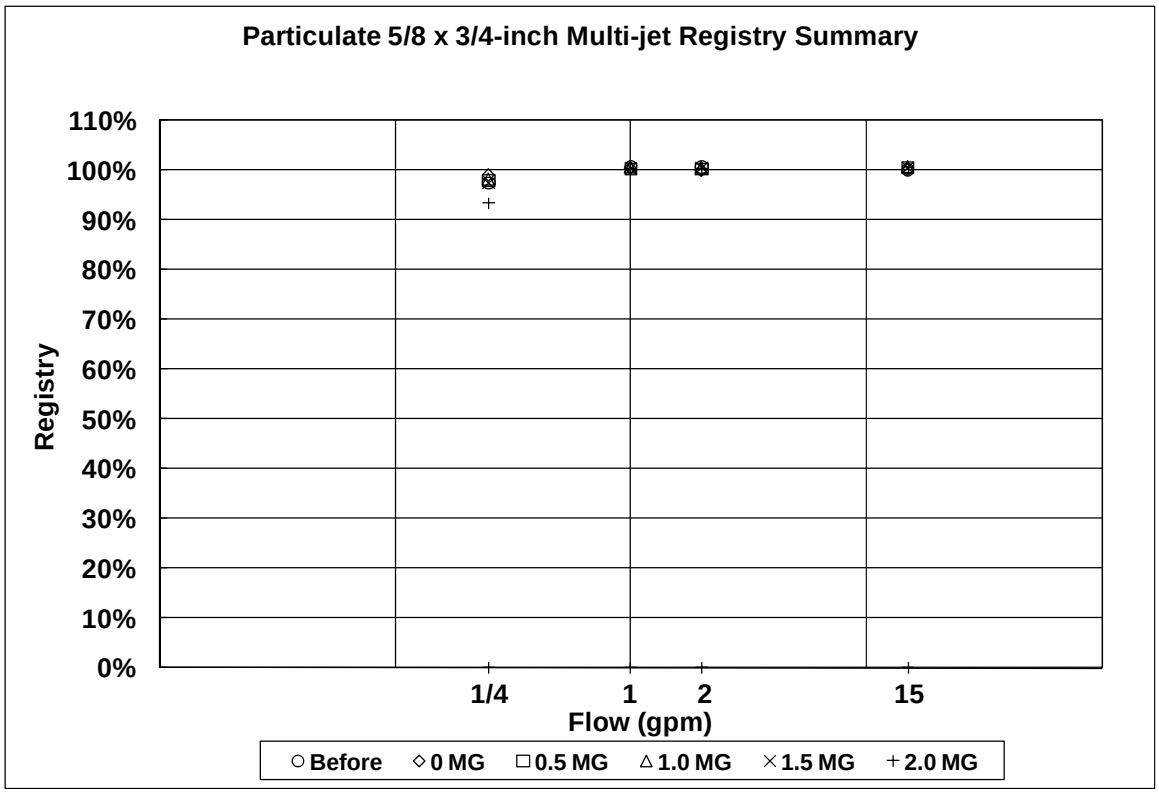

Figure 3.219 5/8x3/4-inch multi-jet registry summary (particulate)

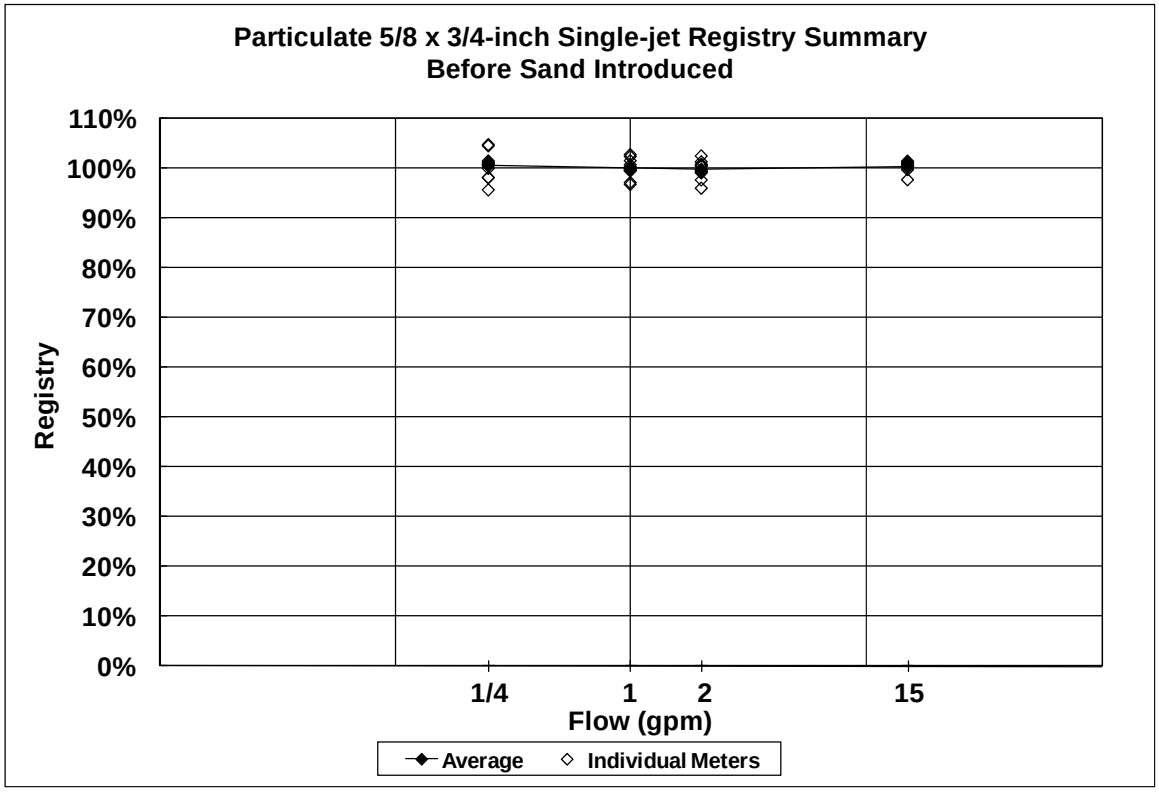

Figure 3.220 5/8x3/4–inch single-jet 0 MG throughput before sand introduction

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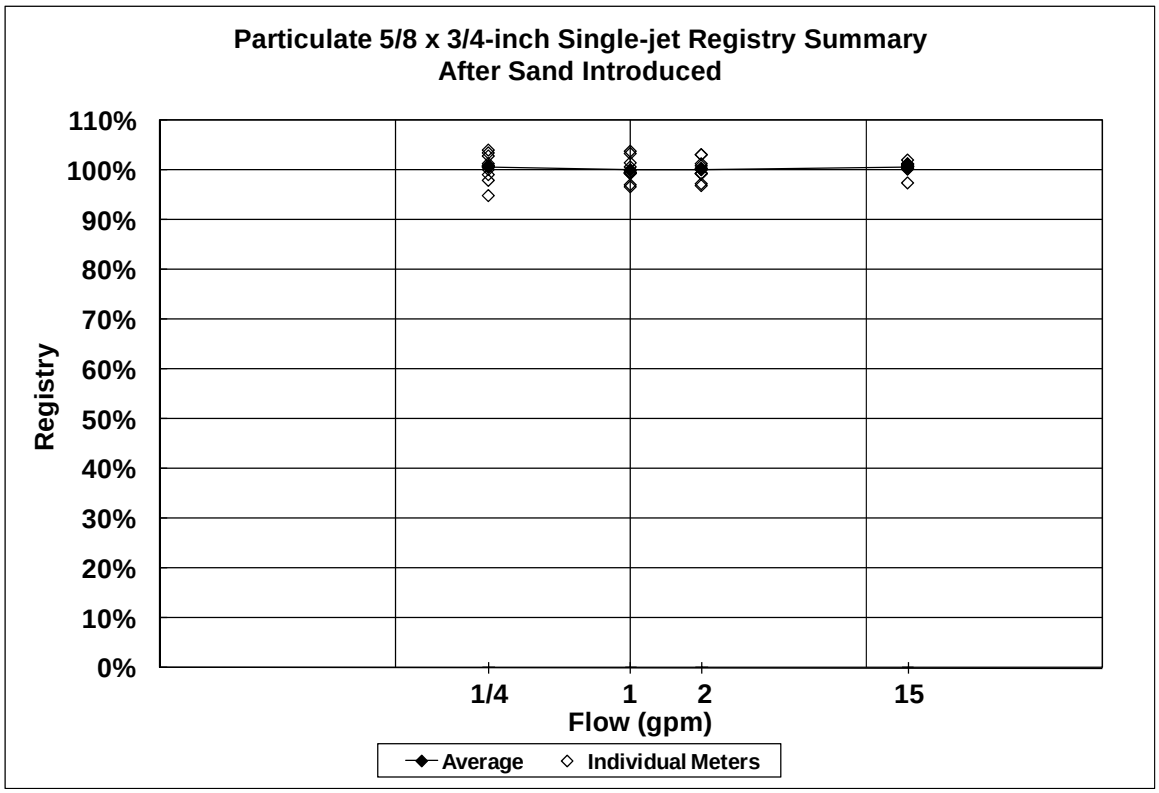

Figure 3.221 5/8x3/4–inch single-jet 0 MG throughput after sand introduction

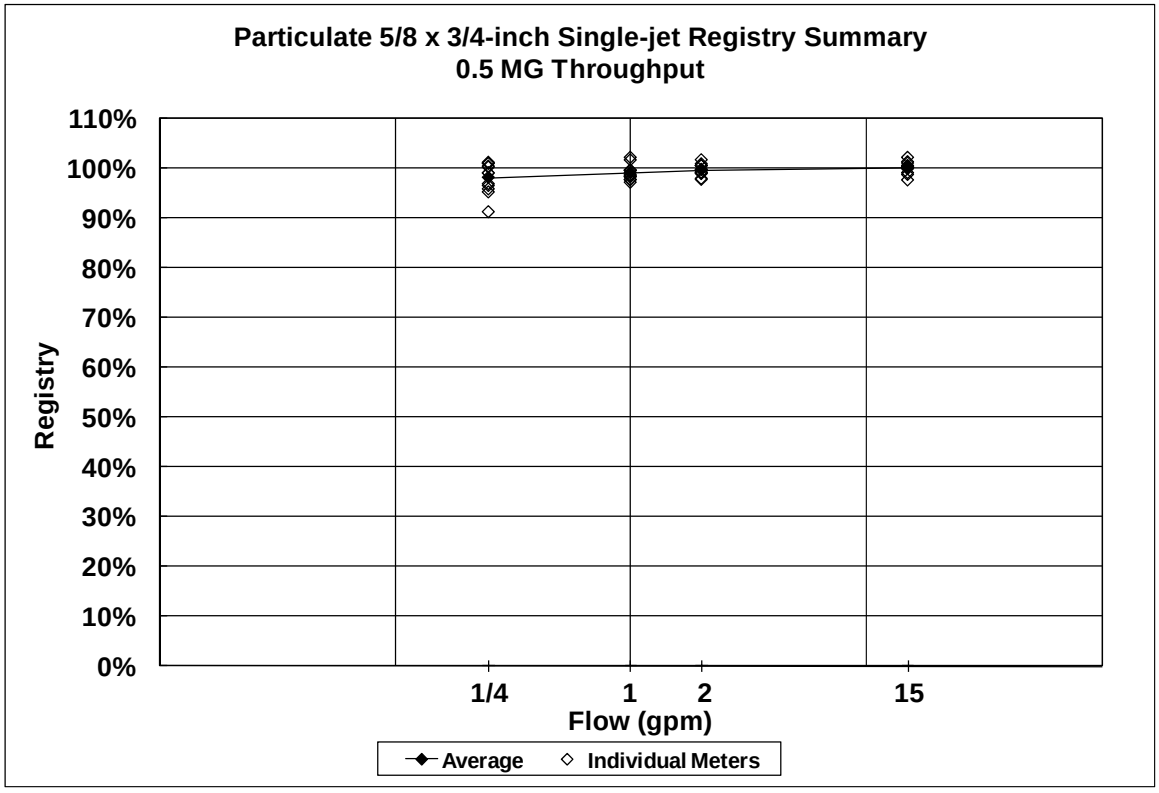

Figure 3.222 5/8x3/4–inch single-jet 0.5 MG throughput (particulate)

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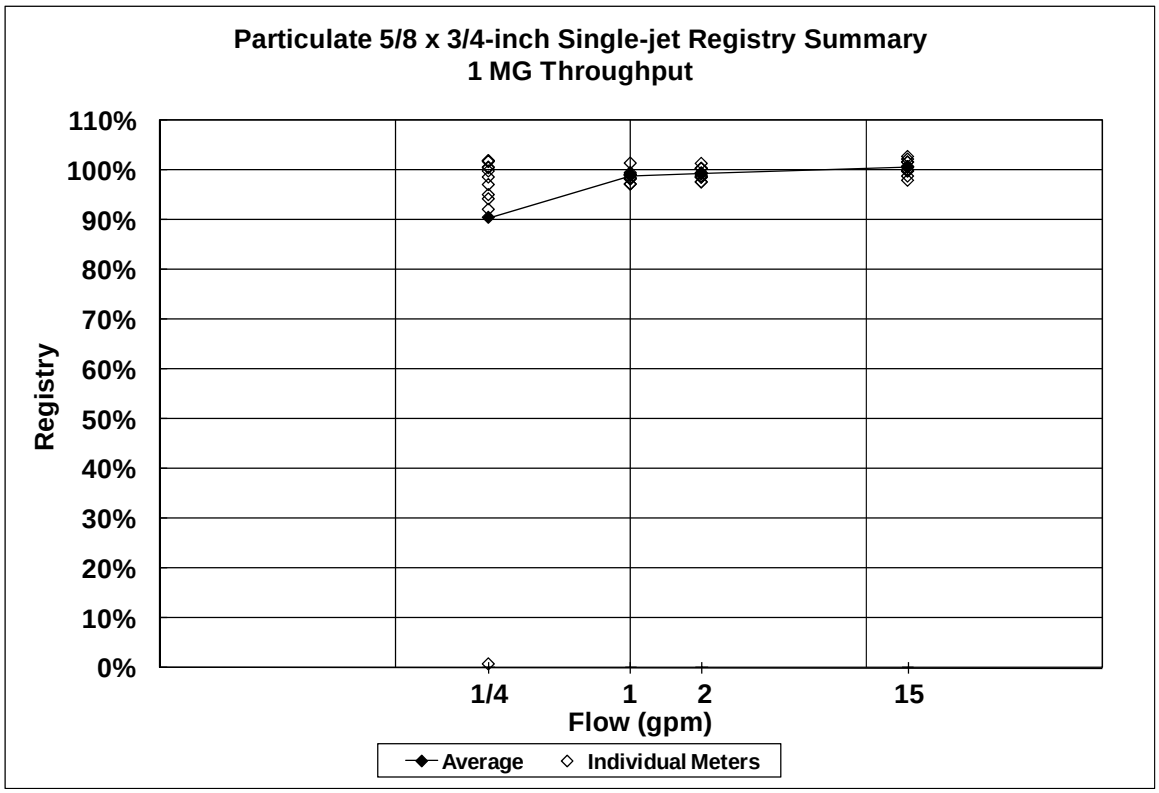

Figure 3.223 5/8x3/4–inch single-jet 1 MG throughput (particulate)

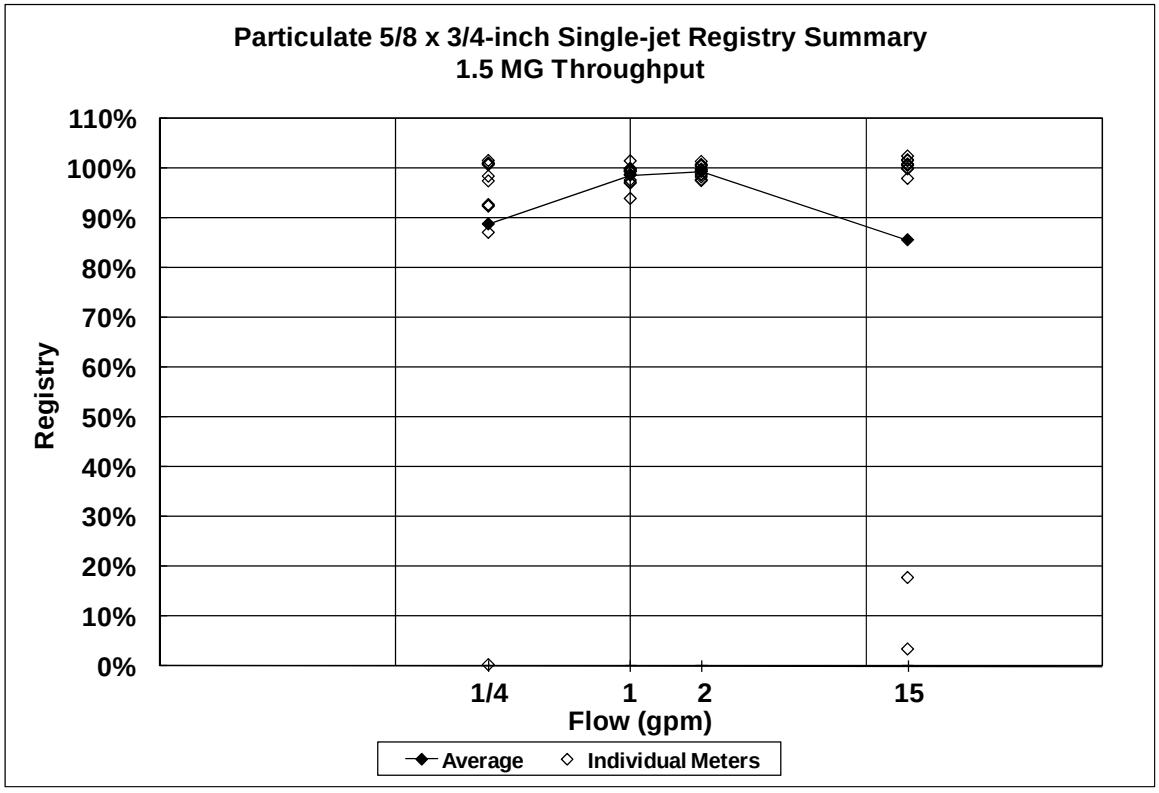

Figure 3.224 5/8x3/4–inch single-jet 1.5 MG throughput (particulate)

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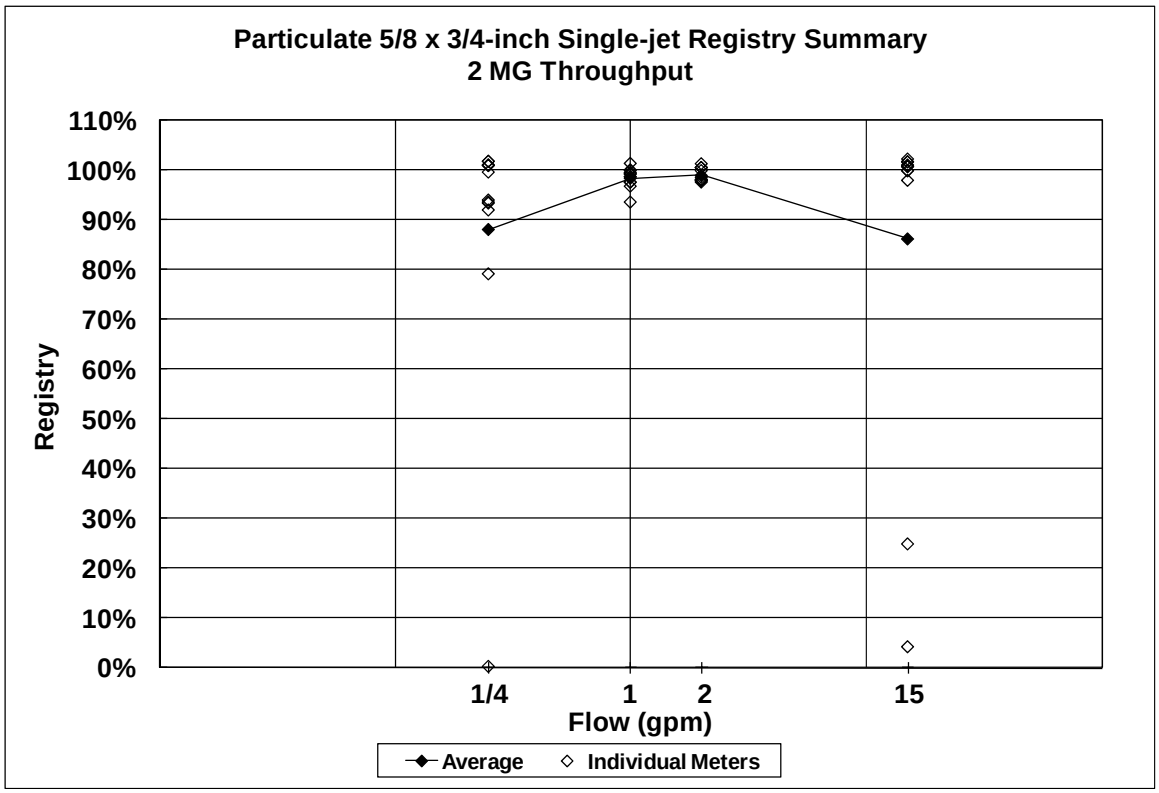

Figure 3.225 5/8x3/4–inch single-jet 2 MG throughput (particulate)

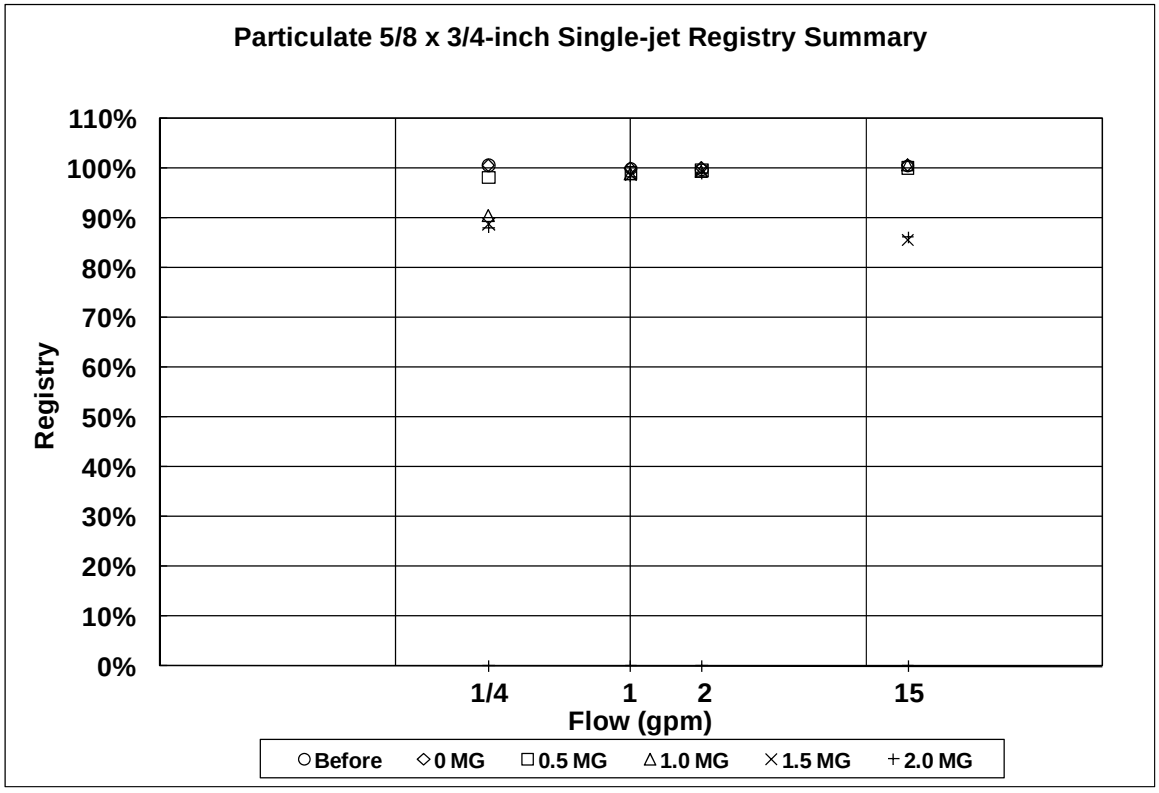

Figure 3.226 5/8x3/4-inch single-jet registry summary (particulate)

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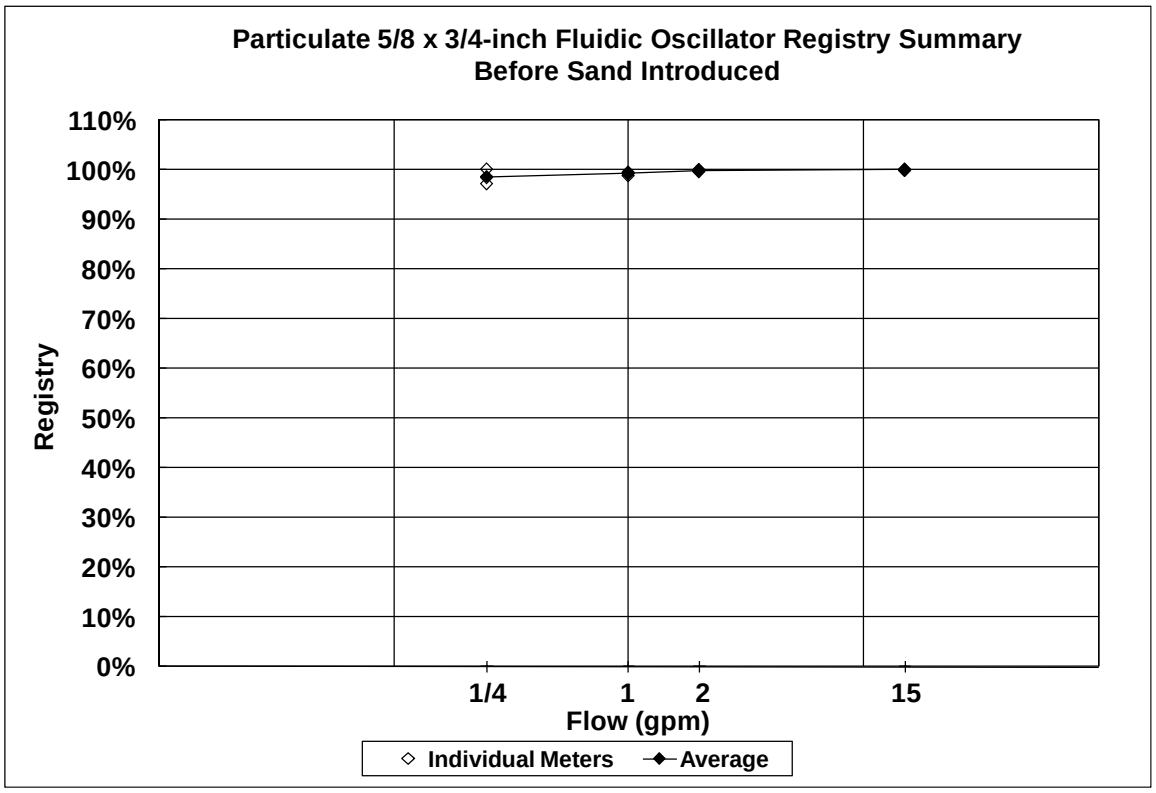

Figure 3.227 5/8x3/4–inch fluidic oscillator 0 MG throughput before sand introduction

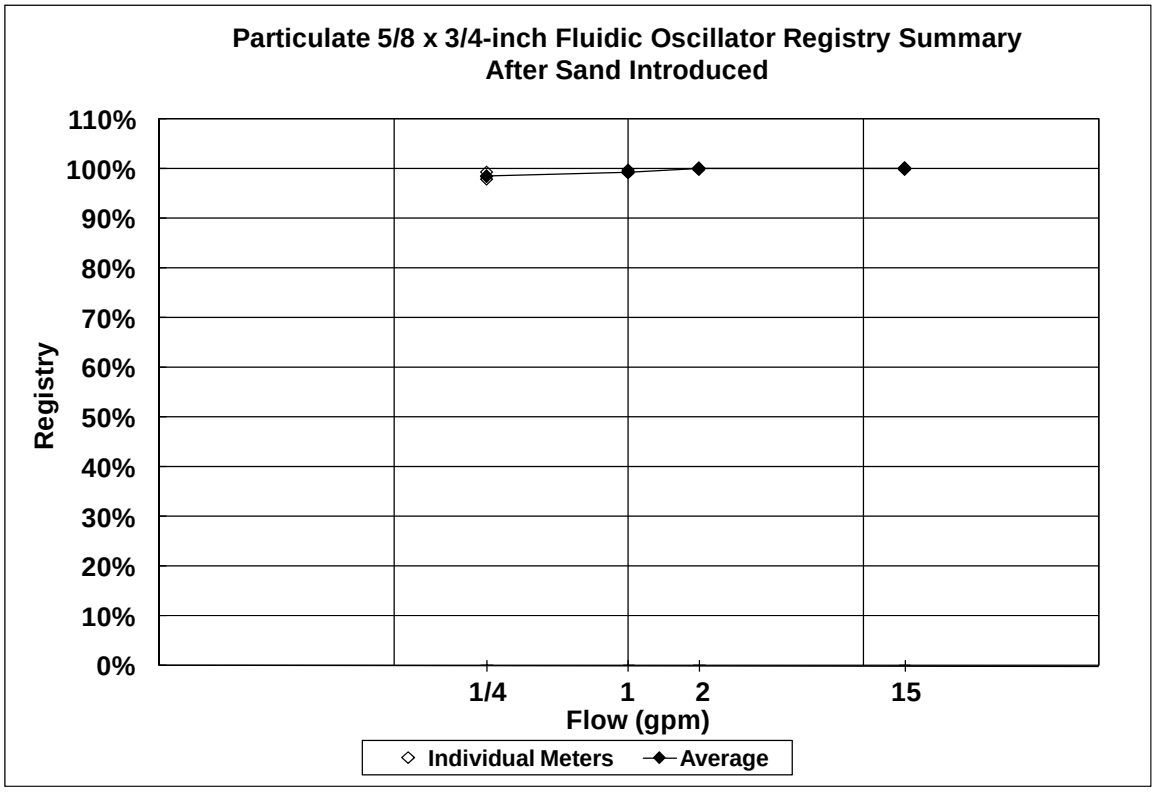

Figure 3.228 5/8x3/4–inch fluidic oscillator 0 MG throughput after sand introduction

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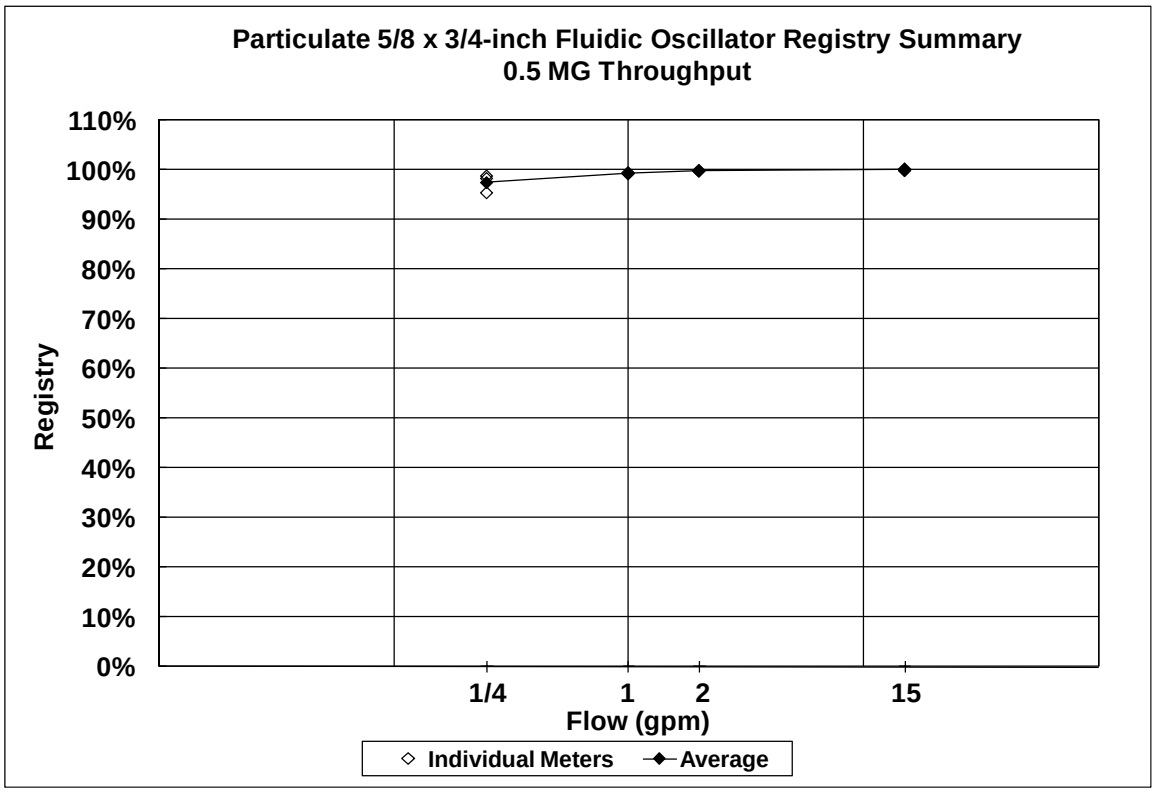

Figure 3.229 5/8x3/4–inch fluidic oscillator 0.5 MG throughput (particulate)

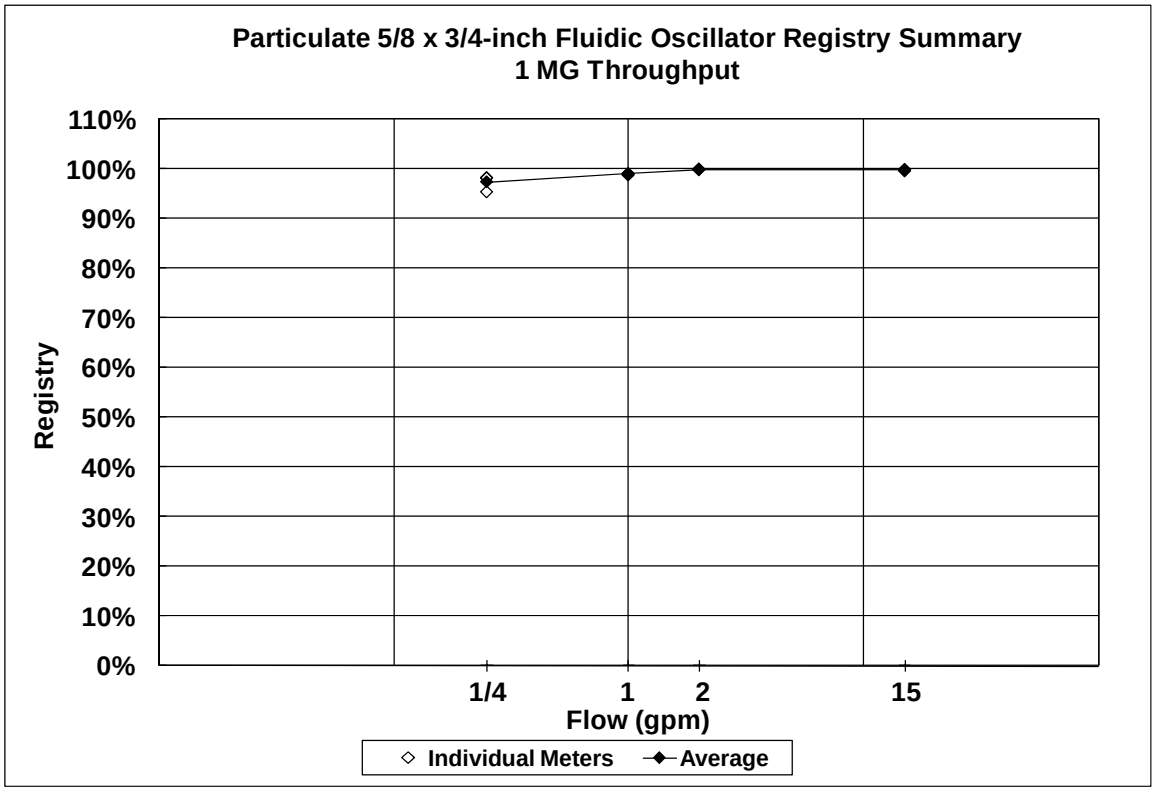

Figure 3.230 5/8x3/4–inch fluidic oscillator 1 MG throughput (particulate)

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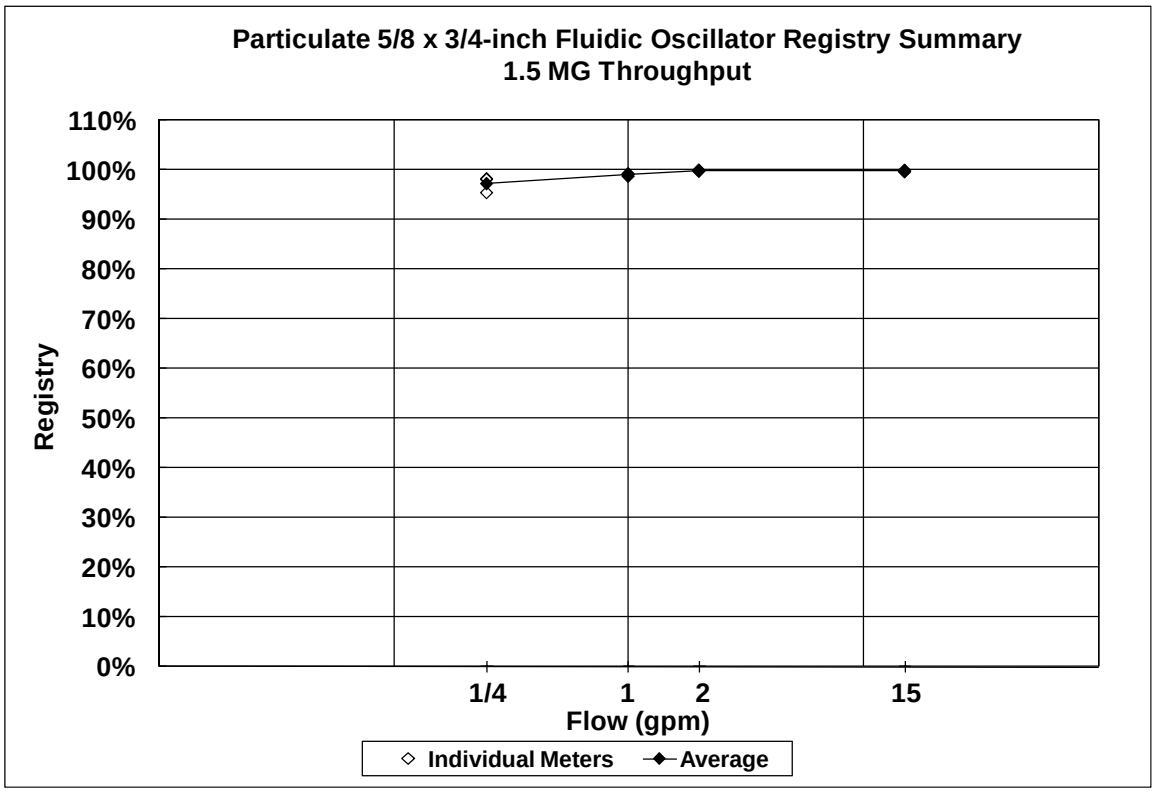

Figure 3.231 5/8x3/4–inch fluidic oscillator 1.5 MG throughput (particulate)

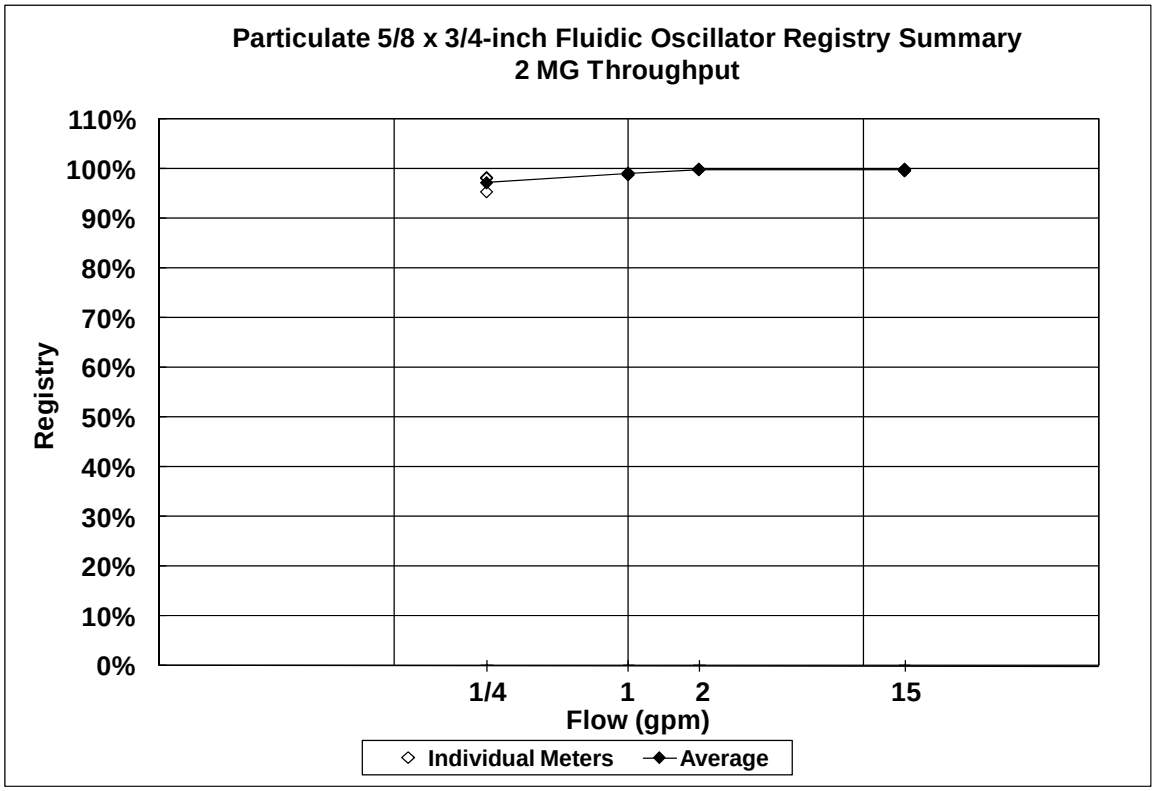

Figure 3.232 5/8x3/4–inch fluidic oscillator 2 MG throughput (particulate)

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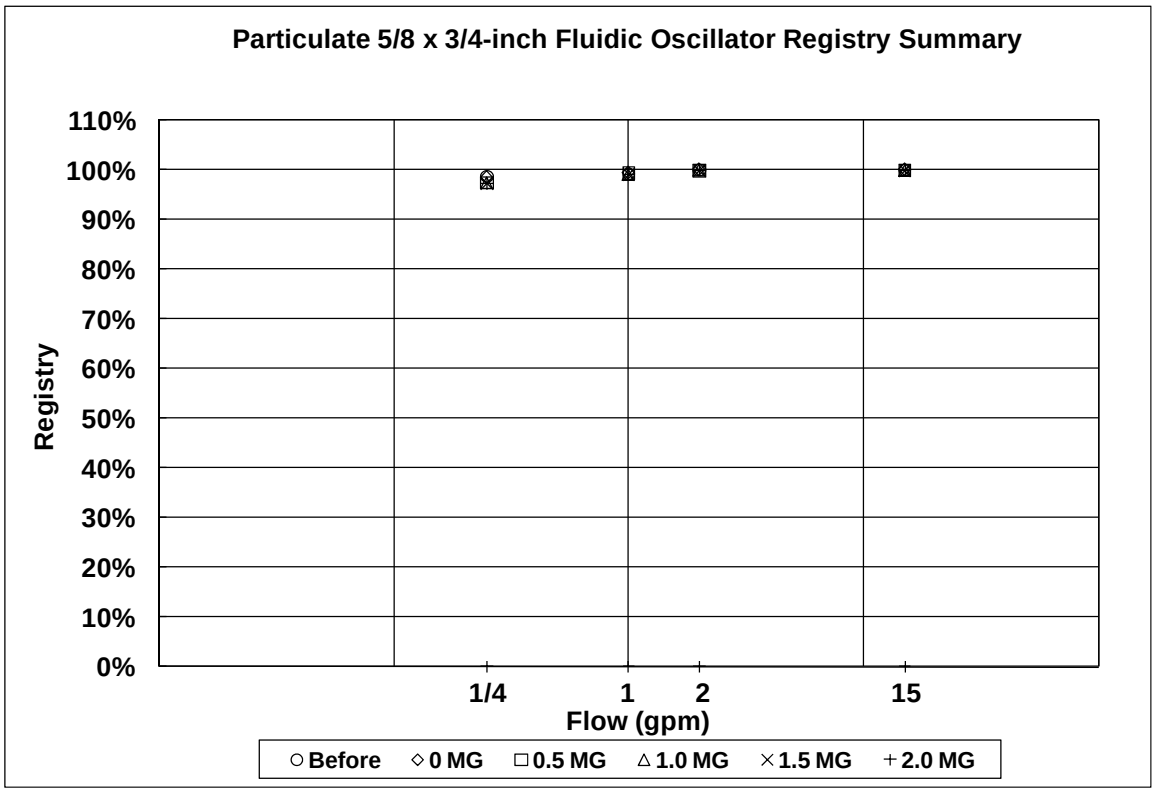

Figure 3.233 5/8x3/4-inch fluidic oscillator registry summary (particulate)

OTHER TESTS AND RESULTS

Seventy-five 5/8 x 3/4-inch meters (the new meter particulate set) were tested to evaluate the meter accuracy repeatability when the same flow rate was tested three times in a row. The average variance for the three repeat flow rates at the minimum AWWA standard flow of ¼ gpm was 0.26% (max 1.39%), at 1gpm the average variance was 0.20% (max 1.76%), at 2gpm the average variance was 0.15% (max 1.04%), and at 15gpm the average variance was 0.25% (max 11.73%). It was interesting to note that the same manufacturers that exhibited low AWWA standard pass rates during the study for their meters, also had high variances in repeatability during these repeat flow tests.

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CHAPTER 4 – SUMMARY AND CONCLUSIONS

NEW METER AND LABORATORY ENDURANCE TEST CONCLUSIONS

These two components of the study produced several findings that will be useful to utilities and other users of small culinary water meters, especially as it applies to meter accuracy as a function of meter type. Although there are a multitude of findings from the results of these two phases, the following list summarizes the major findings of the Phase II new meter testing (on 375 new meters) and the Phase III component 1, laboratory endurance testing of this study.

1. Figures 4.1 through 4.10 are summary plots by meter size of all of the test data for the new meter tests and then after a full-life amount of throughput. Tables 4.1 through 4.5 summarize this data in tabular form. Figures 4.11 through 4.22 are plots illustrating the AWWA pass rates for the meter tests at both the new and full life conditions. A few noteworthy comparisons from these figures and tables are as follows:
    a. One hundred percent of the thirty new 5/8 x 3/4-inch nutating disc and one hundred percent of the six 5/8 x 3/4-inch fluidic oscillator-type meters passed the minimum AWWA accuracy flow rate test (see Figures 4.11 and 4.19).
    b. In contrast, just over fifty percent of the forty-two new 5/8 x 3/4-inch multi-jet meters passed the minimum AWWA accuracy flow rate test (see Figure 4.15).
    c. Of the seven manufacturers representing turbine and propeller meters, none of the six 3/4-inch and none of the six 1-inch meters passed the minimum AWWA standard (see Figure 4.21). Additionally, Figures 4.3 through 4.10 illustrate the relatively low registries for the turbine and propeller-type meters as compared to all of the other meter types.
    d. All seventy-two nutating disc-type meters (in all five sizes) passed the maximum AWWA standard flow rate test in the new condition (see Figure 4.11).
    e. The three 1.5-inch piston meters showed zero change between the new condition and the 100% life condition at each of the three AWWA flow rates (see Figures 4.13 and 4.14).
    f. All six of the 1-inch single-jet meters and the 1.5-inch single jet meter passed all three AWWA standard flow rate tests (see Figures 4.17 and 4.18).
    g. Test results indicate that there may be a break-in period associated with some new meter types. At the minimum AWWA flow rate for the 3/4-, 1- and 1.5-inch nutating disc meters, the accuracy results were improved after a full endurance life cycle as compared to the accuracy results in their new condition (compare Figures 4.11 and 4.12 minimum AWWA flow rate for 3/4-, 1- and 1.5-inch meters).
    h. Most meters that were tested during the project indicated a significant drop in register accuracy at flows that are approximately one half of the minimum AWWA flow rate. This type of registry reduction is expected in mechanical meters because, as flow rates become smaller and smaller, the bearing, friction and drag forces within the metering mechanism become proportionally larger. One example is the new 5/8 x 3/4-inch and 3/4-inch nutating disc-type meters (see Figures 4.1 and 4.3). These meters consistently indicated higher accuracies at the

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lowest flow rates as compared to the other meter types. Additionally, these same nutating disc type meters consistently indicated registry accuracies above 95% at the lowest flow rates as compared to the other meter types after a full life cycle of throughput (see Figures 4.2 and 4.4).

i. The new single-jet-type meters on average showed registry accuracies above 95% at 1/2 the minimum AWWA flow rate, although below that flow rate, accuracy dropped off considerably. Noteworthy, were the twelve 3/4-inch single-jet meters which exhibited the largest degradation of accuracies of all the meters tested during the project (see Figures 3.49 and 3.50). The 1 1/2-inch single-jet meters also exhibited large degradations in accuracy from the new condition to the full life condition (see Figure 3.115).

j. Although the turbine type meters always exhibited registry accuracies below 90% at flow rates less than the minimum AWWA standard flow rate, surprisingly, registry accuracies actually improved at these extremely low flow rates for the 1-inch and 1.5-inch sizes from the new condition to the end of the endurance life cycle (see Figures 3.96 and 3.121).

k. The 5/8 x 3/4-inch fluidic oscillator type meters indicated registry accuracies above 95% at 1/2 the minimum AWWA flow rate but had the most rapid decline in registry accuracy below that flow rate (1/8 gpm) as compared to all other 5/8 x 3/4-inch meters. In other words, as flow rates get smaller and smaller, the 5/8 x 3/4-inch fluidic oscillator type meters do not gradually drop off in registry accuracy, but rather, exhibited a sudden registry reduction.

2. It was apparent that some manufacturers were able to meet the AWWA standard more consistently than other manufacturers. As an example, only one manufacturer represented in this study was able to meet the AWWA standard at all three flow rates (for new meters in all sizes and types offered) more than 85% of the time. None of the other 13 manufacturers were able to exceed a success percentage greater than 85%. This particular manufacturer provided new meters which met the AWWA standard at all three flow rates 95% of the time. In contrast, a second manufacturer's new meters only met the AWWA standard at all three flow rates 17% of the time. Seven manufacturers only passed all three AWWA standard flow rates 50% of the time or less. This result alone indicates most of the meters in the U.S. marketplace are not providing meters that meet the standard.
3. As shown in the figures presented in the results section of this report, not all meters meet the AWWA standard. Of the 375 new meters that were tested during this phase of the study, there were a significantly large percentage of individual meter tests that did not pass the required AWWA standard. Tables 4.1 through 4.5 show the meter type and the number of meters meeting the standard in the new condition and the number of meters meeting the standard at the end of the endurance testing. Additionally, figures 4.11, 4.13, 4.15, 4.17, 4.19 and 4.21 illustrate the percentage of total new meter tests by size and type that passed the minimum, intermediate and maximum AWWA standard. The legend on each of these figures shows the number of individual meters represented in the data set.
4. Of the technologies represented, it is evident that not all meter types are created equal. The results of this phase indicated that some meter types claiming to meet the AWWA

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accuracy standard, did not meet the accuracy standards as well as other meter types of the same size. For example, the data indicated that the new 5/8 x 3/4-inch nutating disc and fluidic oscillator-type meters met the AWWA standard more consistently than the new 5/8 x 3/4-inch multi-jet and single-jet meters.

5. Contained in Figures 3.1 through 3.152 are the registry accuracies of all the Phase II new meter testing and the Phase III component 1, laboratory endurance testing. These test results indicate that the Fluidic oscillator-type meter consistently met the AWWA maximum accuracy standard at flow rates much higher than the AWWA maximum flow rate at new and again after the full life of throughput. This was not always the case for the other meter types. This may be due to the fact that the Fluidic oscillator type meter was the only non-mechanical meter type tested during this research.

Table 4.1
5/8x3/4-inch meters meeting the AWWA registry standard

Meter type	No. of meters	Test flow	Meters passing AWWA standard at throughput				
			0 MG	0.5 MG	1 MG	1.5 MG	2 MG
5/8x3/4 ND	30	0.25	30	28	30	25	28
5/8x3/4 ND	30	2	27	29	30	25	25
5/8x3/4 ND	30	15	30	20	18	19	19
5/8x3/4 DP	48	0.25	37	32	31	33	27
5/8x3/4 DP	48	2	43	41	44	42	42
5/8x3/4 DP	48	15	48	44	46	44	43
5/8x3/4 MJ	42	0.25	22	11	15	9	8
5/8x3/4 MJ	42	1	37	38	33	35	35
5/8x3/4 MJ	42	15	38	33	32	27	24
5/8x3/4 SJ	24	0.25	18	21	22	20	17
5/8x3/4 SJ	24	1	18	17	14	11	14
5/8x3/4 SJ	24	15	18	16	14	14	14
5/8x3/4 FO	6	0.25	6	6	6	6	6
5/8x3/4 FO	6	2	6	6	6	6	6
5/8x3/4 FO	6	15	6	6	6	6	5

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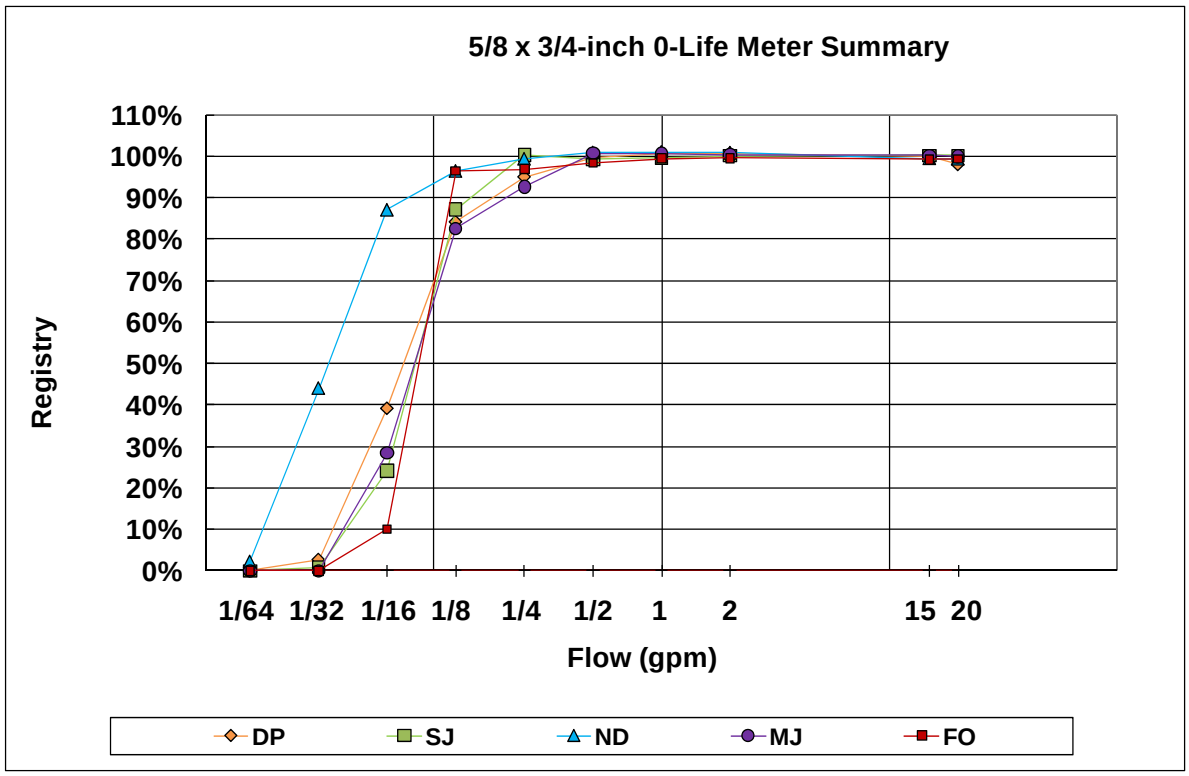

Figure 4.1 5/8 X 3/4-inch meter summary plot for new condition

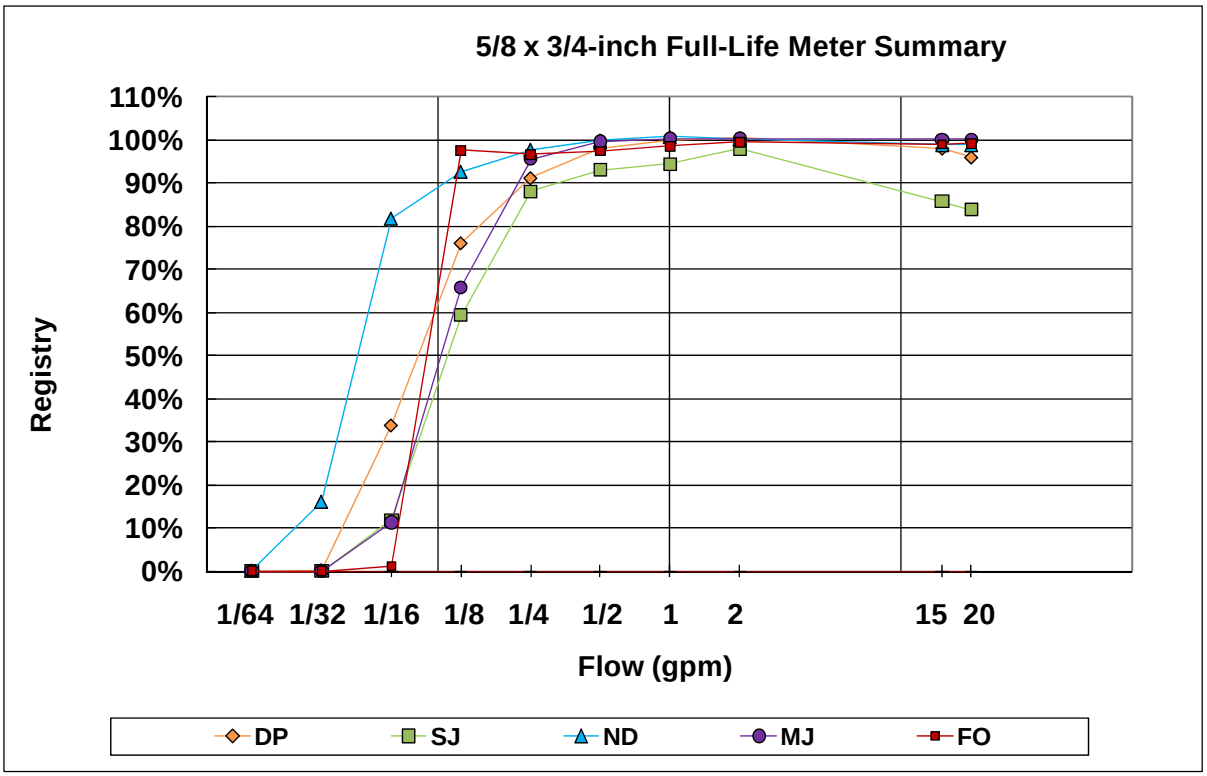

Figure 4.2 5/8 X 3/4-inch meter summary plot after full life

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Table 4.2
3/4-inch meters meeting the AWWA registry standard

Meter type	No. of meters	Test flow	Meters passing AWWA standard at throughput				
			0 MG	0.75 MG	1.5 MG	2.25 MG	3 MG
3/4 ND	18	0.5	12	15	12	17	16
3/4 ND	18	3	18	17	15	12	18
3/4 ND	18	25	18	18	18	18	18
3/4 DP	30	0.5	27	26	28	27	25
3/4 DP	30	3	19	20	20	19	19
3/4 DP	30	25	20	20	20	20	20
3/4 MJ	30	0.5	26	23	24	21	21
3/4 MJ	30	2	23	21	22	22	23
3/4 MJ	30	25	23	21	22	22	23
3/4 SJ	12	0.5	11	12	9	9	6
3/4 SJ	12	2	8	11	8	6	7
3/4 SJ	12	25	11	10	9	7	6
3/4 FO	6	0.5	0	0	0	0	0
3/4 FO	6	3	6	5	5	2	3
3/4 FO[A]	6	25	6	6	5	6	6
3/4 TU	6	1	0	2	2	2	2
3/4 TU[B]	6	28	6	6	6	6	6

[A] Fluidic Oscillator max AWWA flow is 20 gpm which was not tested.
[B] Turbine max AWWA flow is 30 gpm which was not tested.

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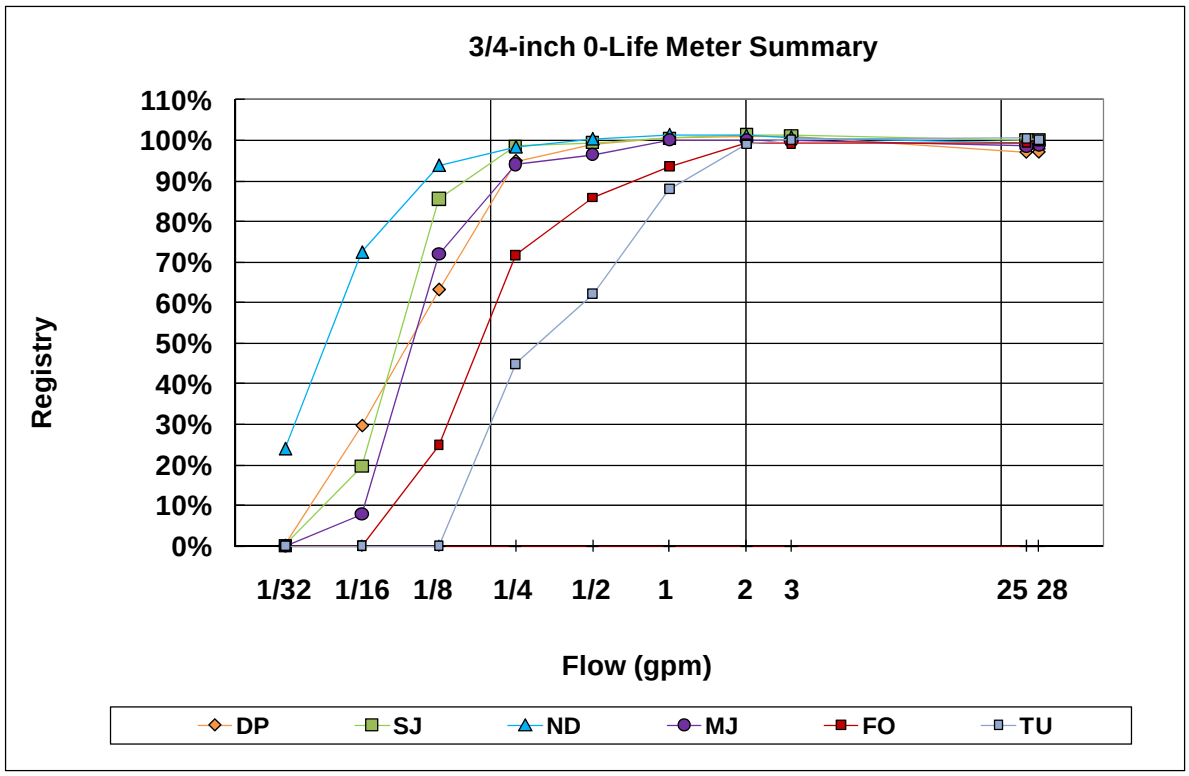

Figure 4.3 3/4-inch meter summary plot for new condition

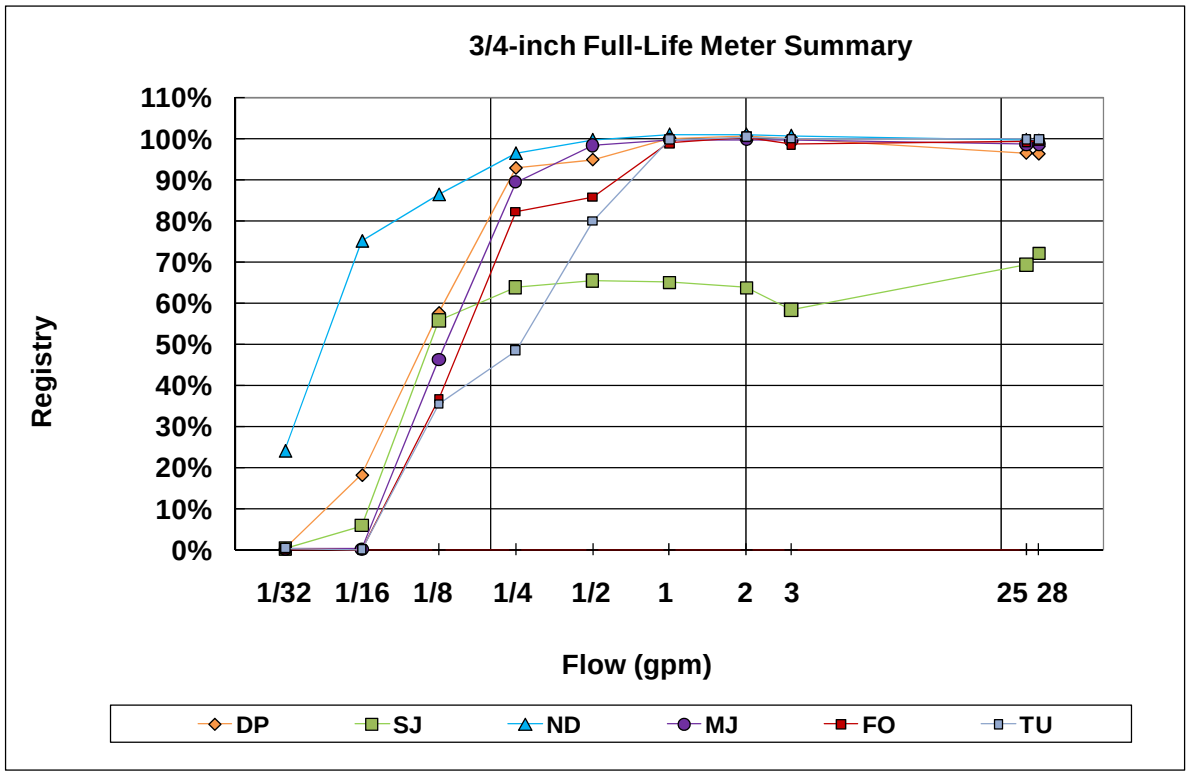

Figure 4.4 3/4-inch meter summary plot after full life

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Table 4.3
1-inch meters meeting the AWWA registry standard

Meter type	No. of meters	Test flow	Meters passing AWWA standard at throughput				
			0 MG	1.25 MG	2.5 MG	3.75 MG	5 MG
1 ND	18	0.75	16	18	16	16	17
1 ND	18	4	16	18	17	16	15
1 ND	18	40	18	18	17	17	16
1 DP	30	0.75	27	25	24	23	24
1 DP	30	4	28	25	22	20	19
1 DP	30	40	26	24	20	21	21
1 MJ	30	0.75	23	16	14	14	14
1 MJ	30	3	21	19	17	16	15
1 MJ	30	40	25	25	25	24	24
1 SJ	6	0.75	6	3	4	4	5
1 SJ	6	3	6	6	6	6	5
1 SJ	6	40	6	6	6	6	5
1 TU[A]	6	0.75	0	0	0	0	0
1 TU	6	3	4	4	4	4	6
1 TU	6	50	5	5	5	5	5

[A] Class1 turbine low AWWA flow is 1.5 gpm which was not tested.

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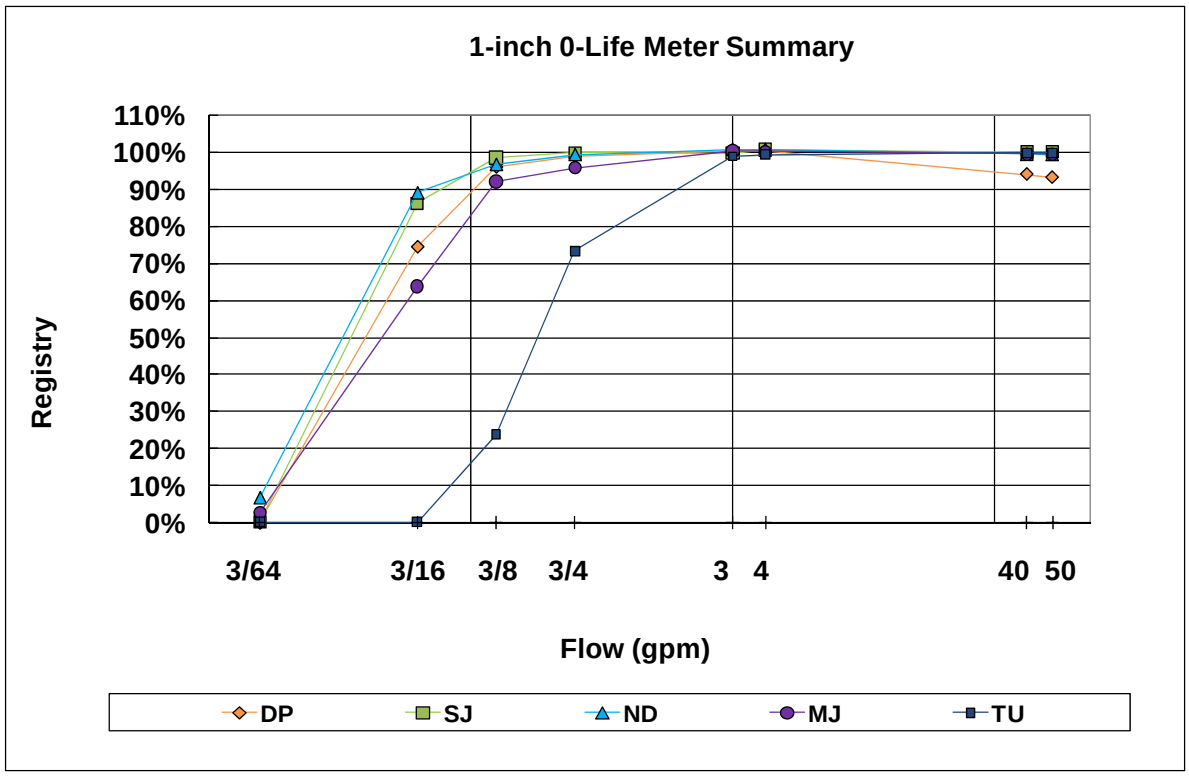

Figure 4.5 1-inch meter summary plot for new condition

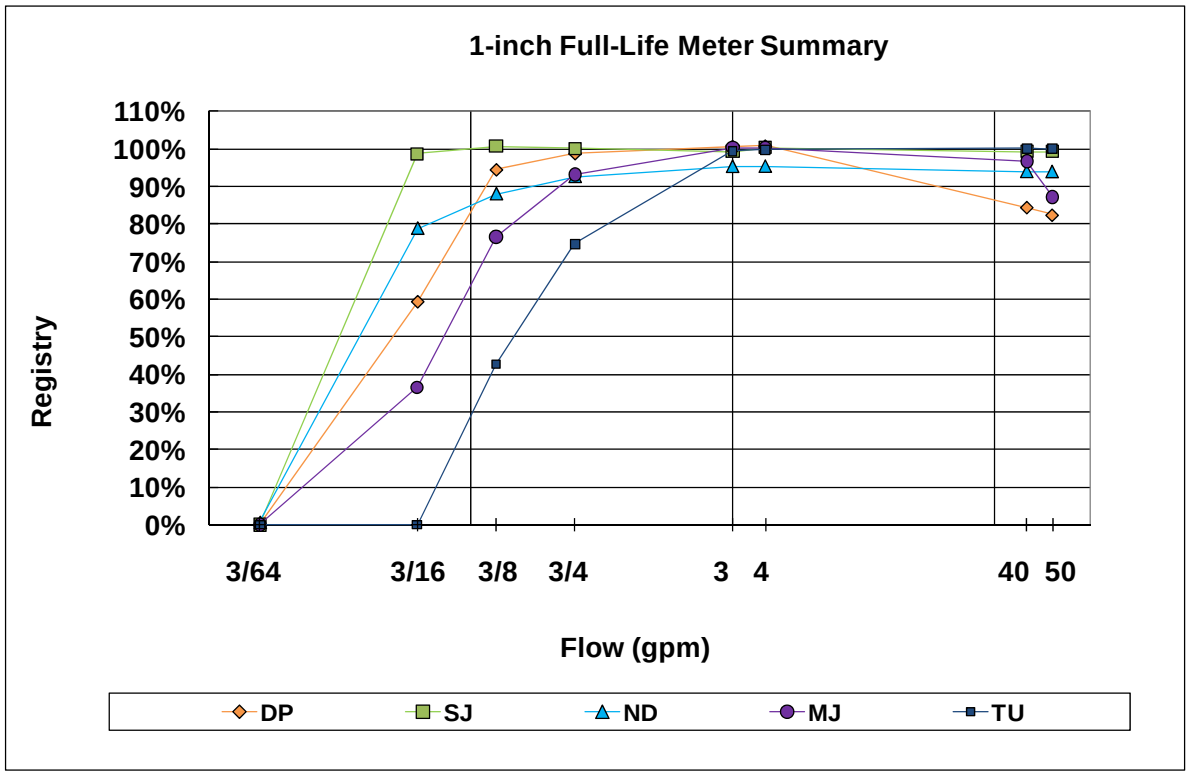

Figure 4.6 1-inch meter summary plot after full life

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Table 4.4
1 1/2-inch meters meeting the AWWA registry standard

Meter type	No. of meters	Test flow	Meters passing AWWA standard at throughput				
			0 MG	1.5 MG	3 MG	4.5 MG	6 MG
1 1/2 ND	3	1.5	2	2	2	2	3
1 1/2ND	3	8	2	2	2	2	3
1 1/2ND	3	50	3	3	3	3	2
1 1/2DP	3	1.5	3	3	3	3	3
1 1/2DP	3	8	2	3	2	3	2
1 1/2DP	3	50	3	3	3	3	3
1 1/2MJ	4	1.5	4	3	3	2	2
1 1/2MJ	4	5	4	4	3	3	3
1 1/2MJ[A]	4	50	3	3	2	3	3
1 1/2SJ	1	0.75	1	1	1	1	1
1 1/2SJ	1	1.5	1	1	1	1	1
1 1/2SJ	1	50	1	1	1	1	1
1 1/2TU[B] CL I	1	8	0	0	1	1	1
1 1/2TU CL I	1	50	1	1	1	1	1
1 1/2TU[C] CL I	1	110	1	1	1	1	1
1 1/2TU[D] CL II	2	5	1	1	0	1	1
1 1/2TU CL II	2	50	1	2	1	1	1
1 1/2TU[E] CL II	2	110	1	2	2	2	2

[A] Multi-jet high AWWA flow is 70 gpm which was not tested.
[B] Class I Turbine low AWWA flow is 12 gpm which was not tested.
[C] Class I Turbine high flow is 100 gpm which was not tested.
[D] Class II Turbine low AWWA flow is 4 gpm which was not tested.
[E] Class II Turbine high AWWA flow is 120 gpm which was not tested.

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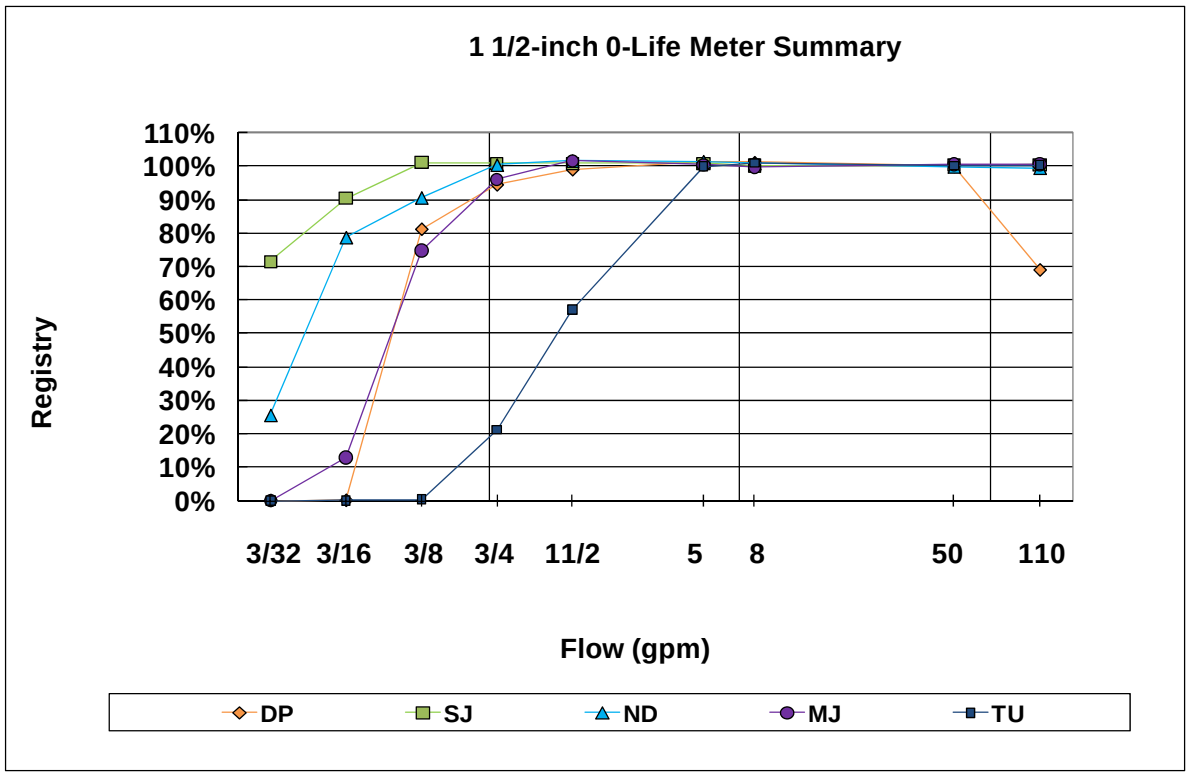

Figure 4.7 1 1/2-inch meter summary plot for new condition

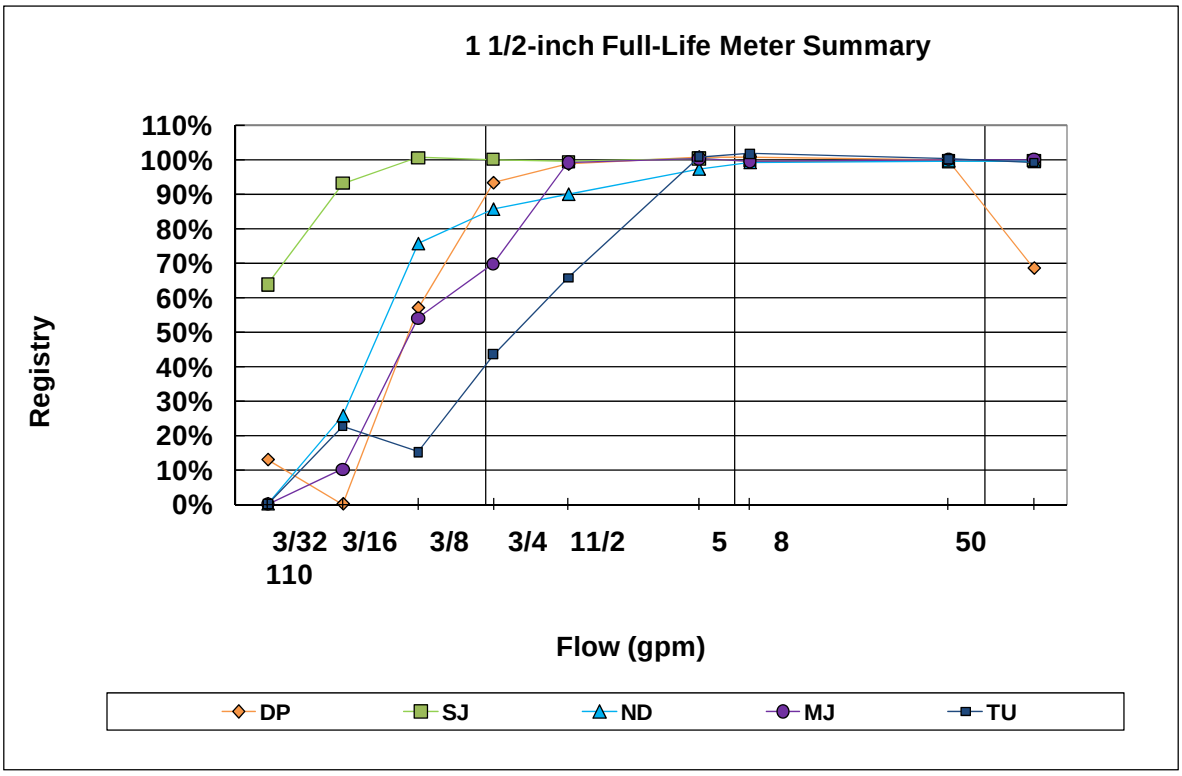

Figure 4.8 1 1/2-inch meter summary plot after full life

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Table 4.5
2-inch meters meeting the AWWA registry standard

Meter type	No. of meters	Test flow	Meters passing AWWA standard at throughput				
			0 MG	3 MG	6 MG	9 MG	12 MG
2 ND	3	2	2	3	3	3	2
2 ND	3	15	2	2	2	3	2
2 ND	3	100	3	3	3	3	3
2 DP	3	2	2	3	3	2	3
2 DP	3	15	3	3	3	3	2
2 DP	3	100	3	3	3	3	2
2 MJ	4	2	3	3	3	3	3
2 MJ	4	8	2	2	3	2	2
2 MJ	4	100	1	1	1	2	1
2 SJ	2	0.5	2	2	2	1	2
2 SJ	2	2	1	2	2	2	2
2 SJ[A]	2	100	2	2	2	2	2
2 CL I TU[B]	2	15	2	2	2	2	0
2 CL I TU[C]	2	150	2	2	2	2	2
2 CL II TU	2	4	3	4	4	4	4
2 CL II TU[D]	2	150	3	3	3	3	3
2 PR[E]	1	100	0	0	0	0	0

[A] Single-jet high AWWA flow is 80 gpm which was not tested.
[B] Class I Turbine low AWWA flow is 16 gpm which was not tested.
[C] Class I Turbine high AWWA flow is 160 gpm which was not tested.
[D] Class II Turbine high AWWA flow is 160 gpm which was not tested.
[E] Propeller AWWA flows are between 35 and 100 gpm. 35 gpm was not tested.

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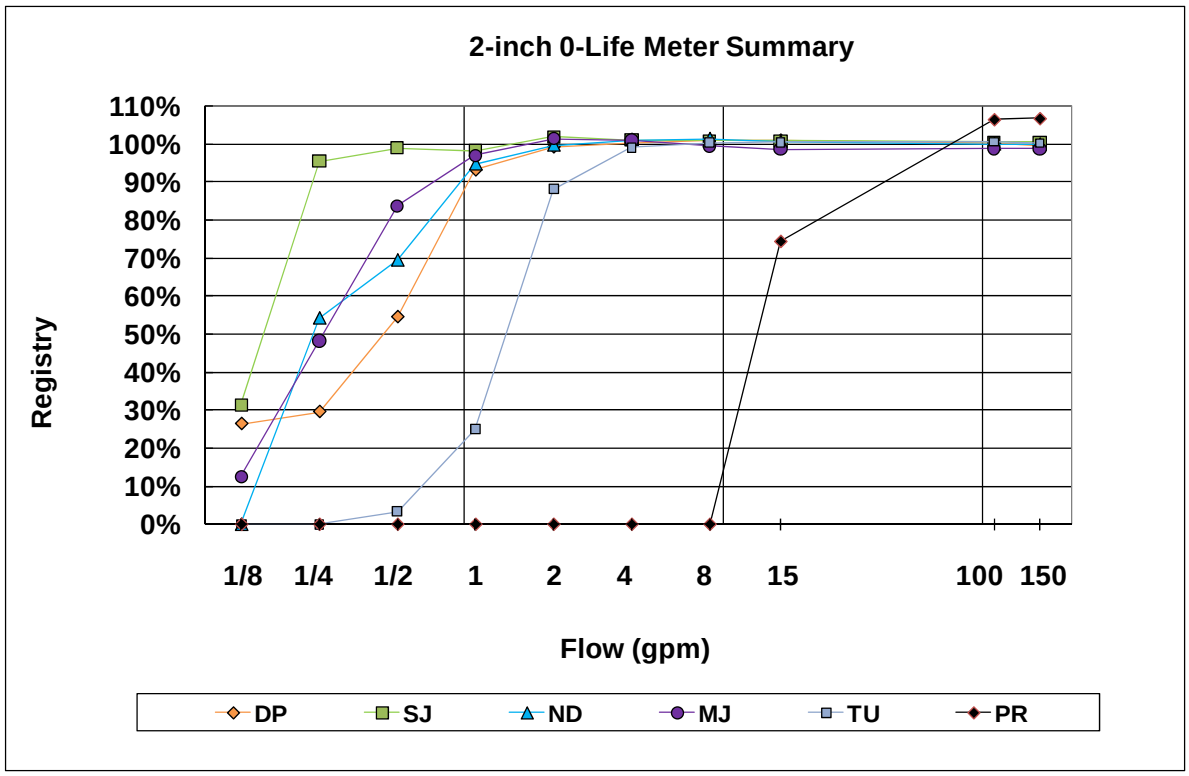

Figure 4.9 2-inch meter summary plot for new condition

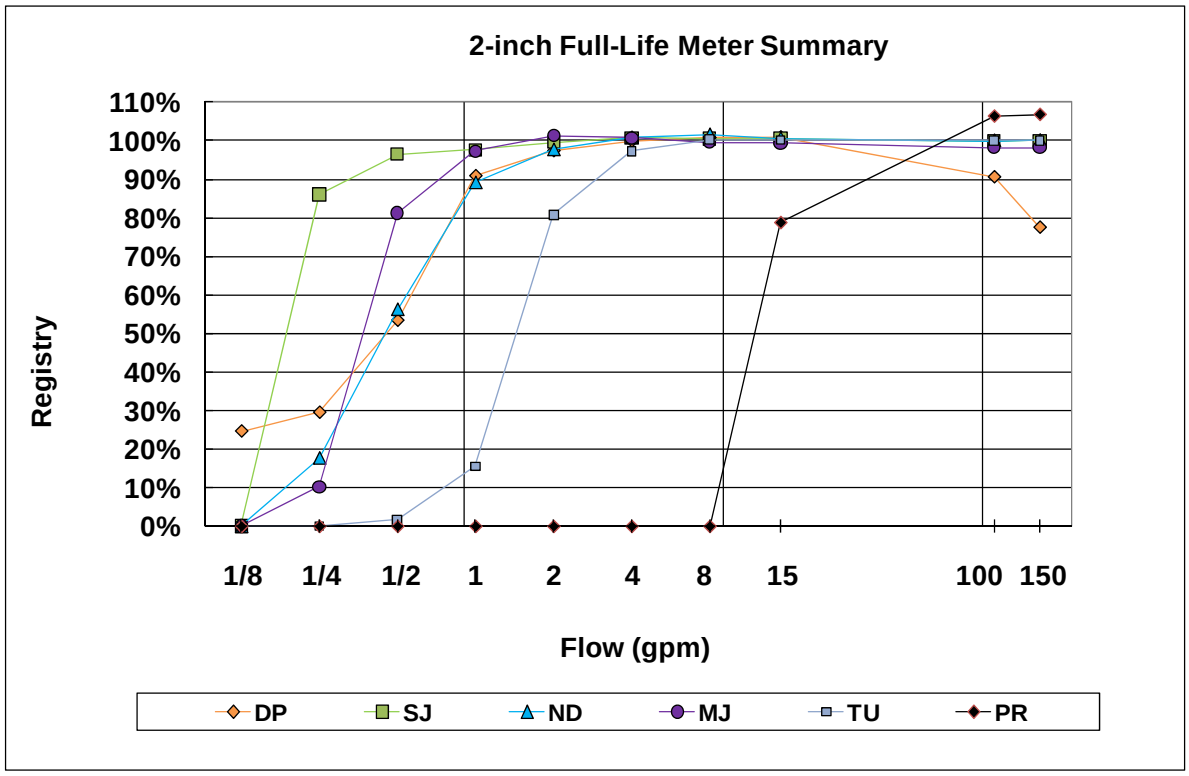

Figure 4.10 2-inch meter summary plot after full life

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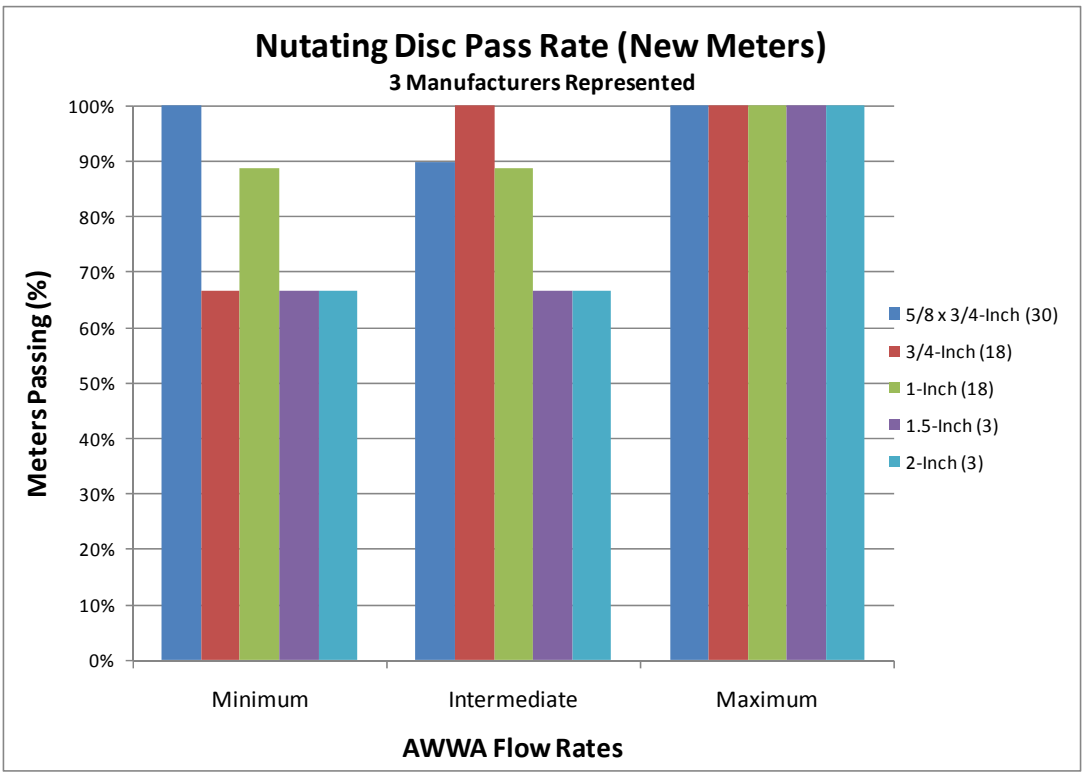

Figure 4.11 New nutating disc pass rates

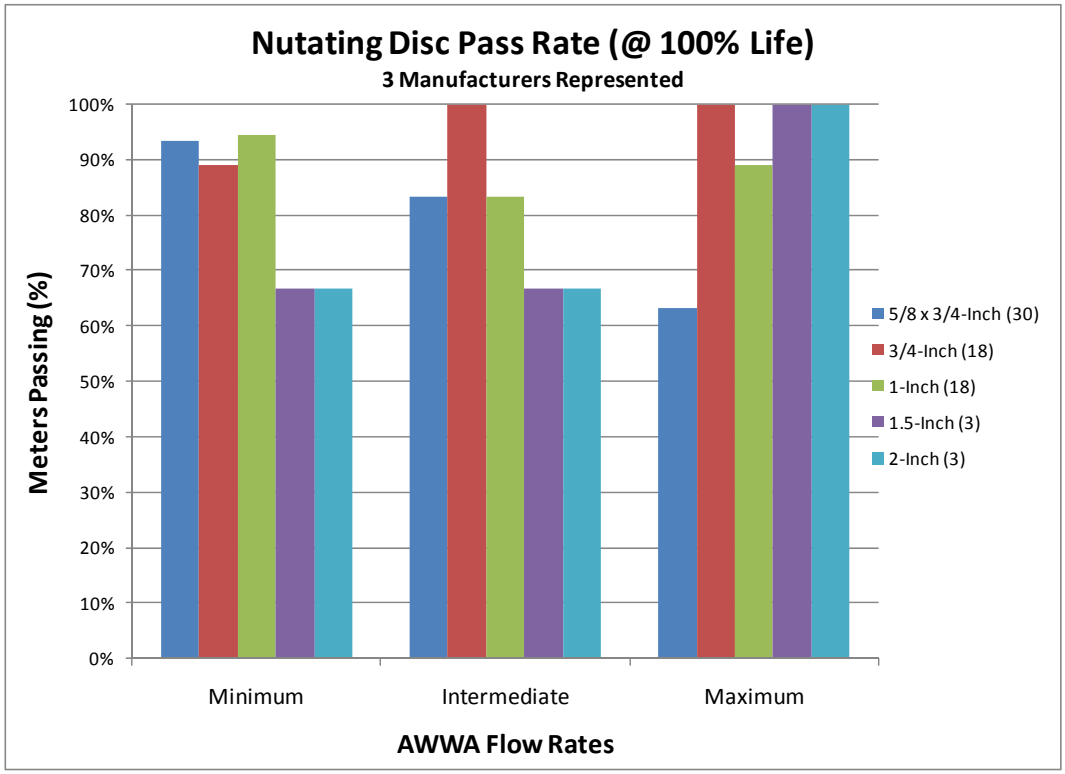

Figure 4.12 Nutating disc pass rates after 100% life cycle

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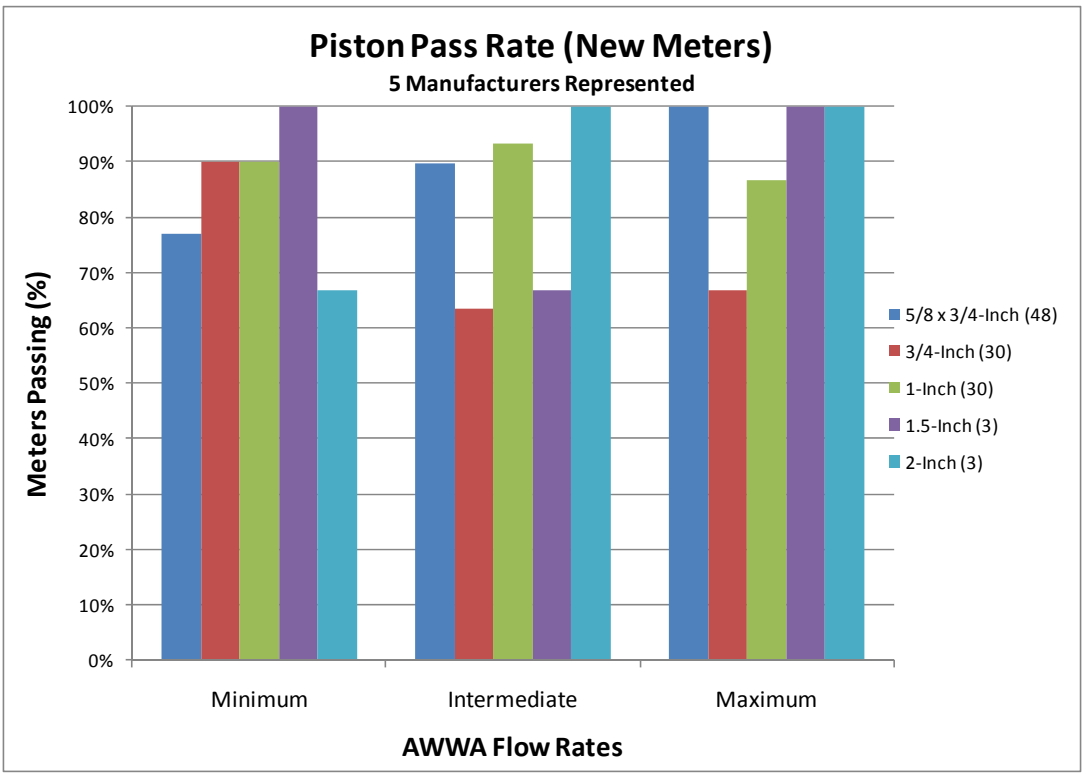

Figure 4.13 Meter piston pass rates

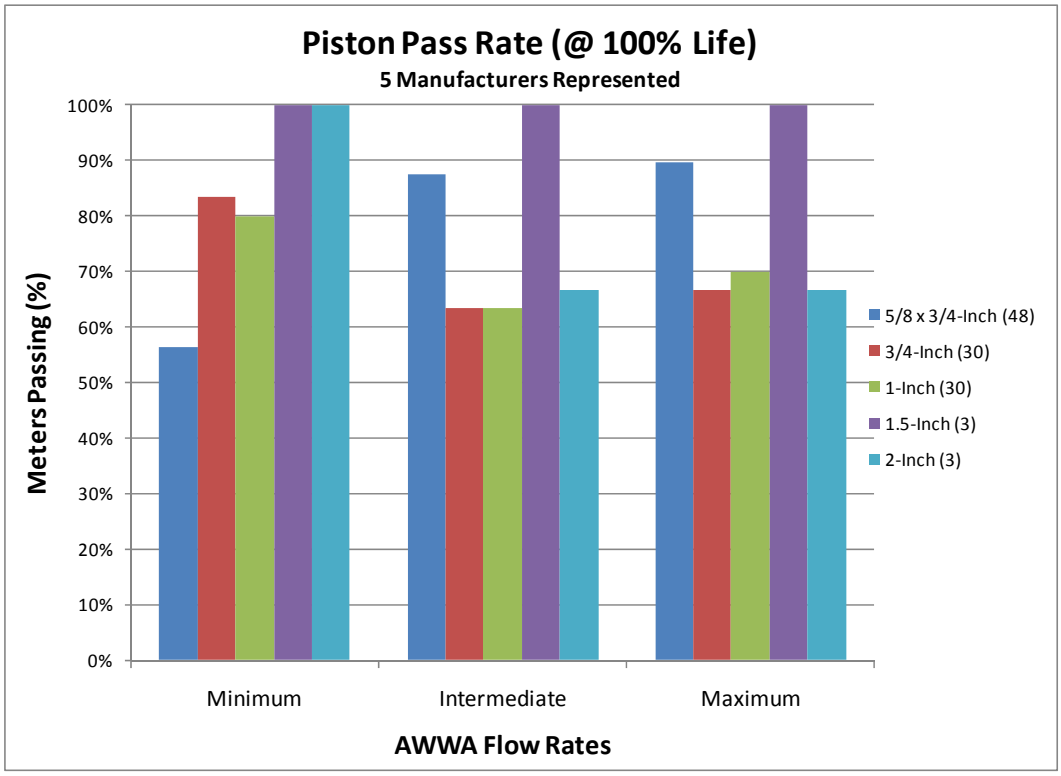

Figure 4.14 Piston pass rates after 100% life cycle

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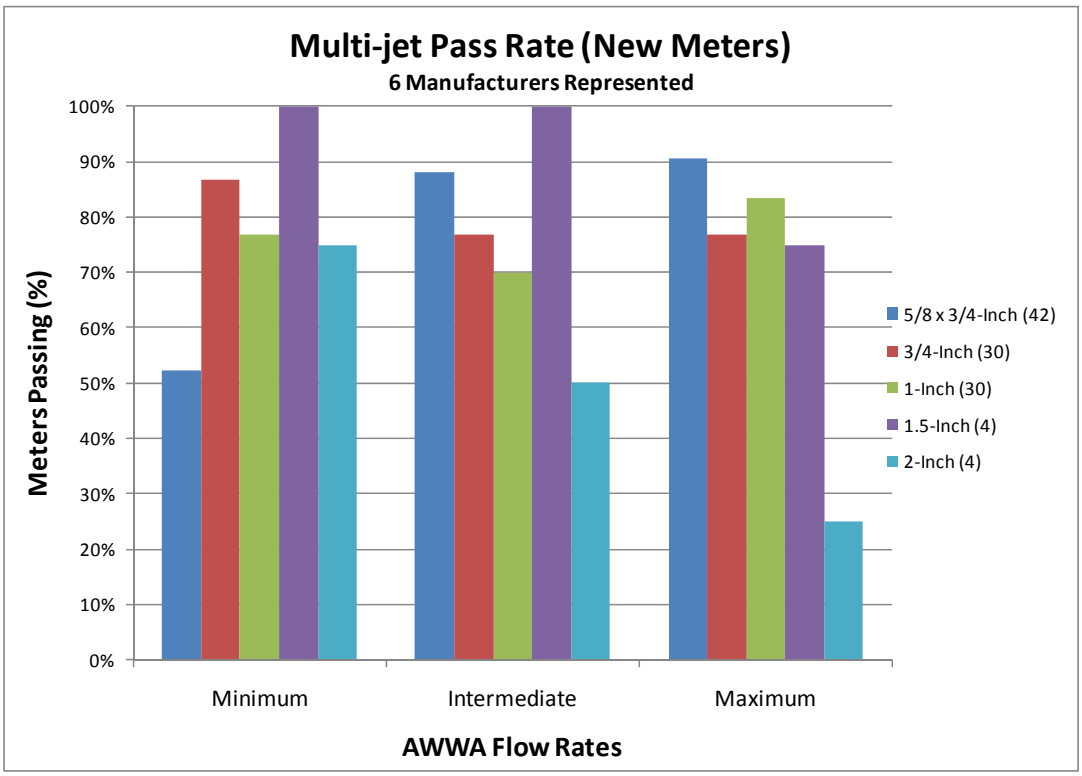

Figure 4.15 New multi-jet pass rates

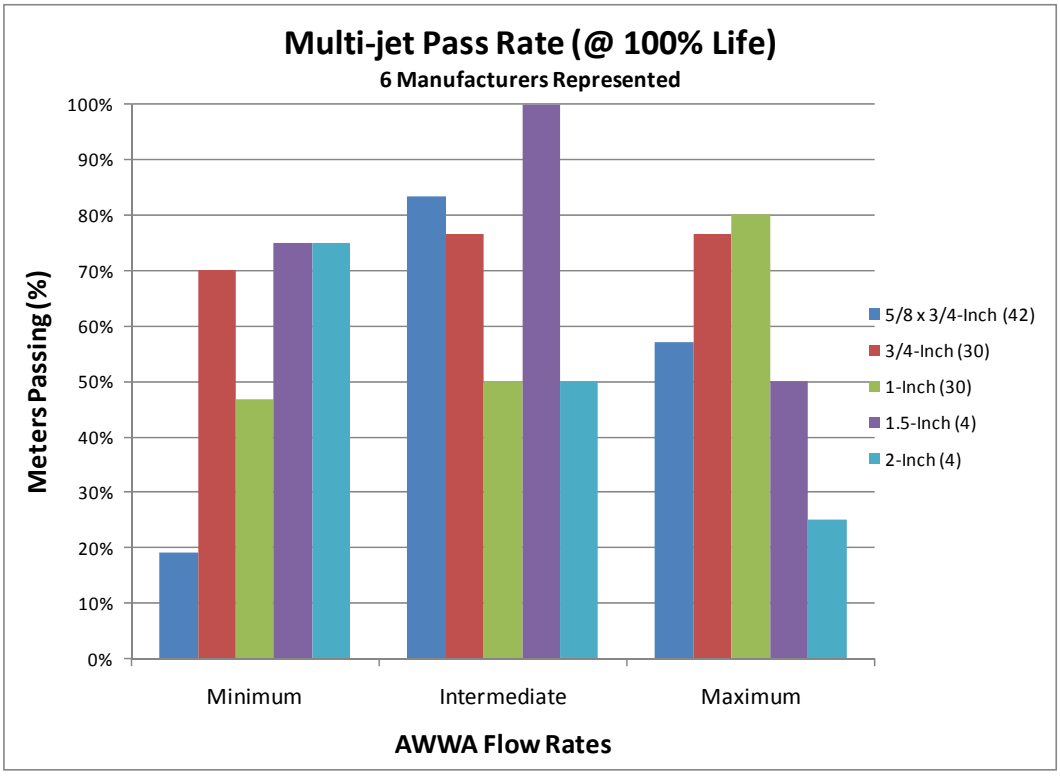

Figure 4.16 Multi-jet pass rates after 100% life cycle

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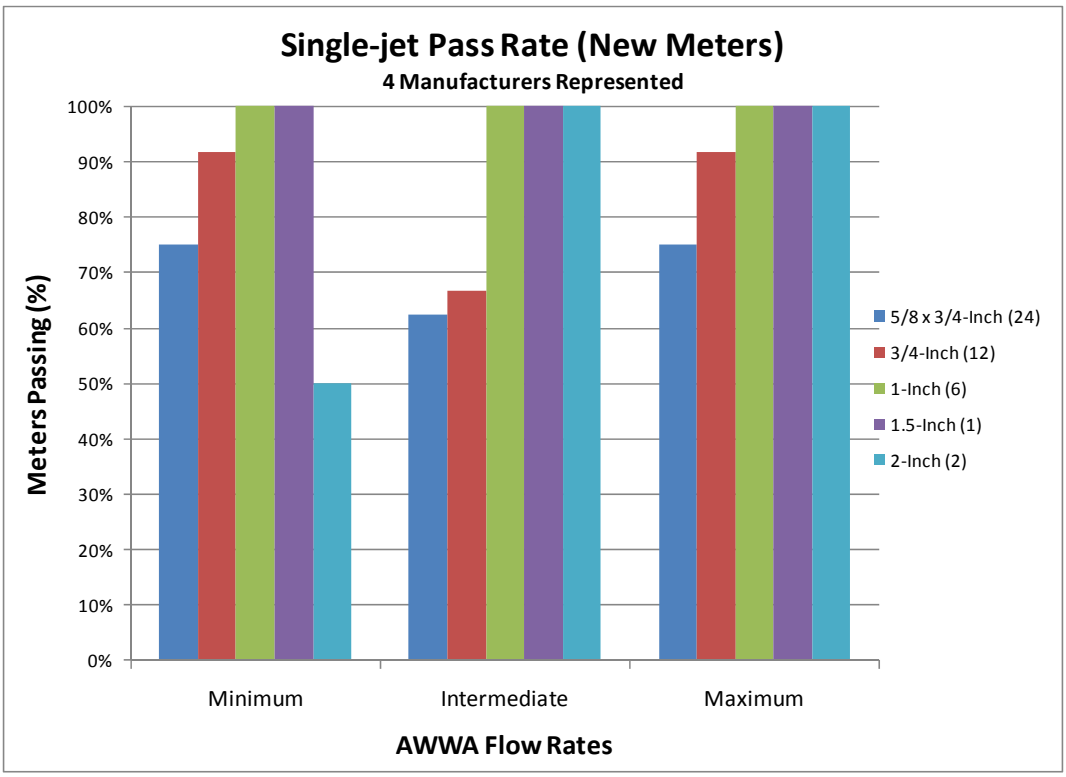

Figure 4.17 New single-jet pass rates

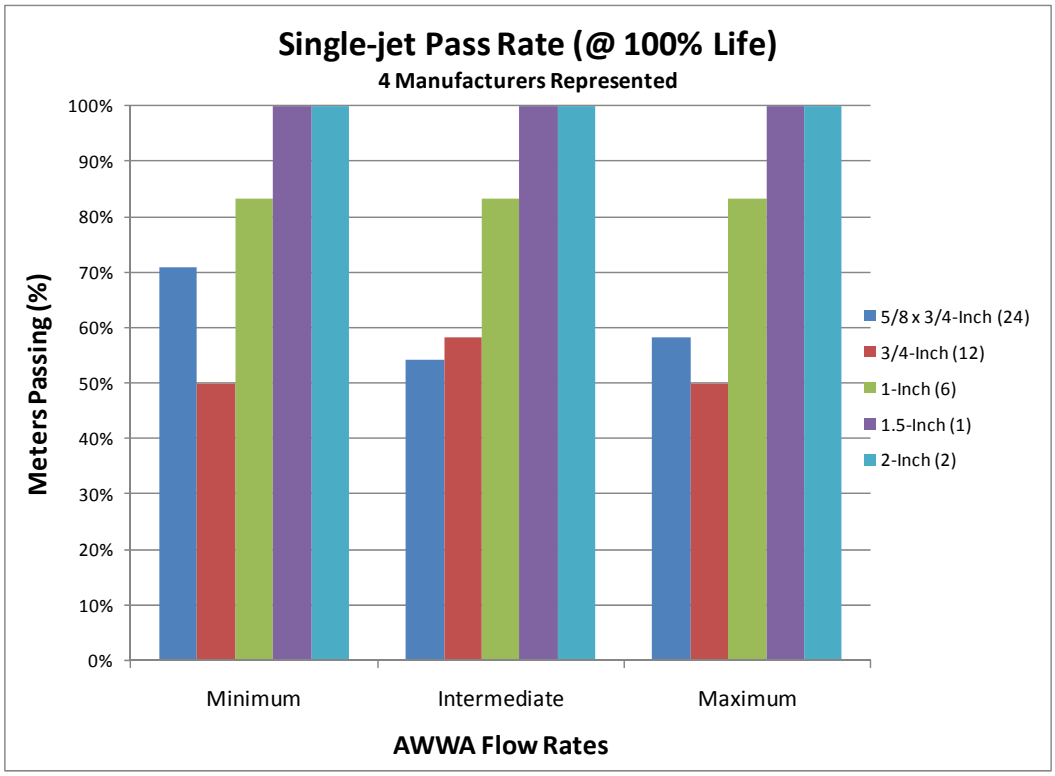

Figure 4.18 Single-jet pass rates after 100% life cycle

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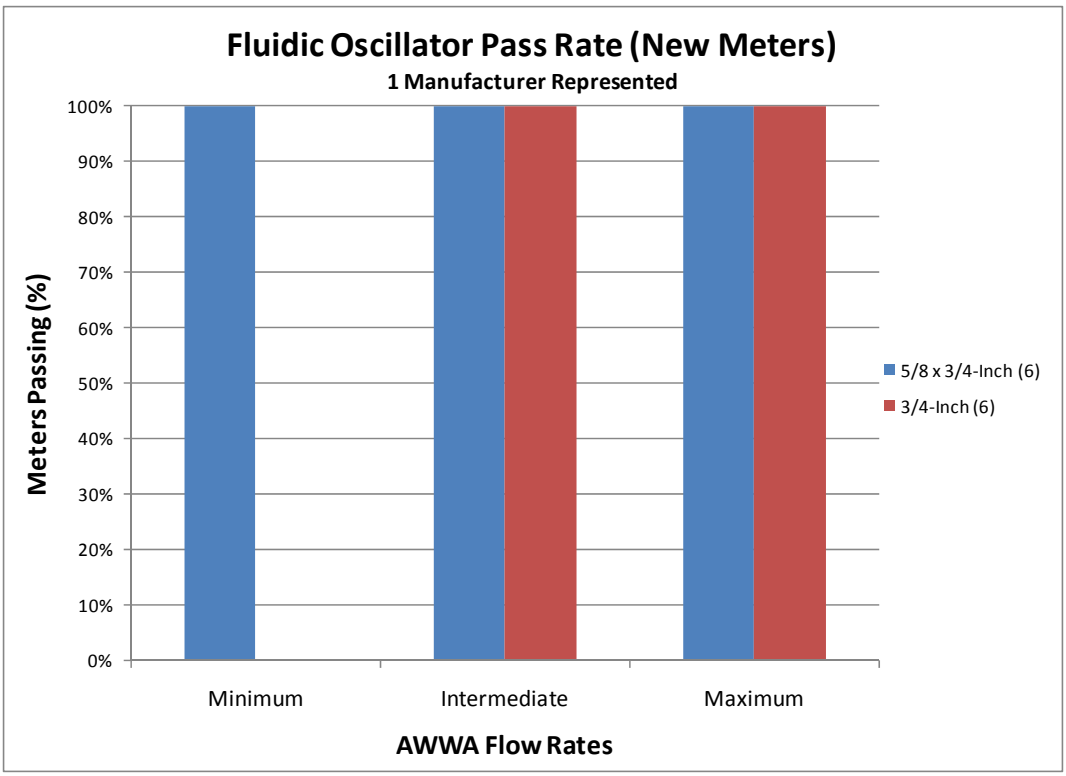

Figure 4.19 New fluidic oscillator pass rates

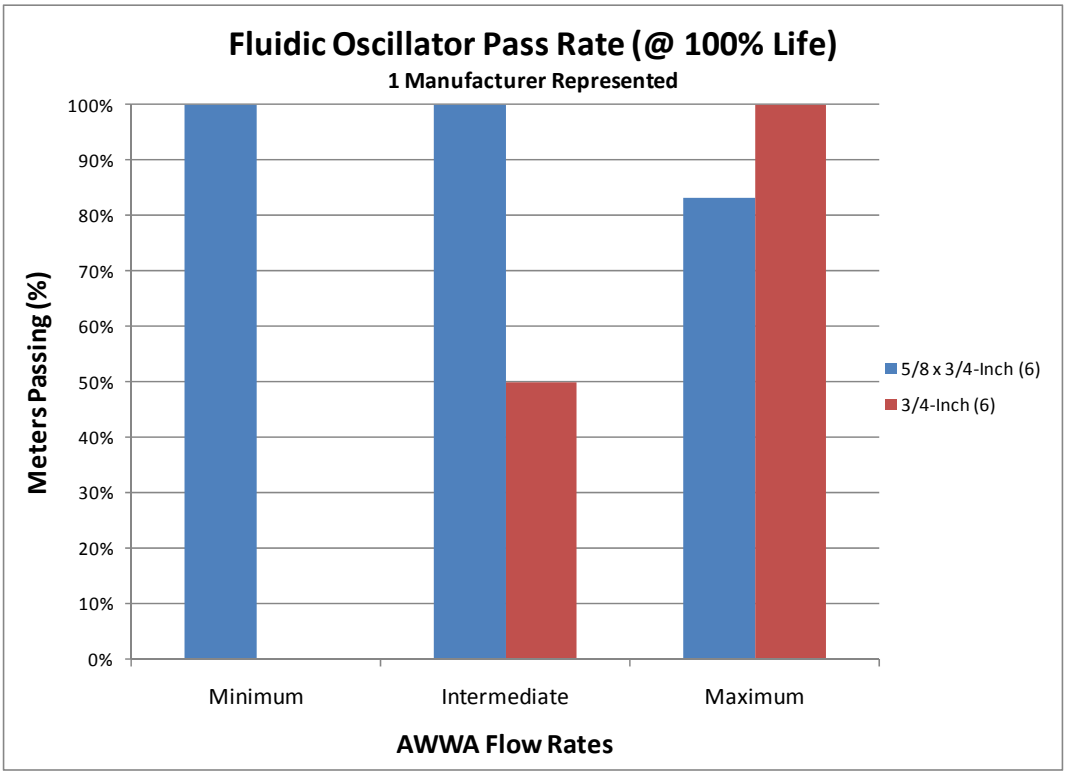

Figure 4.20 Fluidic oscillator pass rates after 100% life cycle

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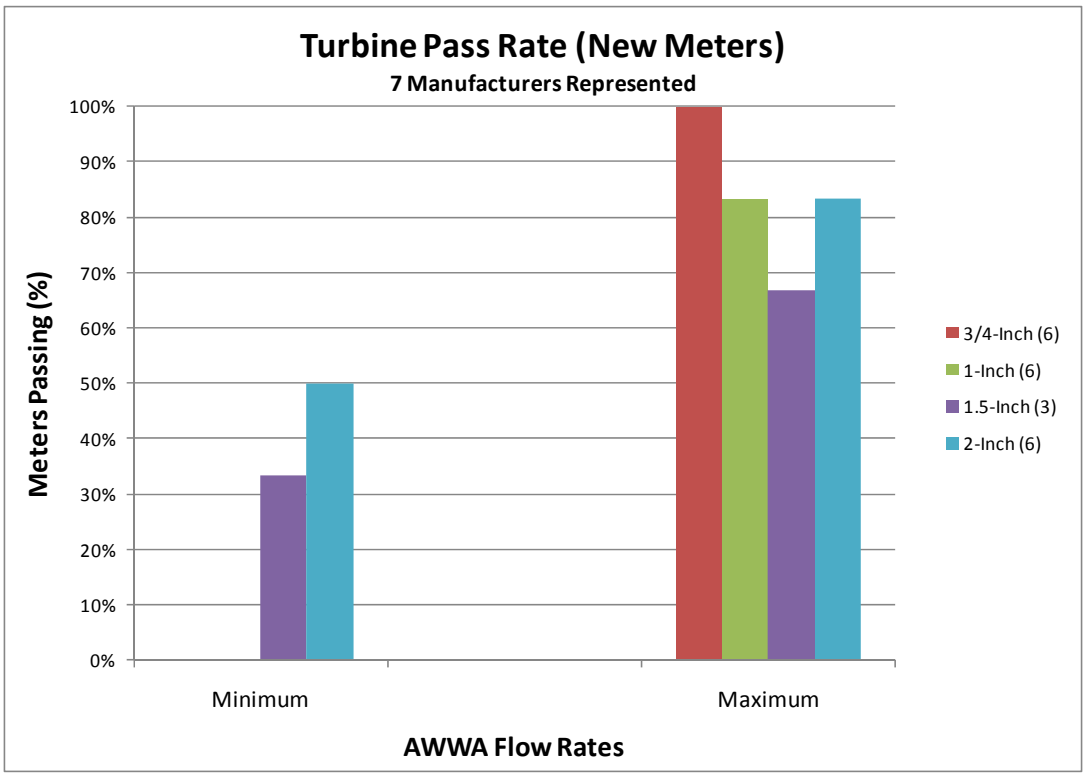

Figure 4.21 New turbine pass rates

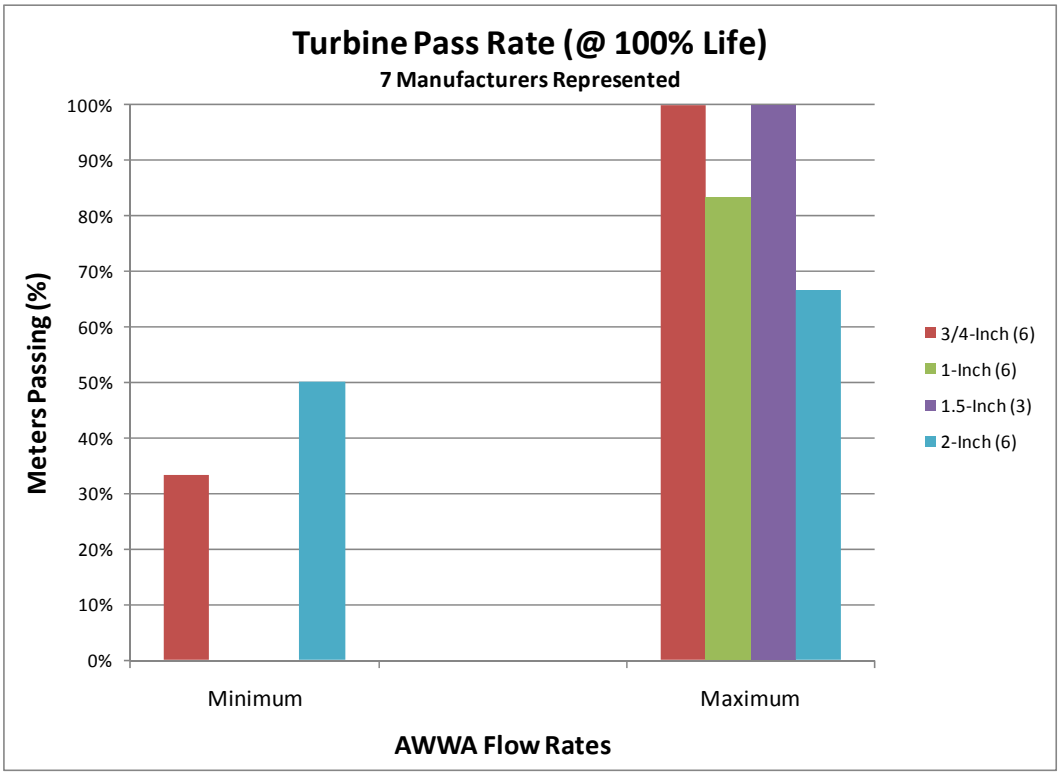

Figure 4.22 Turbine pass rates after 100% life cycle

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PHASE III: PULLED METER TEST CONCLUSIONS

Figures 4.23 through 4.27 are summary plots of the test results for all of the 595 pulled meters that were tested during the study. The number of meters represented by meter type is indicated in the legend of each plot. It can be noted that meter performance for the pulled meters is similar to meter performance of the new meters tested to full life of throughput. A significant number of meters that were donated by utilities were not functioning or did not register flow when they arrived at the Utah Water Research Laboratory. Figures 4.23 through 4.27 do not include these meters. Please note in Figure 4.26 that the average piston registry is very high due to a single meter that was reading over 170% registry at each flow (see Table B.12)

A significant number of meters that were donated by utilities were not functioning or did not register flow when they arrived at the Utah Water Research Laboratory. A nearly equal proportion of the piston meters (7%), the multi-jet meters (7.5%) and the nutating disc meters (5.7%) of the total donation were not functioning. Inquiries to the utilities confirmed that the pulled meters were randomly selected, so this non-functioning percentage may be typical for these three meter types.

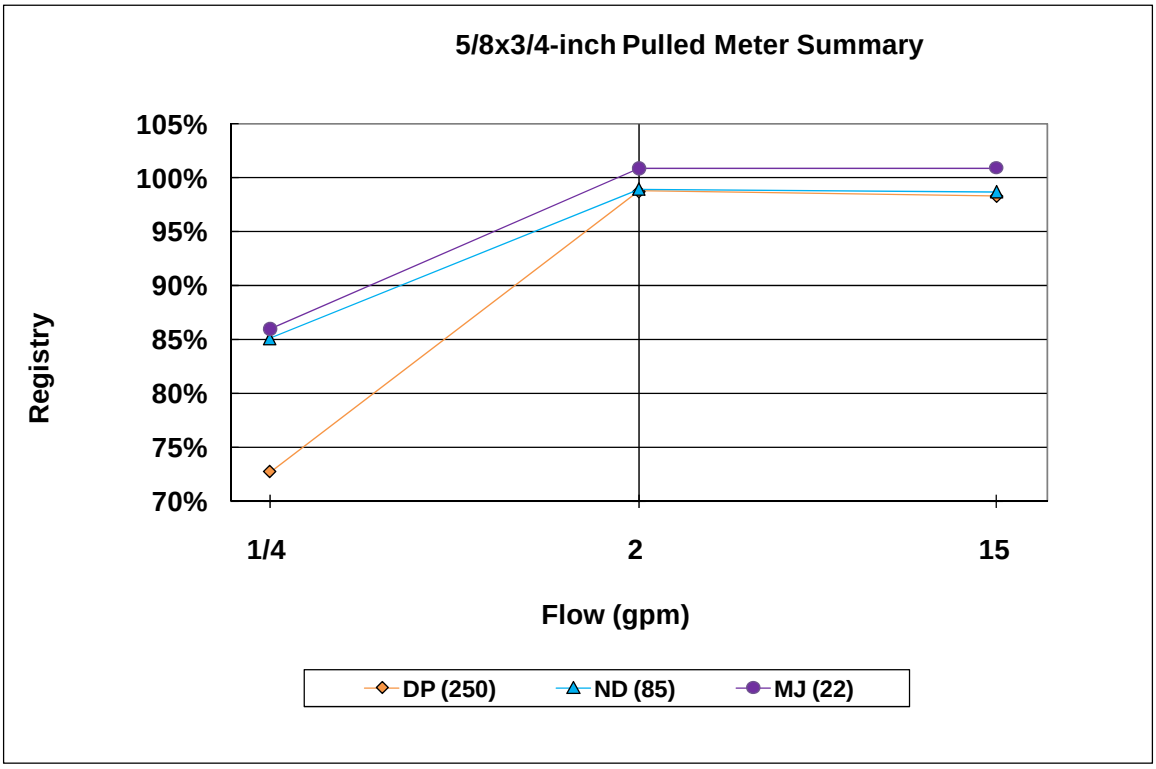

Figure 4.23 5/8 X 3/4-inch pulled meter summary plot.

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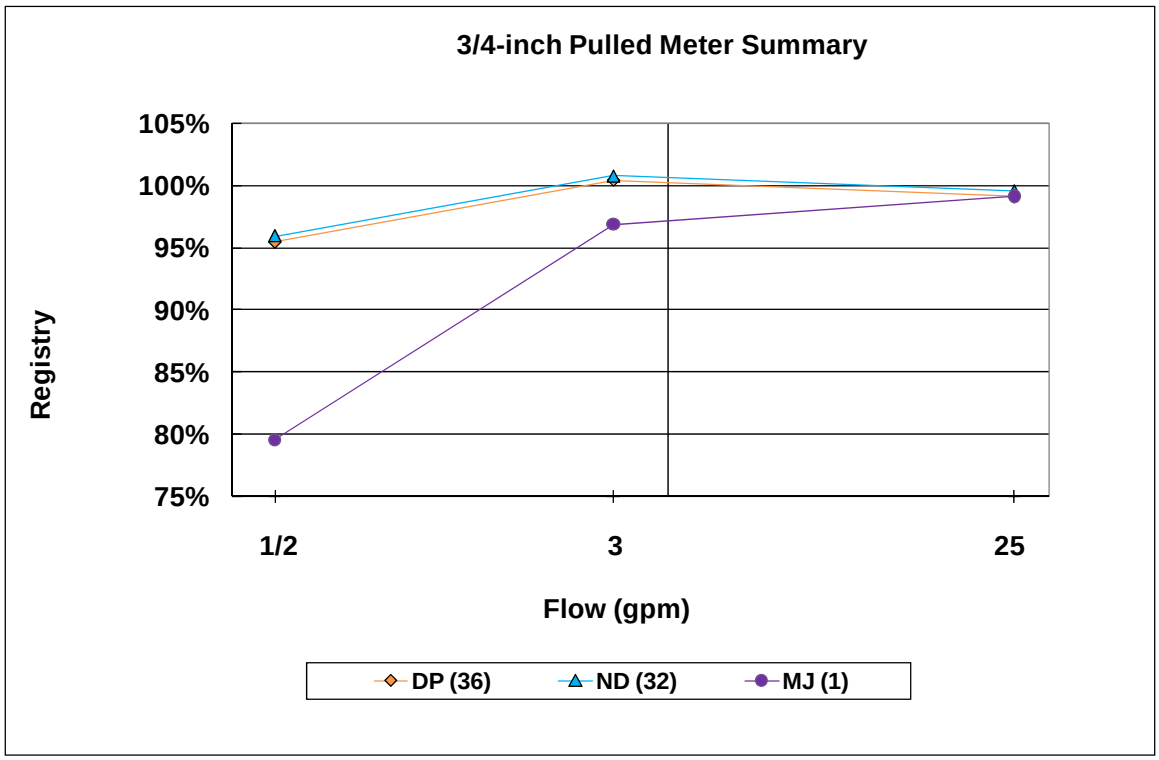

Figure 4.24 3/4-inch pulled meter summary plot.

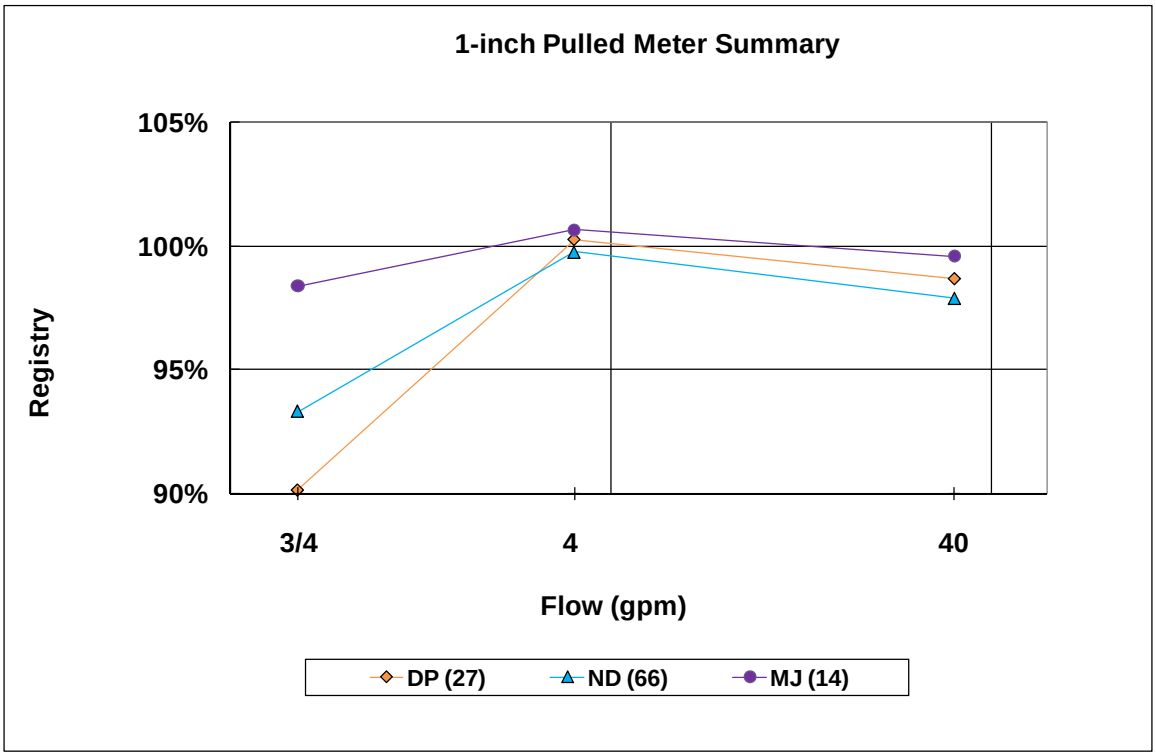

Figure 4.25 1-inch pulled meter summary plot

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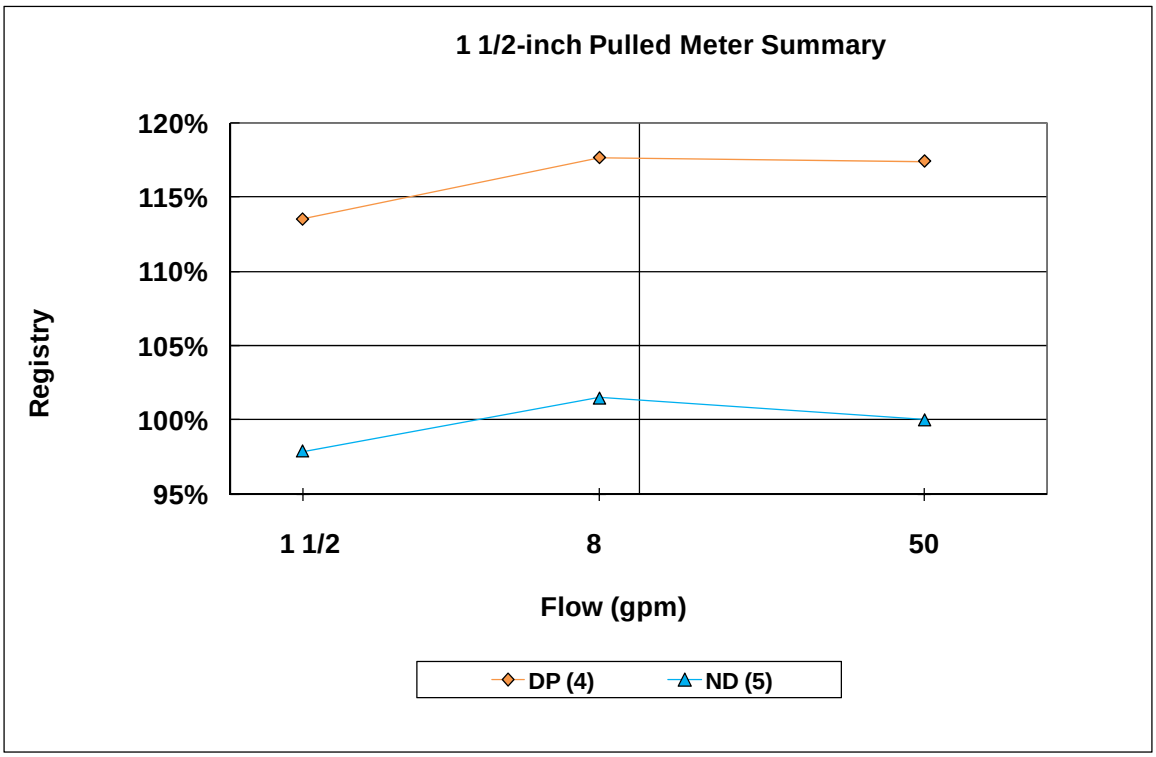

Figure 4.26 1 1/2-inch pulled meter summary plot

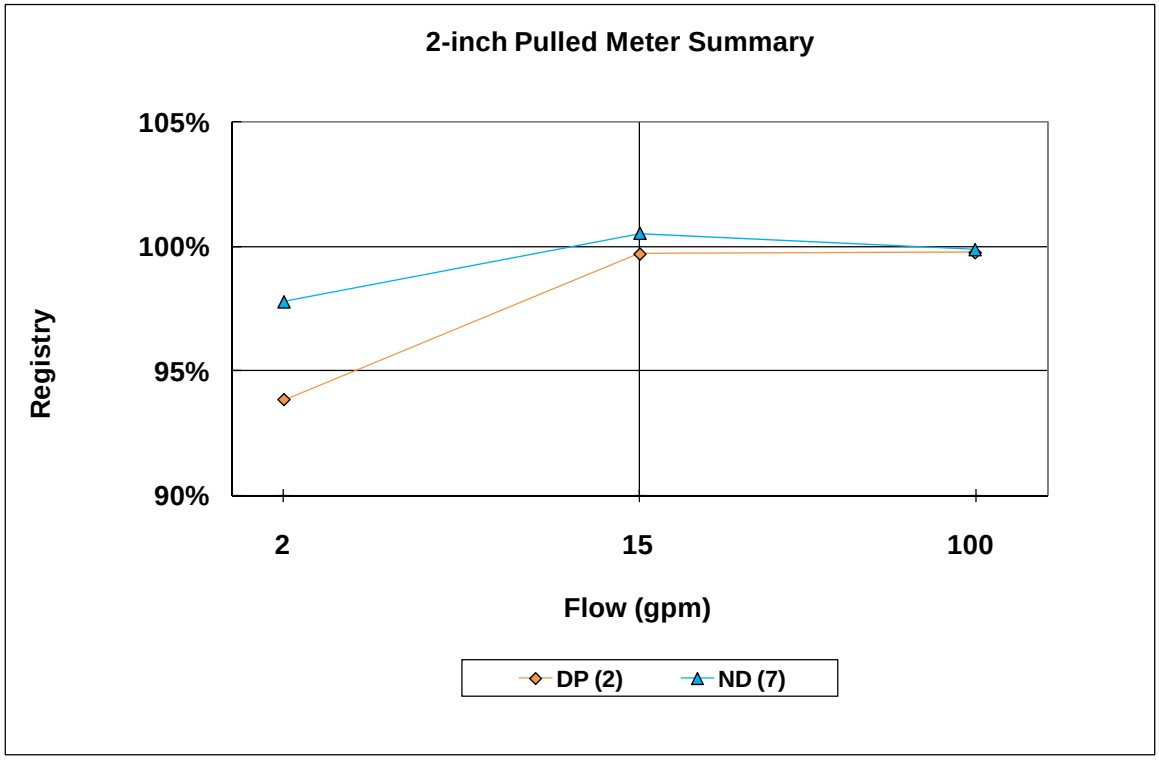

Figure 4.27 2-inch pulled meter summary plot

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Figures 4.28 through 4.32 provide examples of some of the more severe wear patterns noted during disassembly of meters that were pulled and donated by U.S. utilities. Although generally there was very little correlation between wear and registry accuracy noted, the disassembly of specific meters produced some very interesting results.

For example, when the 5/8 x 3/4-inch nutating disc meter in Figure 4.28 was disassembled, it was noted that the interior gasket was severely deteriorated. Accuracy test results indicated that there may have been leakage through the gasket as the AWWA low flow accuracy was significantly affected (1/4gpm: 78.42%, 2gpm: 99.53% and 15gpm: 98.34%).

Figure 4.28 Nutating disc - deteriorated gasket

When the 5/8 x 3/4-inch piston meter in Figure 4.29 was disassembled, it was noted that the magnet did not have an integral connection with the metering device. Consequently, the AWWA maximum flow rate was significantly affected during the accuracy tests due to the magnet decoupling from the odometer at high flows (1/4gpm: 95.49%, 2gpm: 101.13% and 15gpm: 88.50%).

Interestingly, the 5/8 x 3/4-inch piston meter in Figure 4.30, which had a severely worn lower bearing, produced registries that were higher than the AWWA standard at the intermediate and maximum flow rates (1/4gpm: 96.16%, 2gpm: 101.98% and 15gpm: 102.12%).

And when the 5/8 x 3/4-inch piston meter in Figure 4.31 was disassembled, severe scarring was noted on and within the metering device. Consequently, only the AWWA minimum flow rate was adversely affected (1/4gpm: 89.47%, 2gpm: 99.83% and 15gpm: 98.38%).

And finally, when the 1-inch piston meter in Figure 4.32 was disassembled, it was uniformly coated with scale and other water deposits. It is clear from the accuracy tests that the

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low flow accuracy was significantly affected for this meter (3/4gpm: 63.23%, 4gpm: 98.07% and 40gpm: 98.13%).

Figure 4.29 Piston - detached magnet

Figure 4.30 Piston - lower bearing wear

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Figure 4.31 Piston - meter device scarring

Figure 4.32 Piston - scale buildup

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Figures 4.33 through 4.36 are examples of some of the debris that was found within the pulled meters. When the 1-inch piston meter in Figure 4.31 was disassembled, a large amount of sand and small-sized gravel was found. Consequently, all of the accuracy tests failed to pass the standard AWWA requirements (3/4gpm: 0%, 4gpm: 89.48% and 40gpm: 92.98%).

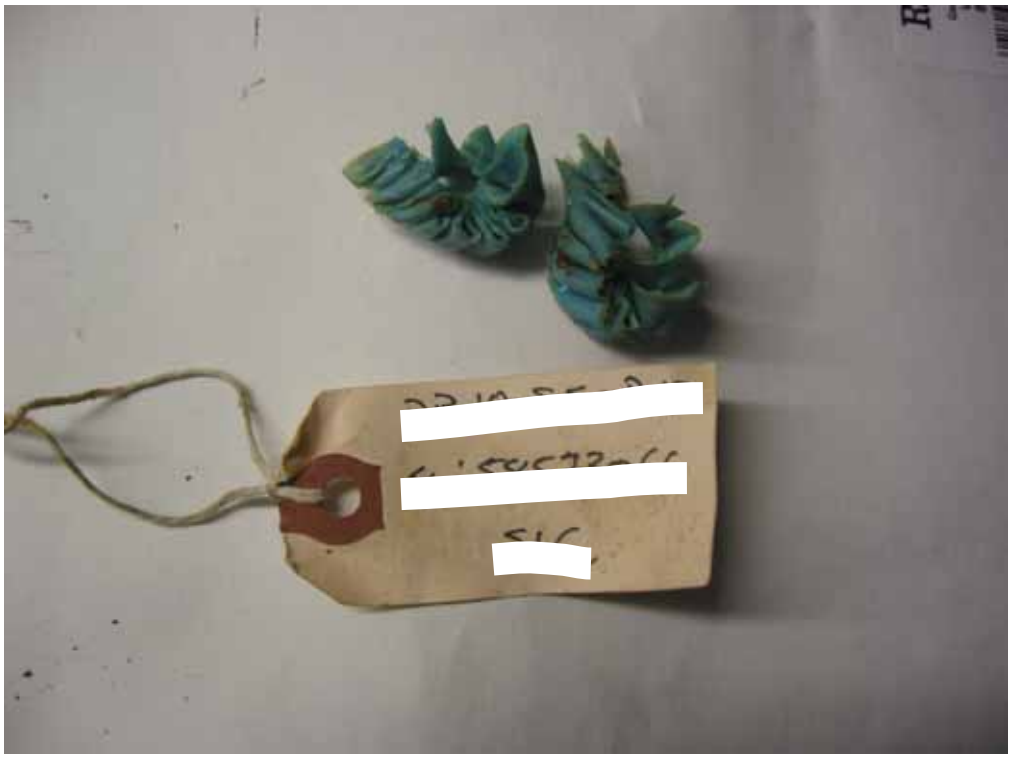

Figure 4.33 PVC pipe shavings

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Figure 4.34 Gasket material

Figure 4.35 Steel pipe corrosion

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Figure 4.36 Sand and gravel

It is concluded that, although some extreme examples of wear and debris (as illustrated in Figures 4.23 though 4.31) were noted during disassembly of the pulled meters, generally, most of the pulled meters that were tested during this project maintained a similar level of registry accuracy as compared to the laboratory endurance-tested meters of the same type and size. This indicates that the endurance testing performed in the laboratory during this study appropriately simulated meter accuracies from "real world" meters operating in culinary water systems of the United States. Figures 3.153 through 3.198 are plots of the data. These plots present the data for each meter test in terms of the relationship between meter registry and service time, throughput, throughput/time, and a problem index. It should be noted that each figure has three linear regressions and that the regressions do not indicate a significant relationship between the variables listed and the registry. Aside from a few of the regressions for the larger sized meters from which the number of meters tested in the sample size is extremely small, the R^2 values on the regression equations are usually very close to zero, indicating that the data is quite random in nature and that no significant correlation between the plotted variables is present. The figures do indicate, however, a general declination in registry accuracy at the AWWA minimum flow rate. This finding is very similar to the laboratory endurance tests for the new meters.

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PHASE III: PARTICULATE TESTING CONCLUSIONS

Figures 4.37 through 4.39 graphically illustrate the particulate testing data for the seventy-five 5/8 x 3/4-inch new meters at three conditions: when the meter was in the new condition (before sand introduced), immediately after the meter was subjected to the slug of sand particulates (after sand introduced), and at the end of the full life endurance life cycle. The figures are very informative in understanding the effects of the particulate slug of sand on the meters.

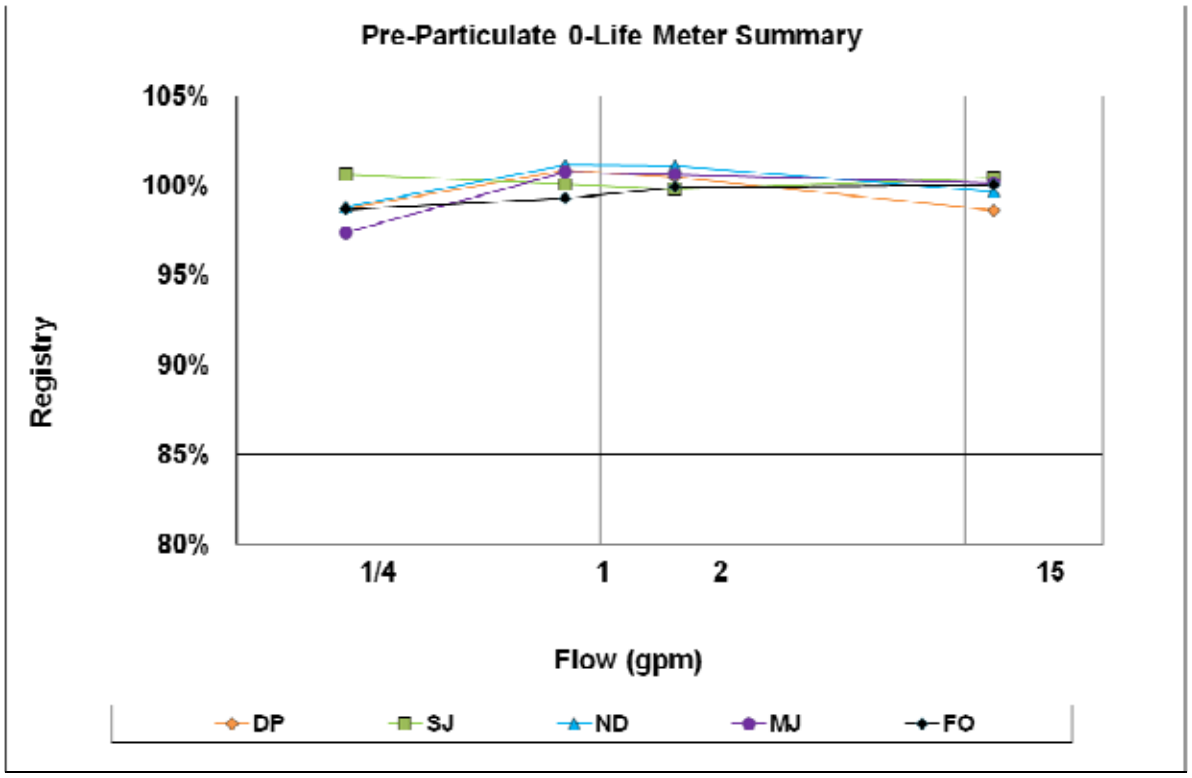

Figure 4.37 5/8 X 3/4-inch particulate meter summary plot for new condition

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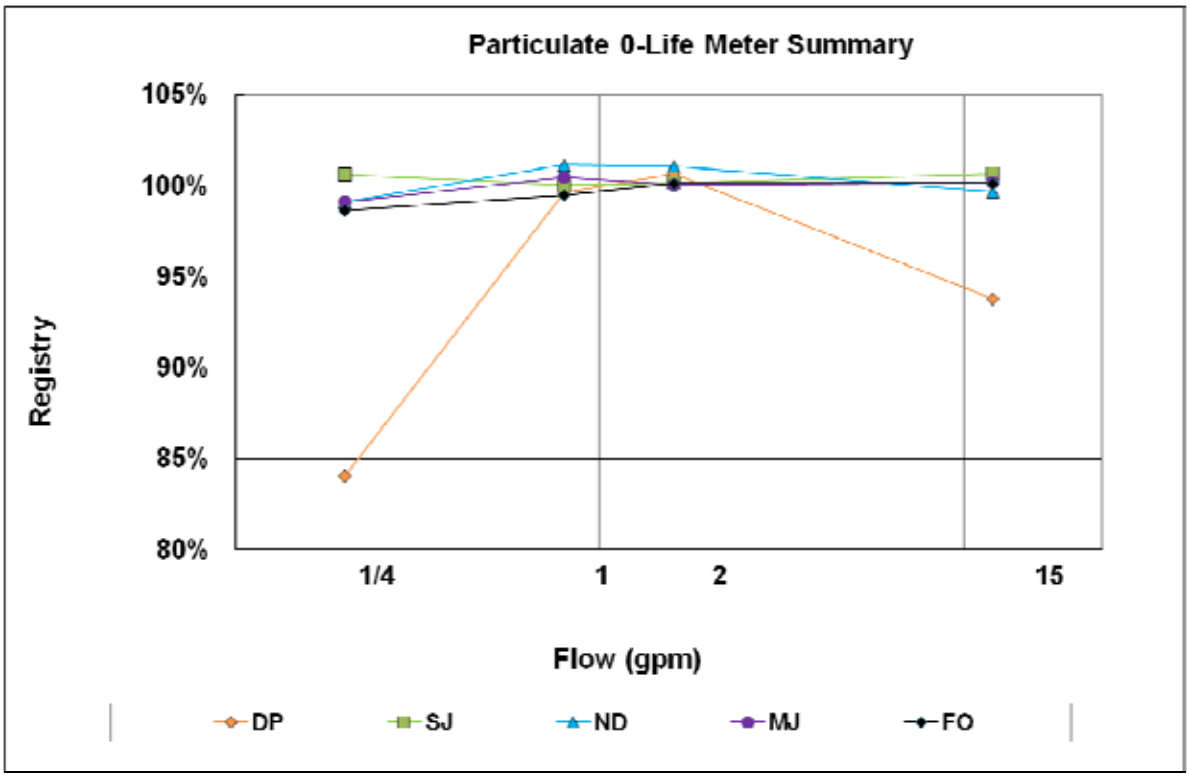

Figure 4.38 5/8 X 3/4-inch particulate meter summary plot immediately after sand injection

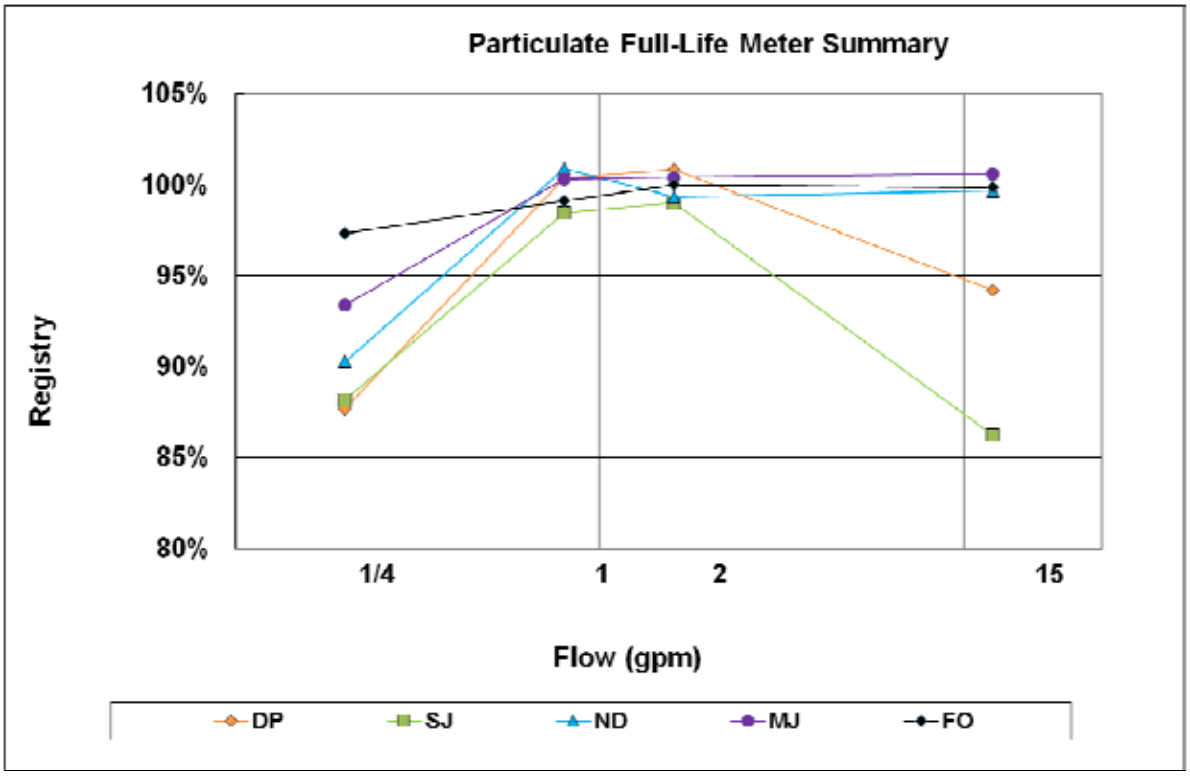

Figure 4.39 5/8 X 3/4-inch particulate meter summary plot for full life condition

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The following is a summary of a few of the more significant findings of the Phase III component 3 of this study.

1. The study indicated that allowing a 2.5gram slug of quartzite sand to pass through a new meter initially affected the piston meter type the most. Figures 3.206 and 3.207 show the new meter piston data immediately before and immediately after the slug of sand was allowed to pass through the meter. This same comparison indicated an insignificant effect on the other meter types when comparing the new "before sand introduced" and the "after sand introduced" new meter accuracy.
2. The study indicated that the multi-jet and fluidic oscillator type meters were best able to tolerate the effects of sand passing through them over the course of a full life cycle of throughput. Figures 3.213 through 3.219 and Figures 3.227 through 3.233 illustrate that essentially no change occurred in the meter accuracy of these two meter types over the course of a full life cycle after sand was injected through the meters.
3. Figure 4.40 is an example of how the scarring patterns associated with passing sand through the meters does not necessarily degrade the registry accuracy after a full life cycle of throughput. The accuracies for this 5/8 x 3/4-inch piston meter all met the standard AWWA requirement at the 100% life test (1/4gpm: 100.26%, 2gpm: 100.43% and 15gpm: 99.95%).
4. The 5/8 x 3/4-inch nutating disc meter in Figure 4.41 was also minimally affected by the sand and subsequent scarring (1/4gpm: 96.68%, 2gpm: 100.75% and 15gpm: 99.87%).
5. However, the low flow accuracy for the specific 5/8 x 3/4-inch multi-jet meter shown in Figure 4.42 was significantly affected by bearing wear (1/4gpm: 0.1%, 2gpm: 98.15% and 15gpm: 99.66%).

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Figure 4.40 Piston - meter chamber scarring

Figure 4.41 Nutating disc - meter bearing scarring

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Figure 4.42 Multi-jet - lower bearing wear

New Meters Meeting the AWWA Accuracy Standard Before and After Sand Introduction

As shown in the figures previously presented, many meters do not meet the AWWA standard. Table 4.6 shows the meter type and the number of meters meeting the standard in the new condition and the number of meters meeting the standard after passing sand and at various throughput benchmarks.

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Table 4.6
Meters passing the AWWA standard before and after sand introduction

Meter type	No. of meters	AWWA flow	Meters passing AWWA standard at throughput					
			0 MG	0 MG[A]	0.5 MG	1 MG	1.5 MG	2 MG
5/8x3/4 ND	15	0.25	15	15	13	13	11	11
5/8x3/4 ND	15	2	12	12	15	14	15	9
5/8x3/4 ND	15	15	15	15	14	15	15	15
5/8x3/4 DP	24	0.25	21	11	13	10	11	11
5/8x3/4 DP	24	2	23	19	20	19	18	18
5/8x3/4 DP	24	15	21	21	21	23	22	21
5/8x3/4 MJ	21	0.25	11	15	16	15	14	17
5/8x3/4 MJ	21	1	16	18	18	17	16	15
5/8x3/4 MJ	21	15	17	18	16	14	15	14
5/8x3/4 SJ	12	0.25	9	8	11	6	6	4
5/8x3/4 SJ	12	2	9	8	9	9	9	5
5/8x3/4 SJ	12	15	11	10	10	7	7	6
5/8x3/4 FO	3	0.25	3	3	3	3	3	3
5/8x3/4 FO	3	2	3	3	3	3	3	3
5/8x3/4 FO	3	15	3	3	3	3	3	3

[A]After particulate introduction.

OTHER GENERAL CONCLUSIONS

When comparing the new meter tests associated with Phase II with the new meters associated with Phase III/Component 3, some of the results appear to differ. Because the Phase II new meter set contained a larger quantity of meters than the Phase III/ Component 3 new meter set, there was a greater potential for outliers in the Phase III/ Component 3 new meter set to negatively affect the average. It should be noted any that apparent differences in the new meter accuracy data between these two phases of work are a result of 1 or 2 meters that performed poorly, thus pulling the average for the entire data set down.

NEED FOR FURTHER RESEARCH

The research team has noted four research needs that if completed with further research will strengthen the findings contained in this report. Essentially, the need is either an extension of the original research objectives for this project or has been noted as a significant finding in the results contained in this report and further investigation is desired.

1. After having tested the fluidic oscillator type meter, which at the commencement of this study was the only solid state meter commercially available for residential culinary use in the United States, it has been noted that a testing program of all Solid State Meters (ultrasonic, magnetic, fluidic oscillator, etc.) is desired to determine

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accuracy and use limitations and to help develop metering standards for these types of meters. With battery life improving and initial cost for these kinds of meters reducing, the demand to use this technology as a small residential meter is also increasing. A comprehension testing program would provide a springboard for these technologies to be incorporated into the United States culinary metering marketplace.

2. It was originally anticipated that the results from this report would be useful in helping utilities approximate the appropriate time to replace meters so that revenues are maximized, yet no statistically significant correlations were found during the study after analyzing the pulled meter data. A closer investigation of meter degradation with age and throughput using larger sample sizes of the same meter make and model is desired. Incorporated with this research would also be the development of an economic model for utility meter replacement programs as a function of meter accuracy and meter accuracy degradation.
3. Research is needed that documents field installations and flow conditions that produce erroneous meter reading. As an example, some meter types are susceptible to registering flow when surges or transients in the system are present even when there is no flow in the pipe. This phenomenon was noted for certain meter types during the project.
4. Since it is apparent that a significantly large number of new meters do not pass the required AWWA standard flow rates for accuracy, additional research is necessary to more carefully document the limitations of the different meter types. It would be very useful to have a testing program that investigates the accuracy of the most common meter sizes in much larger sample sizes so that comprehensive statistical conclusions can be made on the accuracy of specific new meter types. If, for example, 100 identical new 5/8 x 3/4-inch nutating disc type meters were tested at 8 different flow rates and compared to 100 identical new 5/8 x 3/4-inch piston type meters (also tested at the same 8 different flow rates), a much better statistical comparison between the two meter types could be achieved than what is presented within this report.

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APPENDIX A – ACCURACY AND ENDURANCE TESTING

ACCURACY AND ENDURANCE TESTING 5/8X3/4-INCH METERS

Table A.1
Raw data for 5/8x3/4-inch meters at 0 life

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
DP	56	0.00%	0.00%	9.83%	93.35%	98.75%	101.10%	101.00%	99.92%	99.03%	98.89%
DP	57	0.00%	0.00%	86.49%	95.33%	99.24%	101.10%	100.01%	100.90%	99.08%	98.94%
DP	58	0.00%	0.00%	57.00%	91.87%	96.79%	99.64%	101.00%	100.41%	99.42%	99.39%
DP	131	0.00%	0.03%	0.00%	84.74%	95.80%	99.98%	100.97%	100.14%	99.59%	99.55%
DP	132	0.00%	0.07%	0.00%	10.91%	93.35%	99.98%	99.50%	101.43%	99.44%	99.31%
DP	133	0.00%	0.10%	79.27%	94.68%	99.24%	100.48%	100.87%	101.03%	99.61%	99.62%
DP	38	0.00%	0.00%	90.91%	96.81%	99.24%	100.12%	100.51%	100.41%	99.92%	99.25%
DP	39	0.00%	0.00%	84.03%	92.86%	97.77%	98.67%	100.51%	99.92%	99.92%	99.35%
DP	40	0.22%	0.00%	22.60%	92.86%	97.28%	100.12%	101.00%	100.41%	99.92%	99.20%
DP	113	0.00%	0.03%	38.35%	95.04%	98.26%	99.98%	100.87%	100.53%	100.06%	99.85%
DP	114	0.00%	1.74%	79.27%	93.97%	98.26%	99.49%	100.77%	100.33%	100.18%	99.95%
DP	140	0.00%	0.10%	0.00%	95.39%	99.34%	99.98%	100.67%	100.33%	100.22%	100.05%
DP	50	0.21%	0.00%	0.00%	84.96%	93.86%	97.69%	99.52%	99.92%	99.08%	98.01%
DP	51	0.00%	0.00%	0.00%	85.95%	93.86%	96.72%	99.52%	98.94%	99.57%	99.48%
DP	52	0.20%	0.00%	0.00%	85.45%	94.84%	98.67%	99.52%	100.41%	99.67%	99.53%
DP	125	0.00%	0.00%	0.44%	90.51%	96.29%	99.49%	100.77%	100.63%	100.12%	100.08%
DP	126	0.00%	0.14%	72.25%	90.51%	96.78%	99.49%	100.28%	100.83%	99.33%	100.17%
DP	127	0.00%	0.07%	0.00%	88.74%	95.31%	99.49%	99.79%	100.43%	99.87%	99.75%
DP	53	0.00%	0.00%	0.00%	84.46%	92.68%	99.15%	101.49%	101.00%	99.96%	11.04%
DP	54	0.00%	0.00%	0.00%	5.93%	92.88%	99.15%	100.51%	101.39%	99.96%	99.78%
DP	55	0.00%	0.00%	0.00%	83.97%	94.84%	99.15%	101.00%	100.90%	99.42%	99.29%
DP	128	0.00%	0.07%	64.75%	88.29%	96.00%	99.49%	101.26%	101.43%	100.10%	99.85%
DP	129	0.00%	0.17%	0.00%	84.74%	95.31%	98.80%	99.70%	102.03%	99.38%	99.32%
DP	130	0.00%	0.14%	0.00%	84.30%	94.82%	98.99%	100.77%	101.43%	99.99%	99.78%
DP	68	0.00%	0.00%	78.13%	91.38%	97.77%	99.64%	101.00%	100.41%	99.66%	99.58%
DP	69	0.00%	0.50%	0.49%	0.00%	0.00%	97.21%	99.52%	98.94%	99.71%	99.77%
DP	70	0.00%	0.00%	79.12%	94.34%	97.77%	100.12%	100.01%	100.41%	99.71%	99.53%
DP	143	0.00%	80.69%	93.32%	98.41%	100.22%	100.48%	101.26%	100.73%	100.07%	99.82%
DP	144	0.00%	0.00%	87.48%	94.95%	98.75%	99.98%	100.28%	100.93%	99.92%	99.76%
DP	145	0.00%	45.50%	88.57%	96.01%	99.24%	100.48%	101.16%	100.43%	99.89%	99.68%
DP	32	0.05%	0.00%	86.49%	95.82%	100.31%	101.68%	101.61%	101.58%	100.71%	100.54%
DP	33	0.00%	0.00%	85.31%	95.82%	100.22%	101.58%	101.89%	101.68%	100.56%	100.44%
DP	34	0.04%	0.10%	85.99%	97.80%	100.80%	102.07%	101.89%	101.78%	100.83%	100.73%
DP	107	0.00%	0.00%	0.00%	15.44%	94.72%	98.80%	101.75%	101.33%	100.15%	100.04%
DP	108	0.00%	0.03%	86.65%	96.55%	100.52%	102.06%	101.95%	101.63%	100.57%	100.46%
DP	109	0.00%	0.03%	87.52%	97.34%	100.81%	101.57%	101.85%	101.33%	100.20%	100.06%
DP	62	0.20%	0.00%	0.49%	91.38%	96.79%	99.64%	100.01%	100.41%	100.47%	100.40%
DP	63	0.19%	0.00%	0.49%	90.39%	95.82%	100.61%	100.51%	100.90%	100.47%	100.25%
DP	64	0.19%	0.00%	0.49%	67.18%	95.33%	97.21%	99.52%	100.41%	100.22%	100.05%
DP	137	0.00%	0.03%	81.15%	93.97%	98.26%	99.98%	100.97%	100.63%	100.34%	100.25%
DP	138	0.00%	0.03%	0.00%	85.99%	96.29%	100.48%	101.16%	100.43%	100.31%	100.30%
DP	139	0.00%	0.17%	0.00%	91.40%	98.06%	99.98%	101.07%	100.53%	100.44%	100.36%
DP	71	0.00%	0.00%	2.46%	91.38%	95.82%	99.15%	100.51%	100.90%	100.10%	100.16%
DP	72	0.00%	0.00%	0.98%	88.91%	94.84%	98.18%	100.51%	100.90%	100.35%	100.31%

(continued)

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Table A.1 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
DP	73	0.00%	0.50%	2.46%	91.38%	96.31%	99.15%	100.01%	100.41%	99.91%	99.82%
DP	146	0.00%	0.14%	82.11%	92.29%	96.78%	98.99%	99.79%	100.73%	100.40%	100.28%
DP	147	0.00%	0.14%	82.55%	93.17%	96.29%	99.49%	99.79%	100.33%	100.20%	100.10%
DP	148	0.00%	0.07%	83.29%	92.29%	96.98%	98.99%	100.58%	99.64%	100.44%	100.32%
FO	28	0.00%	0.00%	0.00%	96.42%	96.99%	98.57%	98.83%	99.43%	99.21%	99.17%
FO	29	0.00%	0.00%	0.00%	95.53%	96.50%	98.57%	99.32%	99.52%	99.63%	99.59%
FO	30	0.00%	0.00%	0.00%	94.64%	96.70%	99.05%	99.42%	99.82%	99.74%	99.71%
FO	103	0.00%	0.00%	0.00%	97.97%	97.47%	97.90%	99.50%	99.24%	98.80%	98.82%
FO	104	0.00%	0.00%	0.00%	97.52%	96.39%	98.00%	99.70%	99.54%	99.10%	99.23%
FO	105	0.00%	0.00%	60.30%	96.63%	96.98%	98.20%	99.50%	99.44%	99.01%	99.10%
MJ	26	0.05%	0.00%	80.20%	91.28%	100.90%	101.68%	100.70%	100.11%	101.45%	101.60%
MJ	25	0.05%	0.00%	80.10%	92.56%	101.49%	103.04%	101.49%	100.60%	100.67%	100.61%
MJ	27	0.05%	0.10%	80.79%	86.34%	101.39%	102.07%	101.20%	100.90%	102.53%	102.75%
MJ	100	0.00%	0.00%	81.37%	97.97%	101.40%	101.27%	101.16%	100.43%	98.96%	98.85%
MJ	101	0.00%	0.00%	27.49%	96.90%	100.32%	101.67%	100.77%	100.04%	100.95%	101.21%
MJ	102	0.00%	0.03%	81.15%	97.79%	100.32%	100.97%	101.16%	100.83%	100.59%	100.60%
MJ	31	0.00%	0.00%	80.10%	99.28%	102.17%	101.10%	100.51%	99.92%	96.88%	95.74%
MJ	1	0.00%	0.00%	57.49%	99.78%	99.24%	100.61%	98.54%	98.94%	98.70%	94.55%
MJ	21	0.24%	0.00%	62.41%	95.82%	100.22%	101.58%	100.01%	98.45%	99.75%	99.42%
MJ	77	0.00%	0.00%	49.82%	88.29%	100.22%	101.47%	102.04%	101.33%	100.65%	100.22%
MJ	96	0.00%	0.14%	55.19%	91.58%	100.22%	101.47%	102.04%	100.73%	100.44%	100.03%
MJ	106	0.00%	0.03%	0.00%	84.66%	96.59%	100.18%	100.38%	98.54%	100.04%	99.75%
MJ	10	0.00%	0.00%	0.00%	84.96%	99.24%	102.07%	100.51%	100.90%	100.66%	100.23%
MJ	9	0.00%	0.00%	0.00%	0.49%	24.93%	93.80%	97.57%	99.92%	100.11%	99.94%
MJ	8	0.00%	0.00%	0.00%	84.96%	101.19%	101.58%	100.51%	100.41%	100.36%	99.89%
MJ	84	0.00%	0.17%	0.00%	80.48%	96.29%	100.48%	100.67%	100.24%	99.77%	99.31%
MJ	85	0.00%	0.38%	3.18%	86.16%	97.77%	101.47%	101.36%	100.93%	100.50%	100.34%
MJ	86	0.00%	0.10%	0.00%	83.24%	96.78%	100.97%	100.28%	100.73%	100.52%	100.36%
MJ	45	0.00%	0.00%	0.00%	86.93%	97.77%	99.15%	101.00%	100.90%	100.66%	100.72%
MJ	44	0.00%	0.00%	0.00%	74.09%	94.84%	98.18%	100.51%	99.92%	100.71%	101.07%
MJ	46	0.00%	0.00%	56.51%	95.82%	99.73%	100.61%	101.49%	100.41%	100.86%	100.97%
MJ	119	0.00%	0.21%	0.00%	89.18%	96.29%	99.98%	101.26%	99.94%	100.89%	101.04%
MJ	120	0.00%	0.45%	63.57%	94.06%	98.26%	99.98%	100.97%	100.33%	100.84%	101.00%
MJ	121	0.00%	0.03%	52.66%	91.93%	98.06%	98.00%	100.19%	98.05%	99.69%	99.81%
MJ	17	0.00%	0.00%	0.00%	0.00%	0.00%	101.48%	100.31%	100.80%	99.73%	99.69%
MJ	18	0.05%	0.00%	66.54%	90.09%	101.78%	102.07%	100.51%	100.70%	99.80%	99.66%
MJ	19	0.00%	0.00%	0.00%	0.00%	0.00%	102.07%	100.41%	100.70%	98.92%	98.96%
MJ	93	0.00%	0.07%	70.16%	93.88%	99.73%	99.29%	98.91%	99.24%	95.90%	96.54%
MJ	94	0.00%	0.00%	38.09%	96.10%	102.19%	100.68%	100.09%	100.43%	98.98%	98.59%
MJ	95	0.00%	0.03%	33.86%	93.97%	100.91%	100.38%	100.19%	100.33%	99.89%	99.37%
MJ	41	0.00%	0.00%	0.10%	82.29%	97.67%	100.22%	100.51%	100.70%	100.08%	100.19%
MJ	42	0.00%	0.00%	0.00%	87.72%	99.83%	101.00%	100.61%	100.60%	100.56%	100.62%
MJ	43	0.00%	0.00%	0.00%	87.43%	98.75%	100.22%	100.01%	99.92%	99.08%	99.20%
MJ	116	0.00%	0.00%	0.00%	83.32%	97.77%	99.88%	100.67%	100.53%	99.94%	100.03%
MJ	117	0.00%	0.03%	0.00%	92.91%	100.62%	101.67%	102.04%	101.83%	101.75%	102.10%
MJ	118	0.00%	0.00%	0.00%	53.69%	93.44%	99.69%	101.56%	101.43%	101.02%	101.29%
MJ	74	0.00%	0.00%	0.00%	90.89%	100.22%	102.07%	101.49%	101.00%	100.79%	100.31%
MJ	75	0.00%	0.00%	0.00%	90.39%	97.28%	102.07%	100.51%	99.92%	99.86%	99.63%
MJ	76	0.00%	0.00%	0.00%	72.61%	92.39%	101.58%	100.51%	99.43%	99.76%	99.19%
MJ	20	0.00%	0.00%	1.28%	89.40%	97.72%	102.26%	100.48%	100.90%	99.73%	99.93%
MJ	149	0.00%	0.03%	0.00%	92.46%	100.52%	100.97%	100.38%	99.94%	100.90%	100.79%
MJ	150	0.00%	0.00%	74.04%	96.46%	101.21%	99.49%	99.40%	99.44%	100.10%	100.04%
MJ	151	0.00%	0.14%	0.00%	89.80%	98.75%	100.48%	100.28%	99.44%	100.95%	100.90%

(continued)

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Table A.1 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
ND	35	0.00%	0.00%	88.45%	97.31%	99.73%	100.61%	101.00%	100.90%	99.62%	99.32%
ND	36	0.00%	0.00%	93.37%	99.78%	100.22%	100.61%	101.00%	100.06%	99.23%	98.84%
ND	37	0.00%	63.00%	87.47%	96.81%	99.24%	101.10%	100.01%	100.41%	99.38%	99.22%
ND	110	0.00%	8.06%	87.91%	98.50%	99.73%	100.48%	100.87%	100.53%	99.10%	99.05%
ND	111	0.00%	0.28%	92.80%	97.43%	99.54%	100.08%	100.77%	100.14%	99.39%	99.39%
ND	112	0.00%	81.84%	95.33%	98.94%	100.22%	100.97%	101.16%	102.52%	99.44%	99.37%
ND	59	48.50%	69.00%	93.37%	97.80%	99.24%	101.58%	101.00%	100.41%	98.82%	98.60%
ND	60	0.00%	0.00%	91.89%	97.31%	100.22%	101.10%	101.00%	100.90%	98.77%	98.80%
ND	61	0.00%	0.50%	96.51%	96.81%	99.73%	101.10%	100.51%	100.90%	98.87%	98.85%
ND	134	0.00%	0.80%	93.93%	97.61%	100.22%	100.97%	101.36%	100.63%	99.43%	99.35%
ND	135	9.97%	85.10%	94.63%	97.61%	100.22%	100.97%	101.26%	100.43%	99.05%	99.14%
ND	136	0.00%	78.36%	90.53%	98.05%	99.73%	100.48%	100.67%	100.33%	98.74%	98.82%
ND	22	0.00%	59.00%	84.03%	94.84%	95.82%	102.07%	100.51%	100.41%	99.45%	98.62%
ND	23	0.00%	31.00%	79.61%	91.38%	96.79%	102.07%	99.52%	99.62%	99.45%	99.12%
ND	24	0.24%	41.00%	83.54%	92.86%	98.75%	101.58%	100.01%	102.37%	99.15%	98.92%
ND	97	0.00%	55.26%	82.02%	94.51%	99.73%	101.96%	102.73%	100.93%	99.41%	99.19%
ND	98	0.00%	0.21%	81.98%	93.62%	99.24%	100.97%	101.75%	100.93%	99.12%	98.93%
ND	99	0.00%	57.38%	83.99%	95.30%	99.73%	101.96%	102.14%	100.93%	98.67%	98.34%
ND	47	0.21%	69.00%	92.16%	96.81%	99.07%	100.12%	101.00%	100.41%	99.31%	99.07%
ND	48	0.21%	76.51%	93.13%	96.81%	99.07%	100.61%	100.01%	101.39%	99.36%	99.27%
ND	49	0.00%	77.51%	92.64%	96.81%	99.24%	100.12%	100.51%	100.41%	99.31%	99.27%
ND	122	0.00%	77.84%	90.23%	96.19%	99.44%	99.98%	100.38%	100.63%	99.19%	99.50%
ND	123	0.00%	0.14%	0.00%	93.62%	99.24%	98.99%	101.26%	99.94%	99.41%	99.55%
ND	141	0.00%	0.10%	88.65%	94.33%	98.26%	99.49%	100.87%	100.73%	99.45%	99.37%
ND	65	5.98%	57.79%	90.34%	94.66%	98.77%	100.61%	100.51%	100.90%	99.97%	99.90%
ND	66	4.89%	28.40%	90.81%	96.13%	99.26%	100.61%	101.49%	101.88%	100.27%	100.15%
ND	67	1.47%	75.23%	95.03%	97.11%	99.26%	101.58%	101.00%	101.39%	100.07%	99.80%
ND	115	0.00%	73.60%	91.23%	97.52%	100.03%	100.03%	101.65%	100.63%	100.29%	100.18%
ND	124	0.00%	74.37%	91.49%	97.26%	99.73%	100.48%	101.85%	100.63%	100.24%	100.35%
ND	142	0.00%	81.66%	93.32%	97.17%	99.24%	100.97%	100.77%	101.13%	100.21%	100.29%
SJ	6	0.00%	0.03%	82.55%	98.05%	100.46%	99.64%	99.67%	100.90%	100.29%	99.74%
SJ	5	0.00%	0.03%	0.05%	90.29%	97.72%	99.57%	99.82%	100.95%	100.08%	99.44%
SJ	7	0.03%	18.73%	87.47%	92.39%	100.17%	99.63%	99.49%	101.14%	100.14%	99.76%
SJ	81	0.00%	1.07%	88.26%	99.34%	100.27%	99.84%	101.10%	101.12%	100.71%	100.53%
SJ	82	0.00%	0.36%	61.66%	88.91%	97.42%	98.25%	100.88%	101.15%	100.93%	100.67%
SJ	83	0.00%	0.87%	89.55%	99.47%	99.54%	99.34%	100.94%	101.22%	101.28%	101.08%
SJ	14	0.01%	0.00%	0.02%	93.00%	101.15%	98.76%	98.19%	98.35%	99.38%	100.01%
SJ	15	0.00%	0.00%	6.09%	92.07%	103.37%	101.95%	101.86%	101.83%	100.20%	100.19%
SJ	16	0.01%	0.00%	3.64%	90.84%	103.54%	101.46%	101.15%	101.29%	99.54%	100.56%
SJ	90	0.00%	0.02%	0.02%	78.71%	96.88%	97.76%	99.21%	98.81%	100.25%	100.19%
SJ	91	0.00%	0.08%	0.02%	90.33%	101.75%	99.59%	99.16%	98.81%	99.36%	99.11%
SJ	92	0.00%	0.00%	2.94%	96.96%	104.99%	99.88%	99.84%	99.29%	99.81%	100.00%
SJ	2	0.00%	0.00%	0.29%	94.94%	96.60%	98.18%	97.75%	97.96%	99.08%	99.10%
SJ	3	0.00%	0.00%	0.29%	48.97%	99.17%	99.35%	98.13%	99.13%	98.88%	98.85%
SJ	4	0.00%	0.00%	3.54%	100.57%	101.39%	99.44%	98.73%	98.84%	98.18%	98.26%
SJ	78	0.00%	0.03%	90.14%	100.63%	99.63%	98.20%	98.72%	98.15%	99.12%	99.15%
SJ	79	0.00%	0.03%	0.00%	6.48%	99.41%	98.80%	99.21%	98.25%	98.36%	98.45%
SJ	80	0.00%	0.07%	0.00%	93.26%	100.71%	99.19%	99.60%	98.45%	98.19%	98.20%
SJ	11	0.00%	0.00%	1.23%	92.61%	100.71%	96.96%	98.54%	99.92%	101.32%	101.18%
SJ	12	0.00%	0.00%	8.11%	93.60%	101.93%	100.12%	101.00%	101.39%	101.91%	101.37%
SJ	13	0.00%	0.00%	53.07%	97.06%	102.42%	98.96%	99.72%	102.07%	103.39%	103.23%
SJ	87	0.00%	0.03%	0.00%	86.52%	99.14%	97.61%	98.42%	100.98%	100.93%	101.24%
SJ	88	0.00%	0.03%	0.00%	85.90%	100.22%	99.49%	99.40%	101.73%	102.15%	101.79%
SJ	89	0.00%	0.00%	0.00%	80.97%	97.18%	98.55%	97.94%	100.04%	101.17%	101.14%

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Table A.2
Raw data for 5/8x3/4-inch meters at 0.25 life

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
DP	56	0.00%	0.00%	85.75%	95.92%	98.99%	100.27%	100.22%	100.68%	98.91%	98.63%
DP	57	0.00%	1.96%	84.25%	94.02%	97.99%	99.77%	101.21%	99.19%	98.91%	98.63%
DP	58	0.00%	0.00%	0.00%	85.47%	95.99%	98.29%	100.72%	99.69%	99.01%	98.87%
DP	131	0.00%	0.00%	82.27%	94.27%	99.03%	100.83%	100.31%	101.33%	99.69%	99.50%
DP	132	0.00%	0.00%	82.27%	94.97%	99.13%	100.83%	100.21%	101.83%	99.29%	99.04%
DP	133	0.00%	0.03%	84.27%	95.47%	98.63%	101.23%	101.20%	101.33%	99.58%	99.35%
DP	38	0.00%	0.00%	69.21%	88.80%	93.99%	95.31%	97.77%	99.69%	99.37%	99.21%
DP	39	0.00%	2.94%	65.70%	85.00%	92.09%	97.19%	100.22%	100.19%	99.42%	99.21%
DP	40	0.00%	77.47%	87.76%	96.87%	98.99%	100.27%	100.22%	100.19%	99.46%	99.15%
DP	113	0.00%	81.57%	94.14%	97.97%	98.63%	100.83%	100.31%	100.34%	99.70%	99.15%
DP	114	1.17%	80.90%	92.25%	96.87%	98.13%	102.33%	101.20%	100.34%	99.58%	99.09%
DP	140	0.00%	80.17%	93.04%	97.77%	99.73%	100.73%	100.61%	100.74%	99.79%	99.59%
DP	50	0.00%	0.00%	0.00%	85.47%	93.99%	97.29%	99.24%	99.69%	97.76%	95.41%
DP	51	0.00%	0.00%	0.00%	86.42%	93.99%	97.29%	99.24%	100.19%	99.15%	98.92%
DP	52	0.00%	0.00%	0.00%	85.00%	93.49%	98.29%	99.73%	99.69%	99.20%	98.92%
DP	125	0.00%	0.00%	0.50%	89.27%	95.53%	98.43%	100.71%	100.54%	100.19%	99.65%
DP	126	0.00%	0.00%	0.10%	87.97%	95.13%	99.23%	100.71%	100.44%	99.78%	99.55%
DP	127	0.00%	0.03%	0.30%	87.97%	94.43%	98.93%	101.20%	97.46%	99.79%	99.75%
DP	53	0.00%	0.00%	0.00%	77.40%	93.99%	98.78%	100.22%	100.19%	99.60%	99.36%
DP	54	0.00%	0.00%	0.00%	0.00%	91.49%	98.29%	100.22%	100.19%	99.50%	99.12%
DP	55	0.00%	0.00%	0.00%	0.00%	85.99%	97.29%	99.24%	100.19%	14.13%	44.68%
DP	128	0.00%	0.03%	0.00%	73.97%	93.53%	98.33%	100.81%	100.94%	73.43%	12.62%
DP	129	0.00%	0.00%	0.00%	73.47%	93.53%	98.83%	100.81%	100.74%	99.08%	99.36%
DP	130	0.00%	0.00%	0.00%	74.77%	91.53%	98.73%	100.81%	101.33%	99.94%	99.45%
DP	68	0.00%	0.49%	4.51%	91.17%	95.99%	99.77%	100.72%	99.69%	99.08%	99.10%
DP	69	0.00%	0.49%	84.25%	94.49%	98.49%	100.27%	100.72%	100.19%	99.43%	99.30%
DP	70	0.00%	0.49%	83.25%	90.69%	95.49%	98.78%	99.73%	100.19%	98.83%	98.80%
DP	143	0.00%	0.00%	0.00%	75.97%	90.03%	96.83%	99.81%	100.34%	99.69%	99.56%
DP	144	0.00%	0.07%	86.26%	95.47%	98.53%	100.33%	100.81%	100.34%	99.64%	99.51%
DP	145	0.00%	0.00%	65.82%	87.67%	95.03%	98.83%	99.81%	100.34%	99.59%	99.50%
DP	32	0.00%	0.20%	83.75%	96.49%	100.28%	101.86%	101.99%	101.67%	100.57%	100.36%
DP	33	0.00%	0.20%	83.25%	95.82%	100.18%	102.06%	101.99%	101.67%	100.59%	99.39%
DP	34	0.00%	0.10%	88.56%	97.91%	100.88%	102.06%	101.70%	101.67%	100.74%	99.47%
DP	107	0.00%	0.07%	86.96%	95.87%	98.23%	100.93%	101.80%	101.83%	100.42%	100.14%
DP	108	0.00%	0.03%	89.16%	97.07%	99.93%	102.13%	102.20%	102.13%	100.94%	100.56%
DP	109	0.00%	0.03%	85.17%	95.37%	99.13%	101.93%	101.80%	101.43%	100.00%	99.70%
DP	62	0.00%	0.49%	0.00%	87.37%	96.99%	99.28%	100.72%	100.19%	100.21%	100.05%
DP	63	0.00%	0.00%	0.00%	85.47%	94.99%	99.28%	100.72%	100.68%	100.06%	100.00%
DP	64	0.00%	0.00%	0.00%	54.61%	88.49%	95.80%	99.24%	98.70%	99.36%	99.60%
DP	137	0.00%	0.00%	0.30%	87.27%	95.93%	98.73%	100.31%	100.74%	100.20%	100.15%
DP	138	0.00%	0.00%	0.00%	88.47%	95.53%	98.33%	100.31%	100.34%	100.23%	100.12%
DP	139	0.00%	0.00%	0.00%	87.97%	95.73%	99.13%	101.20%	99.45%	100.38%	100.22%
DP	71	0.00%	0.98%	30.09%	91.17%	96.99%	99.28%	100.22%	99.19%	98.23%	98.55%
DP	72	0.00%	0.49%	0.00%	87.37%	96.49%	98.78%	100.22%	100.68%	100.03%	99.74%
DP	73	0.00%	1.96%	0.00%	91.64%	96.99%	99.28%	100.72%	100.68%	99.58%	99.35%
DP	146	0.00%	0.00%	0.30%	76.57%	89.63%	95.74%	99.31%	100.34%	99.44%	99.51%
DP	147	0.00%	0.03%	0.50%	89.97%	97.03%	98.93%	100.31%	100.84%	99.98%	99.65%
DP	148	0.00%	0.03%	0.30%	87.27%	95.03%	97.73%	99.91%	100.34%	100.25%	98.12%
FO	28	0.00%	0.00%	0.00%	95.54%	97.39%	98.98%	99.04%	99.19%	99.16%	99.14%
FO	29	0.00%	0.00%	1.81%	94.87%	96.69%	98.38%	99.14%	99.49%	99.75%	99.70%
FO	30	0.00%	0.00%	0.00%	94.21%	97.39%	98.58%	99.44%	99.69%	99.82%	99.80%

(continued)

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Table A.2 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
FO	103	0.00%	0.00%	0.00%	98.57%	97.43%	98.33%	98.61%	99.35%	99.06%	99.06%
FO	104	0.00%	0.00%	0.00%	97.87%	96.43%	98.33%	98.81%	99.65%	99.38%	99.48%
FO	105	0.00%	0.00%	0.00%	98.07%	96.33%	98.53%	98.81%	99.55%	99.29%	99.40%
MJ	26	0.00%	0.00%	0.40%	67.24%	93.59%	100.87%	100.22%	100.58%	101.54%	101.69%
MJ	25	0.00%	0.00%	37.61%	85.38%	98.09%	101.07%	101.11%	100.58%	100.80%	100.72%
MJ	27	0.00%	0.00%	0.00%	45.96%	91.29%	101.66%	101.01%	100.58%	102.61%	102.88%
MJ	100	0.00%	0.00%	0.00%	78.97%	94.53%	100.83%	101.00%	100.04%	98.86%	98.88%
MJ	101	0.00%	0.00%	58.94%	86.97%	92.33%	100.13%	100.90%	100.34%	101.16%	101.45%
MJ	102	0.00%	0.00%	0.00%	72.07%	90.93%	101.23%	101.00%	100.74%	100.59%	100.65%
MJ	31	0.00%	0.00%	66.70%	96.87%	101.48%	100.27%	99.73%	99.19%	100.37%	99.55%
MJ	1	0.00%	0.00%	70.71%	97.34%	99.98%	100.27%	99.73%	98.20%	98.63%	95.34%
MJ	21	0.00%	0.00%	70.71%	95.92%	99.98%	100.27%	99.73%	98.70%	99.41%	99.24%
MJ	77	0.00%	0.00%	55.35%	90.47%	99.63%	101.73%	102.30%	100.84%	100.59%	100.18%
MJ	96	0.00%	0.03%	1.10%	86.47%	98.83%	102.82%	101.90%	100.84%	100.39%	100.12%
MJ	106	0.00%	0.00%	32.91%	85.47%	96.23%	100.73%	99.71%	99.35%	100.09%	99.78%
MJ	10	0.00%	0.00%	0.00%	56.03%	92.99%	99.77%	100.72%	101.18%	101.52%	101.35%
MJ	9	0.00%	0.00%	0.00%	0.00%	0.00%	91.34%	97.77%	99.69%	100.99%	101.15%
MJ	8	0.00%	0.39%	0.00%	89.27%	100.98%	101.76%	100.72%	101.67%	101.32%	101.10%
MJ	84	0.00%	0.00%	0.20%	76.77%	95.13%	101.33%	100.90%	101.14%	101.04%	101.22%
MJ	85	0.00%	0.03%	0.00%	55.48%	91.53%	101.83%	100.81%	101.83%	101.68%	101.38%
MJ	86	0.00%	0.00%	0.00%	36.29%	88.23%	98.63%	100.41%	100.84%	101.67%	101.53%
MJ	45	0.00%	0.00%	0.00%	86.42%	94.99%	97.29%	100.72%	100.19%	100.95%	100.98%
MJ	44	0.00%	0.00%	0.00%	76.45%	92.49%	95.31%	99.24%	100.19%	101.59%	99.59%
MJ	46	0.00%	0.00%	0.00%	77.40%	94.99%	99.28%	100.72%	100.19%	100.75%	100.78%
MJ	119	0.00%	0.00%	0.00%	83.17%	92.43%	94.94%	100.81%	100.34%	101.13%	101.15%
MJ	120	0.00%	0.00%	37.30%	88.97%	97.13%	98.83%	100.81%	98.35%	101.23%	101.04%
MJ	121	0.00%	0.03%	23.73%	90.17%	96.63%	98.23%	98.81%	99.35%	100.03%	99.95%
MJ	17	0.00%	0.10%	0.30%	87.94%	97.99%	99.68%	99.93%	99.99%	98.99%	98.46%
MJ	18	0.00%	0.10%	0.00%	90.22%	99.49%	100.17%	100.72%	100.48%	99.28%	98.59%
MJ	19	0.00%	0.00%	71.71%	98.01%	101.88%	100.77%	100.42%	99.49%	98.63%	97.83%
MJ	93	0.00%	0.00%	0.40%	83.77%	95.73%	98.03%	98.71%	98.65%	96.16%	96.06%
MJ	94	0.00%	0.03%	41.59%	89.07%	98.63%	99.83%	100.01%	100.14%	98.38%	97.93%
MJ	95	0.00%	0.00%	57.24%	92.57%	99.13%	99.83%	99.71%	99.94%	99.05%	98.66%
MJ	41	0.00%	0.00%	0.00%	52.14%	92.79%	98.98%	100.52%	100.48%	101.18%	101.37%
MJ	42	0.00%	0.00%	0.00%	66.00%	94.69%	99.58%	100.32%	100.58%	100.27%	100.42%
MJ	43	0.00%	0.10%	0.00%	33.33%	94.09%	98.48%	99.63%	99.89%	99.32%	99.38%
MJ	116	0.00%	0.00%	0.10%	70.68%	95.43%	99.73%	100.21%	100.54%	100.10%	100.32%
MJ	117	0.00%	0.00%	0.00%	87.97%	98.53%	101.83%	102.10%	101.93%	101.90%	102.15%
MJ	118	0.00%	0.00%	0.00%	0.30%	91.43%	99.03%	100.90%	101.14%	101.31%	101.47%
MJ	74	0.00%	0.00%	0.00%	82.62%	98.99%	102.75%	101.21%	101.18%	100.88%	100.74%
MJ	75	0.00%	0.00%	0.00%	57.46%	91.49%	99.77%	100.22%	100.19%	99.93%	99.94%
MJ	76	0.00%	0.00%	0.00%	9.97%	91.99%	100.27%	100.22%	100.19%	99.68%	99.60%
MJ	20	0.00%	0.00%	0.00%	95.35%	99.49%	100.27%	101.50%	99.79%	99.69%	100.77%
MJ	149	0.00%	0.00%	0.00%	70.68%	94.03%	99.33%	99.91%	100.24%	100.74%	100.88%
MJ	150	0.00%	0.03%	0.10%	86.27%	97.93%	99.93%	99.61%	99.55%	100.13%	100.22%
MJ	151	0.00%	0.00%	0.00%	81.87%	96.93%	100.73%	100.41%	99.74%	100.75%	100.78%
ND	35	0.00%	69.62%	88.76%	97.34%	99.49%	101.76%	101.21%	100.19%	99.07%	98.92%
ND	36	0.00%	22.06%	90.27%	95.92%	99.98%	100.27%	100.72%	99.69%	98.37%	98.18%
ND	37	0.00%	68.64%	87.26%	94.49%	98.49%	100.27%	100.22%	100.19%	98.67%	98.72%
ND	110	40.73%	84.78%	94.04%	98.17%	99.53%	101.23%	101.30%	100.74%	99.30%	99.15%
ND	111	48.86%	78.42%	91.15%	98.17%	99.53%	100.83%	100.81%	99.45%	99.20%	99.04%
ND	112	10.24%	83.55%	91.85%	98.97%	99.53%	101.33%	101.30%	99.84%	99.44%	99.34%

(continued)

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Table A.2 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
ND	59	0.00%	0.00%	87.26%	96.39%	99.49%	100.27%	101.21%	99.19%	98.17%	98.15%
ND	60	0.00%	0.49%	85.25%	95.44%	98.99%	100.77%	100.72%	99.19%	98.22%	98.30%
ND	61	0.00%	0.00%	81.24%	95.44%	99.49%	101.26%	100.72%	99.69%	98.12%	97.95%
ND	134	0.00%	0.00%	82.07%	95.37%	99.53%	101.33%	101.30%	100.34%	99.17%	99.11%
ND	135	0.76%	80.31%	92.05%	98.17%	100.03%	101.53%	100.90%	100.74%	98.76%	98.82%
ND	136	16.97%	82.56%	93.34%	98.17%	100.03%	101.33%	101.30%	100.34%	98.69%	98.56%
ND	22	0.00%	1.96%	76.23%	93.07%	98.49%	100.77%	101.21%	99.19%	98.18%	97.60%
ND	23	0.00%	0.49%	73.22%	89.27%	96.99%	100.27%	100.22%	99.69%	97.84%	97.50%
ND	24	0.00%	0.00%	77.23%	93.07%	98.99%	101.26%	101.70%	98.70%	97.64%	97.60%
ND	97	0.00%	47.15%	80.78%	92.97%	97.93%	100.93%	101.70%	100.54%	97.97%	97.71%
ND	98	0.00%	0.03%	78.88%	91.97%	96.03%	100.83%	100.81%	100.84%	97.54%	97.34%
ND	99	0.00%	0.17%	70.31%	86.67%	93.03%	99.33%	100.90%	100.24%	97.27%	96.97%
ND	47	0.00%	0.49%	81.24%	90.22%	95.49%	100.27%	100.72%	99.69%	98.96%	98.89%
ND	48	0.00%	0.49%	85.75%	95.44%	98.99%	100.77%	101.21%	99.69%	99.25%	99.04%
ND	49	0.00%	3.43%	89.27%	94.97%	98.99%	100.27%	100.22%	99.69%	99.01%	99.00%
ND	122	0.00%	0.20%	82.27%	91.77%	96.93%	100.43%	99.81%	100.84%	99.18%	99.11%
ND	123	0.00%	61.11%	84.07%	93.27%	96.63%	99.73%	100.21%	99.55%	99.22%	99.16%
ND	141	0.00%	0.10%	78.38%	90.37%	96.03%	98.83%	99.91%	100.44%	99.08%	99.30%
ND	65	0.00%	0.00%	81.24%	94.02%	96.99%	100.27%	101.21%	100.19%	99.92%	100.00%
ND	66	0.00%	0.00%	0.00%	0.00%	0.50%	102.75%	100.22%	100.19%	99.65%	99.49%
ND	67	0.00%	0.00%	75.22%	90.22%	95.99%	103.25%	99.73%	100.68%	99.76%	99.60%
ND	115	0.00%	0.07%	81.78%	93.87%	97.53%	100.83%	101.20%	100.34%	100.30%	100.11%
ND	124	0.00%	0.00%	78.29%	92.37%	96.63%	100.83%	101.00%	101.63%	100.23%	100.24%
ND	142	0.00%	0.13%	86.76%	94.97%	98.13%	100.83%	101.60%	101.33%	100.18%	100.28%
SJ	6	0.00%	0.00%	75.81%	96.69%	99.71%	98.90%	100.10%	100.43%	99.87%	99.50%
SJ	5	0.00%	0.07%	78.19%	95.21%	97.34%	99.08%	98.92%	100.02%	99.74%	99.52%
SJ	7	0.00%	0.12%	83.25%	97.55%	99.79%	98.67%	99.73%	100.34%	99.66%	99.42%
SJ	81	0.00%	0.01%	83.75%	98.35%	99.84%	99.43%	100.48%	101.07%	101.37%	100.53%
SJ	82	0.00%	0.00%	0.08%	78.47%	94.88%	97.74%	100.23%	100.87%	100.57%	100.32%
SJ	83	0.00%	0.00%	57.26%	91.64%	97.98%	99.03%	99.65%	101.17%	100.85%	100.88%
SJ	14	0.00%	0.01%	0.09%	77.59%	94.29%	97.44%	97.47%	97.68%	97.92%	98.63%
SJ	15	0.00%	0.01%	0.18%	84.98%	99.78%	99.63%	100.54%	100.73%	99.41%	100.04%
SJ	16	0.00%	0.01%	0.26%	82.69%	98.81%	99.43%	100.08%	100.26%	99.84%	100.52%
SJ	90	0.00%	0.00%	0.03%	76.79%	95.93%	97.88%	99.36%	99.50%	99.50%	99.73%
SJ	91	0.00%	0.00%	0.02%	84.23%	99.05%	98.80%	98.61%	99.15%	100.28%	99.94%
SJ	92	0.00%	0.00%	0.03%	67.18%	97.78%	98.73%	99.61%	100.00%	98.46%	98.97%
SJ	2	0.00%	0.10%	72.42%	96.58%	97.39%	98.29%	98.06%	97.51%	99.01%	99.15%
SJ	3	0.00%	0.00%	5.92%	96.39%	98.19%	98.48%	98.85%	97.91%	98.86%	98.99%
SJ	4	0.00%	0.00%	62.99%	96.96%	99.68%	99.28%	98.65%	97.81%	97.99%	98.18%
SJ	78	0.00%	0.03%	81.88%	99.57%	98.33%	98.53%	98.41%	97.56%	98.52%	98.60%
SJ	79	0.00%	0.03%	77.59%	98.77%	99.33%	99.13%	99.01%	97.86%	97.82%	97.95%
SJ	80	0.00%	0.03%	23.64%	97.17%	99.73%	99.63%	99.21%	97.96%	97.82%	97.75%
SJ	11	0.00%	0.00%	0.00%	76.07%	97.19%	97.29%	97.47%	98.90%	100.62%	100.73%
SJ	12	0.00%	0.00%	0.00%	76.73%	98.09%	99.87%	100.32%	101.58%	101.69%	101.86%
SJ	13	0.00%	0.10%	18.45%	90.50%	101.18%	98.78%	99.44%	101.58%	102.47%	101.17%
SJ	87	0.00%	0.00%	0.00%	68.98%	95.53%	95.44%	97.31%	100.94%	100.48%	100.51%
SJ	88	0.00%	0.03%	0.00%	63.18%	95.53%	98.13%	98.21%	100.24%	101.15%	100.67%
SJ	89	0.00%	0.03%	0.00%	57.98%	92.43%	97.53%	97.41%	99.74%	79.00%	1.14%

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Table A.3
Raw data for 5/8x3/4-inch meters at 0.5 life

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
DP	56	0.00%	0.00%	0.50%	86.49%	96.32%	98.91%	99.81%	100.66%	99.09%	98.73%
DP	57	0.00%	0.00%	15.56%	91.99%	97.98%	99.49%	100.67%	100.37%	99.04%	98.83%
DP	58	0.00%	0.00%	81.34%	94.49%	97.69%	98.81%	100.96%	101.04%	99.09%	99.07%
DP	131	0.00%	0.00%	70.41%	89.80%	96.47%	99.77%	101.05%	100.60%	99.41%	99.31%
DP	132	0.00%	0.00%	87.65%	95.16%	99.21%	100.97%	101.54%	100.10%	99.08%	98.94%
DP	133	0.00%	17.01%	88.33%	97.22%	99.94%	100.97%	101.64%	100.01%	99.26%	99.13%
DP	38	0.00%	0.00%	0.00%	44.50%	84.07%	92.58%	97.51%	99.99%	99.39%	99.10%
DP	39	0.00%	0.00%	88.36%	94.99%	99.16%	99.88%	100.86%	100.75%	99.54%	99.01%
DP	40	0.00%	28.96%	88.36%	95.49%	98.96%	99.98%	101.06%	100.37%	99.57%	99.31%
DP	113	0.35%	4.80%	90.28%	97.13%	98.57%	100.47%	99.89%	99.81%	99.01%	98.73%
DP	114	0.00%	0.00%	61.84%	82.48%	92.91%	96.47%	97.95%	99.61%	98.71%	98.36%
DP	140	0.00%	0.00%	76.94%	93.38%	96.75%	99.27%	100.37%	100.30%	99.26%	98.89%
DP	50	0.00%	0.00%	0.00%	81.99%	93.96%	96.86%	100.10%	100.28%	98.79%	94.56%
DP	51	0.00%	0.00%	0.00%	85.99%	95.24%	97.35%	99.62%	99.99%	99.24%	99.07%
DP	52	0.00%	0.00%	0.00%	84.99%	94.85%	97.25%	99.81%	100.08%	99.39%	98.59%
DP	125	0.00%	0.00%	0.00%	88.02%	95.38%	99.47%	100.57%	100.60%	99.92%	99.79%
DP	126	0.00%	0.00%	3.60%	91.14%	96.93%	99.27%	100.57%	100.80%	99.54%	99.46%
DP	127	0.00%	0.00%	0.00%	87.84%	96.75%	98.67%	99.89%	99.31%	99.73%	99.44%
DP	53	0.00%	0.00%	0.00%	79.99%	91.61%	96.86%	99.62%	100.75%	74.74%	25.04%
DP	54	0.00%	0.00%	0.00%	10.00%	92.10%	97.35%	100.10%	100.75%	99.64%	99.26%
DP	55	0.00%	0.00%	0.00%	0.00%	0.10%	89.85%	98.66%	99.80%	99.09%	98.64%
DP	128	0.00%	0.00%	0.00%	5.09%	92.64%	97.67%	101.15%	100.01%	78.44%	13.96%
DP	129	0.00%	0.00%	0.00%	2.68%	91.45%	98.27%	100.86%	99.81%	99.44%	99.13%
DP	130	0.00%	0.00%	0.00%	46.47%	91.27%	97.97%	101.34%	100.30%	99.58%	99.24%
DP	68	0.00%	59.43%	81.84%	92.99%	97.98%	99.78%	100.58%	100.75%	99.28%	99.20%
DP	69	0.00%	61.92%	85.85%	95.49%	98.47%	99.78%	100.10%	100.28%	99.63%	99.45%
DP	70	0.00%	8.99%	83.34%	93.49%	98.47%	99.30%	100.58%	100.08%	99.04%	98.90%
DP	143	0.00%	1.50%	88.63%	96.77%	98.75%	100.77%	100.86%	100.01%	99.43%	99.33%
DP	144	0.00%	0.00%	32.14%	84.62%	94.92%	98.67%	99.89%	100.30%	99.48%	99.33%
DP	145	0.00%	0.00%	83.76%	93.82%	98.39%	99.97%	100.37%	100.01%	99.36%	99.25%
DP	32	0.00%	1.20%	85.75%	96.69%	100.82%	101.54%	102.01%	101.90%	100.54%	100.36%
DP	33	0.00%	0.00%	85.75%	96.79%	100.63%	101.34%	102.11%	101.71%	100.52%	100.37%
DP	34	0.00%	4.99%	88.87%	98.29%	101.02%	101.44%	102.20%	101.90%	100.62%	100.41%
DP	107	0.00%	0.80%	86.39%	98.92%	100.85%	101.97%	101.83%	101.30%	100.16%	100.04%
DP	108	0.35%	11.41%	89.60%	100.17%	102.13%	102.67%	102.02%	101.89%	100.62%	100.51%
DP	109	0.00%	0.00%	75.58%	95.52%	100.67%	102.07%	101.54%	101.30%	99.81%	99.68%
DP	62	0.00%	0.00%	64.47%	90.49%	97.79%	98.62%	100.19%	99.99%	100.32%	100.26%
DP	63	0.00%	0.00%	0.20%	85.49%	96.02%	98.52%	100.58%	99.99%	100.27%	100.21%
DP	64	0.00%	0.00%	0.00%	0.00%	86.71%	93.65%	97.51%	99.80%	99.87%	99.71%
DP	137	0.00%	0.50%	0.19%	84.89%	94.46%	98.77%	99.89%	100.30%	100.15%	100.13%
DP	138	0.00%	0.00%	0.49%	85.78%	95.56%	98.77%	100.37%	100.30%	100.07%	100.01%
DP	139	0.00%	0.00%	5.65%	91.41%	97.48%	99.97%	101.15%	101.00%	100.20%	100.08%
DP	71	0.00%	0.00%	2.01%	89.99%	95.53%	98.32%	99.62%	100.66%	99.18%	98.75%
DP	72	0.00%	0.00%	0.00%	82.49%	92.49%	95.40%	99.62%	98.75%	99.43%	99.20%
DP	73	0.00%	0.00%	75.31%	92.49%	97.49%	99.30%	100.10%	100.47%	99.73%	99.50%
DP	146	0.00%	0.00%	0.19%	83.10%	95.83%	98.64%	98.43%	100.60%	99.91%	99.30%
DP	147	0.00%	0.30%	26.30%	91.14%	96.11%	99.67%	100.37%	100.50%	99.59%	99.15%
DP	148	0.00%	0.00%	0.00%	80.15%	93.55%	98.67%	99.40%	101.10%	100.29%	100.02%
FO	28	0.00%	0.00%	0.00%	96.99%	97.30%	97.55%	99.14%	99.61%	98.85%	99.15%
FO	29	0.00%	0.00%	6.73%	96.79%	96.51%	97.55%	99.04%	99.70%	99.37%	99.68%
FO	30	0.00%	0.00%	1.31%	95.89%	97.49%	98.13%	99.62%	99.80%	99.50%	99.78%

(continued)

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Table A.3 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
FO	103	0.00%	0.00%	0.58%	98.20%	98.39%	98.97%	99.11%	99.01%	98.87%	99.02%
FO	104	0.00%	0.00%	39.15%	97.49%	97.38%	98.77%	99.50%	99.41%	99.32%	99.58%
FO	105	0.00%	0.00%	31.36%	97.49%	97.38%	99.07%	99.60%	99.81%	99.23%	99.40%
MJ	26	0.00%	0.00%	62.66%	91.59%	99.35%	100.47%	101.15%	100.08%	101.71%	102.09%
MJ	25	0.00%	0.00%	1.61%	89.19%	100.14%	101.54%	101.92%	100.47%	100.82%	101.03%
MJ	27	0.00%	0.00%	0.00%	86.79%	96.61%	100.37%	101.82%	100.66%	102.74%	103.29%
MJ	100	0.00%	0.00%	0.19%	93.29%	100.12%	101.07%	100.37%	99.51%	98.89%	98.93%
MJ	101	0.00%	0.00%	0.00%	81.58%	98.21%	101.27%	100.28%	99.61%	101.18%	101.68%
MJ	102	0.00%	0.00%	14.71%	89.98%	97.93%	100.47%	100.37%	100.30%	100.47%	100.60%
MJ	31	0.00%	2.80%	75.11%	98.19%	100.92%	99.78%	100.19%	99.32%	99.93%	98.26%
MJ	1	0.00%	0.00%	70.29%	94.99%	98.96%	98.91%	100.29%	96.65%	94.83%	93.81%
MJ	21	0.00%	0.00%	63.46%	92.79%	99.26%	98.81%	100.10%	98.37%	99.54%	99.33%
MJ	77	0.00%	0.00%	30.19%	83.37%	98.39%	100.97%	100.86%	100.30%	100.26%	99.94%
MJ	96	0.00%	0.00%	1.17%	84.17%	99.03%	100.67%	101.34%	100.30%	99.98%	99.69%
MJ	106	0.00%	0.00%	57.95%	91.41%	98.84%	100.67%	99.60%	99.31%	99.75%	99.48%
MJ	10	0.00%	0.00%	0.00%	16.50%	96.51%	98.81%	102.49%	101.23%	101.50%	101.22%
MJ	9	0.00%	0.00%	0.00%	0.00%	76.43%	94.62%	98.66%	99.80%	100.88%	100.91%
MJ	8	0.00%	0.00%	0.00%	75.49%	99.45%	101.44%	102.49%	101.90%	101.32%	100.96%
MJ	84	0.00%	0.00%	0.00%	76.85%	96.56%	101.47%	100.86%	101.30%	101.11%	100.84%
MJ	85	0.00%	0.00%	0.00%	78.37%	97.93%	102.17%	100.86%	101.30%	101.60%	101.46%
MJ	86	0.00%	0.00%	0.00%	78.45%	96.93%	101.77%	102.02%	101.30%	101.55%	101.49%
MJ	45	0.00%	0.00%	0.50%	84.69%	95.04%	97.35%	101.53%	100.47%	101.15%	101.39%
MJ	44	0.00%	0.00%	0.20%	82.99%	94.55%	96.86%	100.58%	100.28%	101.74%	101.99%
MJ	46	0.00%	0.00%	0.00%	86.79%	99.45%	98.81%	100.58%	100.18%	100.90%	101.19%
MJ	119	0.00%	0.00%	0.00%	88.73%	97.84%	99.77%	101.15%	100.30%	101.29%	101.36%
MJ	120	0.00%	0.00%	49.86%	92.22%	98.57%	99.97%	100.37%	101.30%	101.32%	101.18%
MJ	121	0.00%	0.00%	0.00%	86.68%	95.83%	98.27%	99.40%	100.10%	100.18%	100.19%
MJ	17	0.00%	0.00%	31.93%	86.79%	97.00%	98.52%	100.10%	99.51%	98.52%	98.35%
MJ	18	0.00%	0.00%	0.10%	85.99%	97.88%	99.01%	100.86%	100.18%	98.88%	98.63%
MJ	19	0.00%	0.00%	80.03%	98.39%	101.41%	99.98%	100.67%	99.13%	97.76%	97.67%
MJ	93	0.00%	0.00%	24.45%	89.62%	97.84%	98.47%	98.14%	98.71%	95.87%	95.68%
MJ	94	0.00%	0.00%	61.84%	91.41%	100.12%	101.07%	99.60%	99.81%	97.77%	97.45%
MJ	95	0.00%	0.00%	38.66%	88.46%	98.66%	99.37%	99.31%	99.41%	98.64%	98.31%
MJ	41	0.00%	0.00%	0.00%	59.89%	95.73%	98.71%	100.77%	100.47%	100.15%	100.43%
MJ	42	0.00%	0.00%	0.00%	80.79%	96.81%	98.71%	101.25%	100.56%	100.54%	100.80%
MJ	43	0.00%	0.00%	0.00%	68.79%	93.87%	98.03%	100.19%	99.99%	99.57%	99.80%
MJ	116	0.00%	0.00%	0.00%	51.02%	95.47%	99.37%	99.79%	99.81%	99.77%	99.97%
MJ	117	0.00%	0.00%	0.00%	84.89%	99.85%	102.17%	102.12%	101.50%	101.92%	102.16%
MJ	118	0.00%	0.00%	0.00%	19.93%	95.38%	100.37%	100.76%	101.00%	101.04%	101.26%
MJ	74	0.00%	0.00%	0.00%	57.50%	94.65%	100.27%	101.53%	101.23%	101.03%	101.09%
MJ	75	0.00%	0.00%	0.00%	62.69%	95.63%	99.78%	100.10%	99.32%	100.18%	100.25%
MJ	76	0.00%	0.00%	0.00%	56.60%	94.55%	100.08%	100.58%	100.37%	99.73%	99.80%
MJ	20	0.00%	1.80%	0.00%	78.29%	100.63%	100.17%	101.82%	100.08%	99.73%	99.98%
MJ	149	0.00%	0.00%	0.00%	70.86%	95.38%	99.47%	99.89%	100.10%	100.66%	100.76%
MJ	150	0.00%	0.00%	0.00%	78.19%	97.66%	99.47%	99.89%	98.81%	100.11%	100.08%
MJ	151	0.00%	0.00%	0.00%	79.53%	97.20%	99.47%	100.37%	100.10%	100.63%	100.64%
ND	35	67.99%	83.40%	91.38%	97.99%	100.43%	101.05%	101.06%	100.08%	98.74%	98.81%
ND	36	9.26%	81.90%	91.88%	97.49%	100.43%	100.76%	100.58%	99.23%	98.05%	98.21%
ND	37	0.00%	0.00%	88.36%	95.99%	98.77%	99.78%	100.10%	99.61%	98.54%	98.41%
ND	110	0.00%	0.50%	19.48%	97.13%	100.40%	101.47%	100.86%	100.50%	99.11%	99.20%
ND	111	0.00%	7.01%	85.22%	98.47%	100.85%	100.97%	101.34%	101.30%	98.91%	99.00%
ND	112	0.35%	75.56%	94.47%	98.47%	100.85%	101.17%	100.86%	100.30%	99.30%	99.28%

(continued)

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Table A.3 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
ND	59	0.00%	78.40%	89.67%	95.19%	100.92%	100.17%	97.80%	99.32%	98.32%	98.31%
ND	60	0.00%	1.80%	85.85%	95.99%	100.72%	100.17%	99.43%	99.13%	98.47%	98.31%
ND	61	0.00%	77.90%	85.55%	94.99%	99.74%	100.27%	100.19%	98.84%	98.37%	98.31%
ND	134	0.00%	60.55%	86.19%	96.06%	99.76%	101.17%	100.67%	100.01%	98.79%	98.87%
ND	135	0.00%	1.20%	86.68%	95.79%	100.40%	101.77%	101.34%	100.12%	98.46%	98.66%
ND	136	0.00%	6.20%	86.19%	95.16%	99.67%	100.77%	100.76%	100.10%	98.35%	98.52%
ND	22	0.00%	56.43%	74.31%	89.99%	98.96%	99.78%	100.10%	98.94%	97.76%	97.48%
ND	23	0.29%	49.44%	71.29%	86.99%	96.51%	98.32%	100.58%	99.32%	97.90%	97.77%
ND	24	0.00%	64.92%	77.32%	91.99%	99.16%	100.27%	101.06%	100.28%	98.00%	97.87%
ND	97	0.00%	3.50%	77.13%	91.77%	97.84%	100.47%	100.37%	100.30%	97.29%	97.52%
ND	98	0.00%	8.01%	72.75%	88.46%	97.20%	100.27%	100.67%	100.10%	97.26%	97.32%
ND	99	0.00%	0.50%	0.19%	89.98%	97.48%	99.97%	101.05%	100.10%	96.94%	96.93%
ND	47	0.00%	49.44%	85.35%	94.49%	98.96%	99.10%	101.06%	99.80%	99.20%	99.16%
ND	48	0.00%	48.94%	89.87%	95.49%	99.16%	98.71%	101.06%	101.14%	99.40%	99.44%
ND	49	0.00%	79.90%	89.37%	95.99%	98.96%	99.30%	100.38%	100.37%	99.27%	99.26%
ND	122	0.00%	15.01%	79.57%	90.25%	97.66%	99.47%	99.89%	100.60%	99.01%	99.10%
ND	123	0.00%	31.02%	81.32%	92.66%	97.20%	99.27%	100.37%	99.81%	98.98%	99.04%
ND	141	0.00%	6.51%	79.18%	92.22%	97.66%	99.17%	98.63%	99.61%	99.10%	99.01%
ND	65	0.00%	0.00%	86.36%	93.99%	97.98%	99.39%	100.38%	100.66%	99.93%	100.01%
ND	66	0.00%	2.50%	84.35%	93.49%	98.77%	99.69%	101.15%	100.85%	99.80%	99.84%
ND	67	0.00%	0.00%	80.33%	92.49%	96.51%	99.01%	100.86%	101.14%	100.02%	99.86%
ND	115	0.91%	57.84%	80.54%	94.00%	98.57%	99.77%	100.86%	100.60%	100.05%	100.03%
ND	124	0.00%	51.04%	78.89%	94.00%	98.30%	99.77%	101.34%	100.60%	100.10%	100.14%
ND	142	0.00%	28.72%	80.83%	94.27%	99.21%	99.27%	100.57%	100.01%	100.18%	100.08%
SJ	6	0.00%	0.22%	74.14%	95.96%	99.96%	98.13%	101.28%	100.56%	99.90%	99.60%
SJ	5	0.00%	0.15%	82.07%	96.88%	99.76%	97.98%	100.62%	100.40%	99.78%	99.42%
SJ	7	0.00%	18.03%	83.15%	97.71%	99.74%	98.13%	101.10%	100.44%	99.64%	99.43%
SJ	81	0.00%	0.00%	78.98%	97.58%	100.12%	98.94%	98.81%	100.40%	100.07%	100.16%
SJ	82	0.00%	0.00%	0.00%	85.71%	97.79%	98.72%	99.54%	100.53%	100.37%	100.20%
SJ	83	0.00%	0.00%	74.60%	96.59%	100.37%	98.70%	98.22%	100.80%	100.76%	100.78%
SJ	14	0.00%	0.00%	0.05%	77.74%	95.59%	95.85%	96.70%	96.93%	98.77%	99.25%
SJ	15	0.00%	0.00%	0.05%	80.09%	99.70%	98.11%	99.95%	100.29%	99.59%	99.70%
SJ	16	0.00%	0.00%	0.04%	66.64%	99.23%	98.54%	99.46%	99.80%	101.60%	100.72%
SJ	90	0.00%	0.00%	0.00%	56.49%	95.94%	97.30%	98.24%	98.44%	98.05%	98.60%
SJ	91	0.00%	0.00%	0.00%	74.82%	99.53%	98.42%	99.02%	98.68%	99.49%	99.05%
SJ	92	0.00%	0.00%	0.00%	62.57%	96.65%	98.27%	99.70%	99.41%	97.57%	98.28%
SJ	2	0.00%	0.00%	0.70%	94.59%	96.81%	97.16%	99.24%	97.89%	99.09%	99.10%
SJ	3	0.00%	0.00%	64.06%	94.79%	98.67%	98.32%	99.62%	98.17%	98.83%	98.83%
SJ	4	0.00%	0.00%	2.01%	92.39%	99.26%	98.23%	99.14%	97.41%	97.74%	97.95%
SJ	78	0.00%	0.00%	0.88%	97.04%	98.11%	98.17%	97.08%	95.93%	97.53%	97.69%
SJ	79	0.00%	0.00%	2.73%	94.45%	98.57%	98.17%	97.66%	96.53%	96.41%	97.12%
SJ	80	0.00%	0.00%	0.78%	93.20%	97.93%	98.57%	97.95%	96.83%	96.26%	95.82%
SJ	11	0.00%	0.00%	0.00%	71.59%	96.71%	95.99%	97.42%	100.28%	101.32%	101.41%
SJ	12	0.00%	0.00%	0.00%	85.29%	100.14%	99.78%	100.10%	100.66%	102.99%	102.45%
SJ	13	0.00%	0.00%	0.00%	84.39%	100.43%	97.84%	98.85%	101.33%	103.18%	100.98%
SJ	87	0.00%	0.00%	0.00%	57.81%	94.19%	95.77%	97.46%	100.60%	100.23%	99.87%
SJ	88	0.00%	0.00%	0.00%	0.71%	96.75%	97.97%	98.24%	100.30%	101.34%	50.12%
SJ	89	0.00%	0.00%	0.00%	71.22%	94.92%	97.77%	97.46%	99.51%	3.08%	0.72%

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Table A.4
Raw data for 5/8x3/4-inch meters at 0.75 life

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
DP	56	0.00%	0.00%	0.00%	89.03%	95.05%	100.26%	100.69%	100.43%	99.08%	99.06%
DP	57	0.00%	0.00%	83.52%	95.10%	98.14%	100.65%	100.88%	100.62%	99.12%	99.04%
DP	58	0.00%	0.00%	82.61%	95.70%	99.39%	100.56%	100.21%	101.00%	99.30%	99.27%
DP	131	0.00%	0.00%	78.19%	90.95%	97.59%	100.48%	100.65%	100.16%	99.08%	99.08%
DP	132	0.00%	0.00%	86.98%	96.13%	99.69%	101.57%	100.15%	101.12%	98.81%	98.71%
DP	133	0.00%	1.80%	88.05%	96.13%	99.59%	101.57%	100.65%	101.12%	99.11%	99.06%
DP	38	0.00%	0.00%	0.50%	81.77%	94.08%	98.28%	98.50%	99.86%	99.46%	99.25%
DP	39	0.00%	0.40%	80.01%	94.01%	99.10%	100.56%	101.17%	100.52%	99.41%	98.95%
DP	40	0.00%	2.30%	12.00%	94.80%	98.91%	100.75%	100.98%	100.05%	99.80%	99.25%
DP	113	0.00%	0.00%	78.43%	92.03%	96.59%	99.28%	100.15%	99.96%	98.39%	98.22%
DP	114	0.00%	0.00%	75.51%	88.81%	94.90%	98.28%	100.35%	100.16%	97.97%	97.93%
DP	140	0.00%	0.00%	83.80%	93.98%	97.39%	99.78%	100.15%	100.45%	98.82%	98.44%
DP	50	0.00%	0.00%	0.00%	85.55%	95.15%	98.68%	99.74%	100.52%	97.72%	95.40%
DP	51	0.00%	0.00%	0.00%	87.94%	95.53%	94.04%	100.12%	100.14%	99.35%	99.39%
DP	52	0.00%	0.00%	0.00%	87.54%	95.05%	99.57%	98.97%	100.33%	99.45%	98.50%
DP	125	0.00%	0.00%	0.00%	89.49%	96.89%	99.08%	100.15%	100.16%	99.83%	99.65%
DP	126	0.00%	0.00%	0.00%	91.54%	97.09%	99.28%	100.45%	100.93%	99.48%	99.36%
DP	127	0.00%	0.00%	0.00%	88.61%	94.90%	98.28%	99.86%	101.12%	99.48%	99.38%
DP	53	0.00%	0.00%	0.00%	41.78%	92.15%	97.79%	100.12%	100.62%	99.89%	99.68%
DP	54	0.00%	0.00%	0.00%	77.59%	93.12%	98.28%	100.12%	100.05%	99.84%	99.58%
DP	55	0.00%	0.00%	0.00%	74.61%	93.60%	97.99%	99.26%	99.57%	99.20%	98.99%
DP	128	0.00%	0.00%	0.00%	80.51%	93.10%	97.78%	100.65%	100.16%	93.99%	15.76%
DP	129	0.00%	0.00%	0.00%	0.29%	89.40%	98.78%	100.84%	100.25%	99.05%	98.79%
DP	130	0.00%	0.00%	0.00%	0.00%	87.40%	97.28%	100.65%	100.16%	99.18%	98.96%
DP	68	0.00%	0.00%	76.01%	93.01%	96.98%	99.27%	100.21%	99.57%	99.29%	99.28%
DP	69	0.00%	1.80%	83.72%	95.00%	98.43%	100.26%	100.02%	101.19%	99.53%	99.53%
DP	70	0.00%	0.00%	83.52%	95.00%	97.94%	99.77%	100.50%	99.76%	99.04%	98.98%
DP	143	0.00%	0.00%	79.56%	93.00%	97.89%	99.98%	100.84%	100.93%	99.21%	99.07%
DP	144	0.00%	0.00%	82.49%	92.91%	97.39%	100.08%	100.65%	100.45%	99.26%	99.07%
DP	145	0.00%	0.00%	0.00%	89.78%	95.89%	99.58%	100.65%	100.25%	99.16%	99.02%
DP	32	0.00%	0.90%	10.50%	95.90%	100.55%	102.14%	102.12%	102.14%	100.74%	100.60%
DP	33	0.00%	0.00%	79.51%	95.70%	100.07%	101.74%	102.31%	101.95%	100.74%	100.61%
DP	34	0.00%	0.30%	89.42%	98.58%	102.00%	103.22%	102.41%	102.05%	100.95%	99.63%
DP	107	0.00%	0.00%	84.54%	95.74%	99.99%	101.67%	101.93%	101.79%	99.79%	99.80%
DP	108	0.00%	0.00%	85.22%	96.91%	100.69%	102.07%	102.13%	102.18%	100.54%	100.40%
DP	109	0.00%	0.00%	86.05%	96.52%	100.19%	101.87%	101.73%	101.60%	99.75%	99.56%
DP	62	0.36%	0.00%	0.00%	0.00%	96.98%	99.47%	100.50%	100.52%	100.42%	100.38%
DP	63	0.00%	0.00%	0.00%	86.74%	95.53%	99.07%	100.69%	100.14%	100.35%	100.30%
DP	64	0.00%	0.00%	0.00%	0.00%	78.26%	93.84%	98.69%	99.95%	99.69%	99.76%
DP	137	0.00%	0.00%	0.00%	83.15%	93.40%	98.28%	100.15%	99.96%	100.07%	99.89%
DP	138	0.00%	0.00%	0.00%	88.81%	95.40%	99.98%	100.35%	100.16%	99.97%	99.84%
DP	139	0.00%	0.00%	0.00%	86.37%	95.40%	100.28%	100.65%	100.93%	100.07%	99.97%
DP	71	0.00%	0.00%	72.51%	91.52%	96.40%	98.78%	100.41%	100.81%	99.63%	99.05%
DP	72	0.00%	0.00%	0.00%	84.56%	92.25%	96.70%	100.21%	100.52%	98.87%	99.18%
DP	73	0.29%	0.00%	8.80%	92.71%	97.46%	99.77%	100.88%	100.33%	99.63%	99.52%
DP	146	0.00%	0.00%	0.00%	82.27%	94.40%	97.48%	100.15%	98.52%	99.41%	99.19%
DP	147	0.00%	0.00%	80.14%	92.71%	97.09%	99.28%	100.45%	100.45%	99.76%	99.37%
DP	148	0.00%	0.00%	0.00%	85.68%	94.40%	97.98%	100.15%	100.93%	100.21%	99.92%
FO	28	0.00%	0.00%	0.00%	97.49%	96.50%	96.80%	98.88%	99.48%	98.71%	98.98%
FO	29	0.00%	0.00%	0.00%	97.29%	95.82%	96.70%	98.97%	99.57%	99.23%	99.42%
FO	30	0.00%	0.00%	0.00%	96.39%	95.53%	97.39%	99.45%	99.76%	99.32%	99.52%

(continued)

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Table A.4 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
FO	103	0.00%	0.00%	0.00%	98.86%	98.39%	98.58%	98.08%	99.29%	98.94%	98.90%
FO	104	0.00%	0.00%	0.00%	97.79%	97.29%	98.68%	98.57%	99.48%	99.41%	99.48%
FO	105	0.00%	0.00%	0.00%	97.69%	97.69%	98.68%	98.38%	99.39%	99.28%	99.34%
MJ	26	0.00%	0.00%	0.00%	74.71%	95.72%	102.33%	101.46%	101.10%	101.87%	102.19%
MJ	25	0.00%	0.00%	0.00%	58.09%	92.25%	101.15%	101.26%	101.48%	100.94%	101.08%
MJ	27	0.00%	0.00%	0.00%	74.21%	93.41%	100.16%	101.17%	101.67%	102.75%	103.19%
MJ	100	0.00%	0.00%	57.84%	91.25%	99.19%	100.68%	100.55%	90.45%	99.12%	99.18%
MJ	101	0.00%	0.00%	67.36%	91.34%	99.29%	101.17%	100.55%	100.45%	101.53%	101.93%
MJ	102	0.00%	0.00%	0.00%	86.86%	95.00%	100.08%	100.65%	100.45%	100.73%	100.84%
MJ	31	0.00%	0.00%	63.71%	97.98%	100.55%	100.75%	99.74%	99.09%	98.07%	97.26%
MJ	1	0.00%	0.00%	42.01%	93.51%	98.62%	100.26%	99.45%	98.33%	93.37%	92.31%
MJ	21	0.00%	0.00%	59.01%	95.50%	99.87%	100.26%	98.31%	98.62%	99.51%	99.41%
MJ	77	0.00%	0.00%	25.62%	87.64%	100.19%	100.97%	101.83%	100.45%	100.37%	100.14%
MJ	96	0.00%	0.00%	0.00%	80.22%	97.39%	100.08%	101.14%	100.25%	100.01%	99.81%
MJ	106	0.00%	0.00%	42.71%	88.32%	98.19%	100.28%	99.66%	98.52%	99.44%	99.30%
MJ	10	0.00%	0.00%	0.50%	74.41%	93.79%	101.74%	101.17%	101.48%	101.52%	101.15%
MJ	9	0.00%	0.00%	1.30%	0.00%	72.57%	94.33%	97.92%	99.48%	100.87%	101.15%
MJ	8	0.00%	0.00%	0.00%	63.37%	98.43%	102.73%	101.46%	99.29%	101.27%	101.01%
MJ	84	0.00%	0.00%	0.00%	79.83%	97.39%	101.77%	101.44%	101.12%	101.07%	101.17%
MJ	85	0.00%	0.00%	0.00%	80.22%	98.39%	101.97%	101.63%	101.89%	101.56%	101.40%
MJ	86	0.00%	0.00%	0.00%	80.51%	97.09%	101.47%	100.84%	101.70%	101.56%	101.49%
MJ	45	0.00%	0.00%	0.00%	80.58%	94.08%	97.30%	99.83%	100.52%	101.26%	101.33%
MJ	44	0.00%	0.00%	0.00%	76.80%	93.60%	95.32%	98.78%	99.57%	101.80%	101.67%
MJ	46	0.00%	0.00%	0.00%	80.08%	94.86%	98.48%	100.31%	100.43%	101.31%	100.94%
MJ	119	0.00%	0.00%	0.00%	84.90%	97.39%	99.58%	100.84%	99.68%	101.82%	101.88%
MJ	120	0.00%	0.00%	33.04%	90.56%	97.89%	100.08%	100.94%	99.77%	101.57%	101.44%
MJ	121	0.00%	0.00%	40.75%	92.03%	97.59%	98.48%	99.17%	99.29%	100.36%	100.30%
MJ	17	0.00%	0.00%	13.50%	89.43%	98.04%	99.67%	99.26%	99.19%	98.56%	98.26%
MJ	18	0.00%	0.00%	0.00%	84.46%	97.75%	99.96%	99.45%	99.67%	98.88%	98.54%
MJ	19	0.00%	0.00%	75.61%	98.68%	102.00%	101.25%	99.36%	98.90%	97.66%	97.55%
MJ	93	0.00%	0.00%	6.98%	88.61%	97.49%	98.38%	98.38%	98.81%	95.35%	95.58%
MJ	94	0.00%	0.00%	9.71%	91.64%	99.89%	100.08%	99.56%	99.68%	97.71%	97.36%
MJ	95	0.00%	0.00%	0.00%	85.78%	97.29%	98.88%	99.17%	99.39%	98.52%	98.20%
MJ	41	0.00%	0.00%	0.00%	0.90%	96.59%	99.47%	100.41%	100.62%	100.16%	100.42%
MJ	42	0.00%	0.00%	0.00%	81.37%	97.08%	100.16%	100.50%	100.71%	100.55%	100.84%
MJ	43	0.00%	0.00%	0.00%	62.87%	93.12%	98.48%	99.93%	100.05%	99.53%	99.81%
MJ	116	0.00%	0.00%	0.00%	71.63%	95.70%	99.38%	99.86%	100.06%	99.41%	99.69%
MJ	117	0.00%	0.00%	0.00%	92.03%	100.49%	101.87%	101.53%	101.79%	101.79%	101.98%
MJ	118	0.00%	0.00%	0.00%	66.95%	95.80%	100.38%	100.94%	100.83%	101.17%	101.29%
MJ	74	0.00%	0.00%	0.00%	53.22%	93.12%	101.74%	102.03%	101.00%	101.07%	101.08%
MJ	75	0.00%	0.00%	0.00%	69.14%	95.05%	101.44%	101.17%	100.52%	100.26%	100.35%
MJ	76	0.00%	0.00%	0.00%	8.46%	93.12%	99.77%	100.12%	100.62%	99.68%	99.78%
MJ	20	0.00%	0.00%	0.00%	87.24%	101.03%	100.85%	100.41%	100.14%	99.86%	99.97%
MJ	149	0.00%	0.00%	0.00%	55.33%	95.40%	98.78%	99.86%	100.45%	100.79%	100.79%
MJ	150	0.00%	0.00%	0.00%	83.93%	99.09%	99.58%	100.35%	98.72%	100.26%	100.22%
MJ	151	0.00%	0.00%	0.00%	76.80%	96.69%	100.48%	100.65%	99.68%	100.80%	100.85%
ND	35	0.00%	74.92%	88.82%	96.59%	100.84%	101.25%	101.17%	100.05%	98.85%	98.97%
ND	36	1.43%	77.92%	90.02%	97.49%	100.36%	101.74%	101.36%	100.52%	98.27%	98.26%
ND	37	0.00%	77.12%	88.52%	96.00%	99.87%	100.75%	100.31%	99.00%	98.52%	98.55%
ND	110	0.00%	75.03%	89.47%	97.59%	100.39%	101.27%	100.84%	99.20%	99.03%	99.10%
ND	111	0.00%	74.53%	88.34%	97.59%	100.09%	100.78%	100.65%	98.81%	98.79%	98.81%
ND	112	0.00%	24.31%	94.54%	99.05%	100.89%	101.27%	100.84%	98.72%	99.04%	99.15%

(continued)

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Table A.4 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
ND	59	0.00%	1.90%	77.81%	95.70%	102.29%	101.54%	100.60%	99.38%	98.43%	98.39%
ND	60	0.00%	58.52%	86.62%	98.18%	101.32%	100.75%	100.12%	99.86%	98.73%	98.59%
ND	61	0.21%	24.31%	87.12%	97.89%	100.84%	101.74%	100.31%	98.14%	98.46%	98.51%
ND	134	0.00%	0.20%	78.83%	92.52%	98.09%	101.47%	100.94%	99.48%	98.60%	98.51%
ND	135	0.00%	79.03%	91.91%	97.59%	100.39%	101.77%	101.44%	100.16%	98.18%	98.36%
ND	136	0.00%	66.33%	87.61%	95.64%	99.39%	101.27%	101.63%	99.00%	98.30%	98.42%
ND	22	0.00%	49.71%	78.01%	92.51%	99.39%	100.75%	101.17%	99.09%	97.83%	97.58%
ND	23	0.00%	0.00%	65.01%	87.04%	96.50%	99.77%	100.69%	99.57%	98.22%	97.63%
ND	24	0.00%	44.01%	78.51%	93.31%	99.39%	101.25%	101.74%	97.09%	98.14%	97.88%
ND	97	0.00%	0.00%	68.19%	86.56%	95.70%	99.48%	100.84%	97.08%	97.06%	97.76%
ND	98	0.00%	0.50%	68.43%	89.30%	96.09%	99.78%	100.65%	98.23%	97.11%	97.41%
ND	99	0.00%	0.50%	71.11%	87.83%	95.60%	100.08%	100.15%	98.33%	97.01%	97.11%
ND	47	0.00%	2.80%	86.72%	96.19%	98.14%	100.36%	100.69%	99.86%	99.34%	99.26%
ND	48	0.00%	76.02%	88.92%	96.39%	98.91%	100.26%	100.69%	100.52%	99.52%	99.48%
ND	49	0.00%	6.10%	87.02%	96.49%	99.39%	99.67%	100.21%	100.14%	99.46%	99.40%
ND	122	0.00%	0.00%	71.60%	86.37%	94.40%	98.08%	99.66%	99.00%	98.70%	98.89%
ND	123	0.00%	0.00%	0.00%	91.74%	95.89%	99.48%	100.65%	99.96%	98.94%	98.89%
ND	141	0.00%	0.00%	80.78%	91.44%	96.69%	99.48%	99.66%	99.96%	98.97%	98.96%
ND	65	0.00%	3.70%	83.92%	94.20%	98.43%	100.26%	101.55%	100.62%	100.16%	100.19%
ND	66	0.00%	72.52%	87.92%	95.20%	99.39%	100.56%	101.07%	101.00%	100.02%	99.91%
ND	67	0.00%	8.90%	81.51%	93.81%	97.08%	100.16%	100.98%	100.71%	100.17%	100.03%
ND	115	0.00%	0.00%	78.58%	90.76%	96.39%	99.48%	100.84%	100.25%	99.85%	99.86%
ND	124	0.00%	0.00%	75.31%	90.08%	94.90%	99.28%	100.35%	100.16%	99.84%	99.78%
ND	142	0.00%	0.00%	73.07%	88.03%	94.60%	98.78%	100.94%	100.45%	99.97%	99.96%
SJ	6	0.00%	0.00%	0.09%	82.52%	97.79%	99.77%	99.98%	100.43%	100.10%	99.78%
SJ	5	0.00%	0.00%	0.05%	85.70%	98.14%	98.38%	99.64%	100.29%	100.04%	99.72%
SJ	7	0.00%	0.00%	0.09%	89.08%	98.36%	99.77%	100.00%	100.48%	99.01%	100.69%
SJ	81	0.00%	0.15%	79.22%	97.20%	99.89%	99.03%	98.82%	100.71%	100.26%	100.25%
SJ	82	0.00%	0.00%	0.00%	79.88%	95.73%	98.48%	99.36%	100.49%	100.49%	100.27%
SJ	83	0.00%	0.00%	1.10%	93.59%	99.09%	99.83%	98.33%	100.69%	100.80%	100.79%
SJ	14	0.00%	0.00%	0.00%	79.93%	94.54%	97.74%	97.03%	96.74%	99.55%	99.90%
SJ	15	0.00%	0.00%	0.00%	86.74%	101.23%	99.54%	100.61%	100.20%	99.66%	99.51%
SJ	16	0.00%	0.00%	0.00%	26.46%	100.17%	99.87%	99.99%	99.90%	101.16%	100.97%
SJ	90	0.00%	0.00%	0.00%	58.02%	93.75%	96.68%	98.31%	99.05%	97.96%	98.45%
SJ	91	0.00%	0.00%	0.02%	70.85%	97.12%	97.48%	97.93%	98.43%	99.22%	98.86%
SJ	92	0.00%	0.00%	0.00%	75.32%	95.94%	97.56%	98.99%	98.96%	97.78%	98.60%
SJ	2	0.00%	0.00%	0.00%	81.47%	98.62%	98.58%	98.11%	97.86%	99.16%	99.19%
SJ	3	0.00%	0.00%	1.70%	92.91%	95.34%	97.99%	98.88%	97.86%	98.86%	98.78%
SJ	4	0.00%	0.00%	0.00%	71.13%	98.14%	98.78%	98.02%	97.57%	97.79%	97.92%
SJ	78	0.00%	0.00%	0.00%	59.33%	93.40%	97.58%	97.59%	97.47%	97.57%	98.05%
SJ	79	0.00%	0.00%	0.00%	85.29%	97.29%	98.08%	97.78%	96.79%	96.94%	96.92%
SJ	80	0.00%	0.00%	0.00%	93.30%	98.39%	98.68%	97.69%	96.70%	96.59%	96.59%
SJ	11	0.00%	0.00%	0.00%	80.28%	97.46%	98.88%	97.83%	100.33%	101.93%	26.56%
SJ	12	0.00%	0.00%	0.00%	85.75%	100.84%	101.05%	100.60%	100.05%	103.68%	103.36%
SJ	13	0.00%	0.00%	0.00%	85.05%	99.01%	99.27%	99.55%	100.62%	102.38%	101.35%
SJ	87	0.00%	0.00%	0.00%	69.09%	95.89%	95.99%	97.49%	100.93%	100.04%	2.91%
SJ	88	0.00%	0.00%	0.00%	58.85%	95.40%	97.48%	98.18%	100.45%	101.06%	100.66%
SJ	89	0.00%	0.00%	0.00%	51.04%	90.70%	96.78%	96.90%	100.16%	2.82%	0.90%

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Table A.5
Raw data for 5/8x3/4-inch meters at 1.0 life

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
DP	56	0.00%	0.36%	7.31%	84.66%	98.31%	100.15%	100.21%	100.84%	99.08%	98.86%
DP	57	0.00%	0.24%	82.58%	93.18%	99.30%	99.68%	100.70%	100.36%	99.03%	98.86%
DP	58	0.00%	0.00%	80.86%	95.18%	98.31%	99.68%	100.70%	100.36%	99.23%	99.01%
DP	131	0.00%	0.00%	42.02%	90.82%	96.99%	100.19%	100.05%	100.16%	99.17%	99.10%
DP	132	0.00%	0.00%	81.04%	95.11%	98.19%	100.39%	100.84%	101.32%	98.90%	98.73%
DP	133	0.00%	0.00%	83.04%	94.61%	98.19%	100.19%	101.54%	100.83%	99.23%	99.07%
DP	38	0.00%	0.00%	0.00%	2.00%	81.43%	95.92%	96.36%	98.91%	99.53%	99.13%
DP	39	0.00%	0.00%	0.00%	0.50%	83.91%	95.45%	97.44%	99.88%	99.23%	98.83%
DP	40	0.00%	0.67%	0.00%	93.68%	98.80%	100.15%	100.21%	100.84%	99.50%	99.17%
DP	113	0.00%	2.68%	86.54%	94.51%	98.29%	99.50%	100.35%	99.86%	98.65%	98.27%
DP	114	0.00%	0.00%	0.50%	71.56%	87.29%	93.81%	95.90%	98.90%	97.96%	97.93%
DP	140	0.00%	0.00%	0.50%	76.85%	90.19%	95.57%	98.87%	99.67%	98.79%	98.51%
DP	50	0.00%	0.00%	0.86%	86.67%	94.83%	97.80%	100.21%	99.88%	97.38%	93.73%
DP	51	0.00%	0.00%	0.00%	88.67%	95.82%	98.27%	99.71%	100.36%	99.43%	98.71%
DP	52	0.00%	0.00%	0.43%	87.67%	94.83%	97.80%	99.71%	100.36%	99.38%	97.87%
DP	125	0.00%	0.00%	3.50%	90.32%	96.49%	98.72%	99.86%	100.64%	99.89%	99.47%
DP	126	0.00%	0.00%	2.50%	89.62%	96.19%	98.72%	100.35%	100.64%	99.64%	99.02%
DP	127	0.00%	0.00%	1.00%	88.33%	95.49%	98.23%	100.35%	100.64%	99.00%	94.55%
DP	53	0.00%	0.00%	0.00%	74.14%	92.35%	97.33%	100.21%	100.36%	99.78%	99.56%
DP	54	0.00%	0.00%	0.00%	0.00%	2.48%	78.52%	92.11%	98.91%	99.83%	99.41%
DP	55	0.00%	0.00%	0.00%	19.04%	92.35%	97.80%	98.72%	100.36%	98.43%	98.81%
DP	128	0.00%	0.00%	0.30%	0.00%	80.99%	91.84%	100.35%	99.38%	79.40%	32.50%
DP	129	0.00%	0.00%	0.30%	0.20%	0.50%	91.35%	99.86%	99.38%	99.25%	98.88%
DP	130	0.00%	0.00%	0.00%	0.50%	82.79%	94.30%	100.35%	100.64%	53.33%	19.77%
DP	68	0.00%	0.00%	80.43%	90.67%	97.31%	99.68%	100.70%	100.36%	99.31%	99.15%
DP	69	0.00%	0.00%	85.60%	93.68%	99.30%	100.62%	101.19%	100.36%	99.36%	99.39%
DP	70	0.00%	0.00%	83.44%	93.18%	97.81%	99.68%	100.70%	99.88%	98.86%	98.90%
DP	143	0.00%	0.00%	81.04%	92.32%	97.49%	99.70%	100.84%	100.35%	99.14%	99.14%
DP	144	0.00%	0.00%	0.00%	64.87%	90.99%	96.75%	99.86%	100.16%	99.27%	99.12%
DP	145	0.00%	0.00%	81.54%	92.32%	97.99%	99.70%	100.84%	100.64%	99.14%	99.12%
DP	32	0.00%	0.24%	84.99%	96.08%	100.79%	102.40%	102.58%	102.39%	100.95%	100.77%
DP	33	0.00%	0.24%	85.17%	96.08%	100.49%	101.93%	102.38%	102.19%	100.88%	100.72%
DP	34	0.00%	0.14%	90.93%	98.29%	101.68%	102.50%	102.38%	102.29%	101.15%	100.81%
DP	107	0.00%	0.00%	83.74%	95.01%	99.79%	101.07%	101.83%	101.80%	99.99%	99.85%
DP	108	0.00%	0.00%	85.54%	96.01%	100.38%	101.66%	102.33%	102.29%	100.63%	100.50%
DP	109	0.00%	0.00%	81.84%	94.31%	99.59%	101.27%	101.83%	101.80%	99.84%	99.69%
DP	62	0.00%	0.00%	0.43%	81.66%	93.34%	97.80%	99.91%	100.84%	100.39%	100.31%
DP	63	0.00%	0.00%	1.29%	84.16%	96.32%	99.68%	100.70%	100.36%	100.29%	100.26%
DP	64	0.00%	0.00%	0.43%	82.66%	94.34%	97.80%	99.71%	100.36%	99.60%	99.81%
DP	137	0.00%	0.00%	0.50%	83.04%	93.99%	98.23%	99.66%	100.16%	100.05%	99.93%
DP	138	0.00%	0.00%	0.00%	86.33%	94.69%	98.52%	99.36%	99.86%	100.03%	99.90%
DP	139	0.00%	0.00%	0.20%	87.63%	96.19%	99.50%	99.36%	100.16%	100.03%	99.99%
DP	71	0.00%	0.00%	79.57%	91.68%	97.81%	99.68%	100.70%	100.84%	99.57%	98.75%
DP	72	0.00%	0.00%	0.43%	81.66%	91.85%	95.45%	98.72%	100.84%	99.87%	99.64%
DP	73	0.00%	0.00%	51.62%	92.68%	97.31%	100.15%	100.70%	100.36%	99.72%	99.44%
DP	146	0.00%	0.00%	2.80%	82.54%	93.49%	96.75%	99.56%	100.54%	99.77%	99.31%
DP	147	0.00%	0.00%	82.74%	94.31%	97.99%	99.70%	100.65%	101.13%	99.77%	99.36%
DP	148	0.00%	0.00%	2.80%	84.83%	94.69%	98.23%	99.86%	100.83%	99.89%	99.41%
FO	28	0.00%	0.00%	0.00%	97.49%	96.62%	96.95%	98.13%	99.49%	98.48%	98.70%
FO	29	0.00%	0.00%	1.63%	97.59%	95.53%	96.76%	98.33%	99.39%	99.07%	99.24%
FO	30	0.00%	0.00%	0.00%	97.19%	95.63%	97.23%	98.63%	99.59%	99.12%	99.31%

(continued)

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Table A.5 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
FO	103	0.00%	0.00%	2.00%	97.31%	97.99%	98.03%	98.57%	99.19%	98.89%	98.91%
FO	104	0.00%	0.00%	1.60%	98.11%	96.99%	97.83%	98.97%	99.67%	99.31%	99.42%
FO	105	0.00%	0.00%	1.80%	97.71%	97.09%	97.73%	98.87%	99.48%	99.27%	99.41%
MJ	26	0.00%	0.00%	71.66%	94.18%	100.09%	100.99%	101.09%	100.36%	102.00%	102.28%
MJ	25	0.00%	0.00%	0.09%	78.85%	96.82%	102.12%	101.79%	100.55%	101.03%	101.17%
MJ	27	0.00%	0.00%	0.00%	39.88%	94.53%	101.37%	101.29%	100.55%	102.62%	103.03%
MJ	100	0.00%	0.00%	0.20%	83.24%	98.09%	100.09%	100.74%	99.96%	99.20%	99.21%
MJ	101	0.00%	0.00%	56.83%	91.02%	99.19%	100.78%	100.74%	101.03%	101.62%	101.92%
MJ	102	0.00%	0.00%	0.00%	0.40%	86.99%	96.06%	100.84%	100.45%	100.79%	100.84%
MJ	31	0.00%	0.00%	22.80%	83.16%	97.81%	99.68%	100.21%	99.39%	96.77%	96.06%
MJ	1	0.00%	0.00%	55.92%	90.17%	98.80%	99.68%	99.42%	98.91%	93.03%	92.82%
MJ	21	0.00%	0.00%	69.68%	93.68%	99.80%	100.15%	99.71%	99.88%	99.48%	99.38%
MJ	77	0.00%	0.00%	1.30%	82.54%	98.49%	100.39%	101.83%	100.83%	100.27%	99.80%
MJ	96	0.00%	0.00%	0.50%	81.34%	97.99%	99.99%	101.04%	100.54%	99.95%	99.72%
MJ	106	0.00%	0.00%	63.83%	91.82%	98.99%	100.19%	99.86%	99.19%	99.49%	99.16%
MJ	10	0.00%	0.00%	0.00%	8.52%	90.36%	99.68%	101.19%	101.32%	101.75%	100.96%
MJ	9	0.00%	0.00%	0.00%	0.00%	67.52%	93.09%	97.74%	99.88%	101.15%	100.76%
MJ	8	0.00%	0.00%	0.00%	45.09%	98.31%	102.50%	100.70%	102.77%	101.45%	100.91%
MJ	84	0.00%	0.00%	0.00%	64.87%	94.49%	100.68%	101.54%	101.03%	101.13%	101.13%
MJ	85	0.00%	0.00%	0.00%	80.64%	98.19%	102.15%	101.04%	102.09%	101.68%	101.50%
MJ	86	0.00%	0.00%	2.00%	81.84%	97.99%	101.17%	100.84%	101.61%	101.45%	101.52%
MJ	45	0.00%	0.00%	2.58%	86.67%	95.82%	97.80%	100.21%	101.32%	101.54%	101.49%
MJ	44	0.00%	0.00%	0.00%	76.65%	93.84%	96.86%	98.72%	100.36%	102.05%	102.04%
MJ	46	0.00%	0.00%	0.00%	84.66%	97.31%	99.21%	100.21%	100.84%	101.55%	101.42%
MJ	119	0.00%	0.00%	0.00%	73.55%	92.99%	98.72%	100.55%	100.54%	101.91%	101.95%
MJ	120	0.00%	0.00%	14.31%	91.82%	98.19%	100.19%	100.84%	100.83%	101.65%	101.47%
MJ	121	0.00%	0.00%	2.00%	88.33%	96.99%	97.73%	99.36%	99.57%	100.43%	100.34%
MJ	17	0.00%	0.00%	37.42%	85.66%	98.01%	98.92%	99.51%	99.20%	98.46%	98.07%
MJ	18	0.00%	0.00%	1.89%	84.26%	98.51%	99.77%	99.91%	99.59%	98.81%	98.38%
MJ	19	0.00%	0.00%	62.63%	92.58%	100.69%	100.52%	99.42%	98.81%	97.45%	97.31%
MJ	93	0.00%	0.00%	1.40%	84.63%	96.59%	97.44%	98.17%	98.12%	94.92%	95.34%
MJ	94	0.00%	0.00%	0.80%	80.74%	97.49%	98.62%	99.46%	99.28%	97.44%	97.07%
MJ	95	0.00%	0.00%	0.20%	80.34%	97.29%	98.32%	99.06%	98.99%	97.96%	97.86%
MJ	41	0.00%	0.00%	0.00%	42.58%	95.53%	99.02%	100.90%	100.65%	100.41%	100.49%
MJ	42	0.00%	0.00%	0.00%	76.55%	96.92%	99.96%	100.70%	100.65%	100.75%	100.89%
MJ	43	0.00%	0.00%	0.60%	61.12%	94.24%	99.21%	100.21%	100.26%	99.76%	99.85%
MJ	116	0.00%	0.00%	0.00%	58.88%	94.69%	98.81%	99.95%	99.96%	99.85%	100.21%
MJ	117	0.00%	0.00%	4.10%	91.02%	100.38%	101.56%	101.83%	101.90%	102.18%	102.24%
MJ	118	0.00%	0.00%	0.00%	0.60%	95.09%	99.90%	101.04%	101.32%	101.45%	101.54%
MJ	74	0.00%	0.00%	0.00%	13.53%	90.36%	100.62%	101.69%	101.32%	101.15%	101.13%
MJ	75	0.00%	0.00%	0.00%	61.62%	94.34%	100.15%	100.70%	100.46%	100.32%	100.35%
MJ	76	0.00%	0.00%	0.00%	7.51%	91.36%	99.68%	100.70%	100.36%	98.66%	100.03%
MJ	20	0.00%	12.34%	72.52%	95.78%	100.29%	100.62%	101.69%	100.17%	99.91%	100.00%
MJ	149	0.00%	0.00%	0.00%	2.00%	92.49%	98.03%	100.35%	100.35%	100.83%	100.85%
MJ	150	0.00%	0.00%	0.20%	75.65%	95.99%	99.50%	99.86%	99.38%	100.18%	100.26%
MJ	151	0.00%	0.00%	0.00%	72.66%	96.19%	100.19%	100.05%	100.64%	100.86%	100.90%
ND	35	0.00%	0.24%	88.61%	95.68%	100.29%	100.62%	101.19%	100.84%	98.82%	98.88%
ND	36	0.00%	11.93%	86.03%	95.68%	99.80%	101.56%	100.70%	99.39%	98.27%	98.39%
ND	37	0.00%	0.00%	86.46%	95.18%	98.80%	100.15%	101.19%	100.36%	98.52%	98.54%
ND	110	0.00%	74.86%	91.54%	97.51%	99.99%	100.98%	100.84%	100.06%	99.10%	99.21%
ND	111	0.60%	28.26%	92.34%	97.51%	99.99%	100.39%	100.65%	100.06%	98.80%	98.86%
ND	112	0.37%	78.33%	91.24%	98.11%	100.68%	101.17%	100.84%	100.35%	99.31%	99.19%

(continued)

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Table A.5 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/64gpm	1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	15gpm	20gpm
ND	59	0.00%	0.00%	83.87%	93.18%	98.80%	99.68%	100.70%	98.91%	98.26%	98.37%
ND	60	0.00%	0.84%	81.29%	92.68%	99.30%	100.15%	100.21%	98.43%	98.26%	98.52%
ND	61	0.00%	0.00%	77.42%	90.67%	97.81%	100.62%	100.30%	98.91%	98.16%	98.43%
ND	134	0.00%	0.00%	78.65%	92.81%	98.49%	100.98%	101.34%	98.60%	98.54%	98.66%
ND	135	0.97%	78.33%	91.24%	97.31%	99.99%	100.98%	101.83%	99.86%	98.39%	98.56%
ND	136	0.37%	76.05%	88.84%	97.01%	99.79%	101.17%	101.83%	99.86%	98.31%	98.44%
ND	22	0.00%	4.65%	77.42%	91.17%	98.31%	100.15%	101.69%	100.46%	98.06%	97.54%
ND	23	0.00%	0.00%	74.84%	89.17%	96.32%	99.21%	101.19%	100.36%	98.40%	97.97%
ND	24	0.00%	0.00%	79.14%	91.17%	98.31%	99.68%	101.19%	100.84%	98.58%	97.78%
ND	97	0.37%	0.00%	75.23%	93.62%	92.69%	100.19%	100.84%	99.67%	97.68%	97.61%
ND	98	0.00%	0.00%	73.03%	89.82%	95.99%	99.90%	100.15%	99.67%	97.38%	97.20%
ND	99	0.22%	46.60%	79.04%	90.82%	96.99%	99.90%	100.35%	99.67%	97.09%	97.15%
ND	47	0.00%	0.00%	83.87%	93.28%	98.70%	99.21%	99.71%	102.29%	99.50%	99.37%
ND	48	0.00%	5.01%	87.75%	95.18%	99.30%	98.74%	101.19%	100.84%	99.59%	99.57%
ND	49	0.00%	75.90%	88.61%	94.68%	97.81%	99.68%	101.19%	99.39%	99.45%	99.27%
ND	122	0.00%	1.49%	77.53%	89.32%	95.99%	98.91%	99.06%	100.35%	98.95%	98.98%
ND	123	0.00%	0.00%	72.73%	88.82%	94.99%	98.52%	101.04%	100.35%	98.92%	98.96%
ND	141	0.00%	0.00%	79.54%	89.32%	96.69%	99.21%	99.66%	99.57%	99.04%	99.13%
ND	65	0.00%	0.00%	82.15%	91.68%	96.82%	99.68%	100.21%	101.81%	100.23%	100.17%
ND	66	0.00%	0.00%	80.86%	92.18%	97.31%	99.21%	100.40%	101.81%	99.95%	100.03%
ND	67	0.00%	0.12%	77.42%	89.17%	96.32%	99.21%	100.70%	101.32%	100.12%	100.19%
ND	115	0.37%	0.00%	74.03%	87.83%	95.49%	98.52%	100.15%	100.35%	99.94%	100.05%
ND	124	0.00%	0.00%	74.83%	89.32%	95.49%	99.21%	101.04%	101.51%	100.09%	99.92%
ND	142	0.00%	0.00%	78.74%	90.62%	96.19%	100.98%	100.84%	100.54%	100.18%	99.99%
SJ	6	0.00%	0.00%	0.04%	83.51%	97.96%	98.13%	100.45%	100.74%	100.17%	99.91%
SJ	5	0.00%	0.00%	0.04%	76.75%	96.57%	98.13%	99.81%	100.36%	100.16%	99.74%
SJ	7	0.00%	0.00%	78.67%	96.13%	99.92%	97.94%	100.35%	100.60%	100.22%	99.84%
SJ	81	0.00%	0.00%	70.73%	95.96%	100.14%	98.42%	99.61%	100.54%	100.41%	100.28%
SJ	82	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	74.56%	0.08%	0.04%
SJ	83	0.00%	0.00%	64.78%	94.46%	99.82%	97.93%	99.00%	100.83%	101.08%	100.89%
SJ	14	0.00%	0.00%	0.00%	65.17%	92.25%	96.34%	96.26%	96.69%	99.95%	100.03%
SJ	15	0.00%	0.00%	0.04%	77.45%	99.65%	98.88%	99.96%	99.15%	100.31%	100.42%
SJ	16	0.00%	0.00%	0.04%	77.32%	98.93%	99.21%	99.59%	99.94%	101.22%	101.20%
SJ	90	0.00%	0.00%	0.05%	60.58%	94.32%	96.02%	98.19%	98.12%	98.82%	99.01%
SJ	91	0.00%	0.00%	0.43%	72.28%	97.64%	96.85%	97.93%	98.05%	99.52%	98.98%
SJ	92	0.00%	0.00%	0.18%	35.20%	95.19%	96.31%	98.89%	98.68%	97.73%	98.42%
SJ	2	0.00%	0.00%	61.85%	94.48%	98.11%	97.89%	98.53%	97.85%	99.31%	99.22%
SJ	3	0.00%	0.00%	7.40%	89.07%	97.22%	98.17%	99.22%	98.62%	98.94%	98.84%
SJ	4	0.00%	0.00%	0.00%	0.80%	95.73%	97.51%	98.72%	97.46%	97.89%	97.82%
SJ	78	0.00%	0.00%	0.00%	0.60%	87.39%	96.16%	97.58%	96.57%	97.77%	97.84%
SJ	79	0.00%	0.00%	0.10%	68.86%	95.69%	97.83%	98.27%	96.96%	96.94%	96.87%
SJ	80	0.00%	0.00%	0.00%	0.20%	83.89%	95.47%	97.58%	96.96%	96.54%	96.53%
SJ	11	0.00%	0.00%	0.00%	56.61%	95.33%	98.27%	97.24%	99.88%	34.79%	20.04%
SJ	12	0.00%	0.00%	0.00%	79.15%	99.20%	100.38%	100.21%	99.88%	103.26%	102.95%
SJ	13	0.00%	0.00%	0.00%	72.54%	99.30%	98.97%	98.92%	101.32%	101.22%	100.93%
SJ	87	0.00%	0.00%	0.00%	61.68%	94.49%	95.77%	97.09%	100.83%	30.16%	3.01%
SJ	88	0.00%	0.00%	0.00%	64.87%	95.49%	97.24%	98.57%	99.57%	100.04%	99.91%
SJ	89	0.00%	0.00%	0.00%	0.00%	0.00%	84.96%	94.91%	98.12%	0.99%	0.44%

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ACCURACY AND ENDURANCE TESTING 3/4-INCH METERS

Table A.6
Raw data for 3/4-inch meters at 0 life

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
DP	8	0.17%	73.70%	91.74%	97.76%	99.99%	100.83%	102.09%	101.50%	99.21%	99.15%
DP	9	0.00%	0.00%	80.54%	92.49%	98.99%	100.83%	100.80%	100.54%	99.22%	99.12%
DP	10	0.17%	73.70%	91.84%	98.45%	100.49%	101.12%	100.90%	100.73%	99.36%	99.30%
DP	62	0.00%	0.96%	82.70%	94.38%	99.33%	100.28%	100.53%	100.53%	99.23%	99.23%
DP	63	0.00%	3.07%	82.99%	94.38%	99.13%	101.10%	100.83%	100.83%	99.00%	99.06%
DP	64	0.17%	72.98%	88.39%	96.38%	100.62%	101.56%	100.53%	100.53%	99.08%	99.19%
DP	43	0.00%	0.00%	22.01%	89.50%	96.10%	100.83%	102.79%	102.94%	90.91%	90.23%
DP	44	0.00%	0.00%	71.03%	90.70%	97.79%	101.31%	102.59%	102.84%	86.29%	85.36%
DP	45	0.10%	0.00%	0.00%	82.54%	97.00%	97.49%	101.30%	103.13%	83.97%	83.24%
DP	85	0.00%	0.00%	69.44%	90.39%	97.53%	100.92%	102.52%	102.52%	86.15%	85.21%
DP	92	0.00%	0.00%	56.28%	90.39%	97.83%	100.92%	102.02%	102.02%	91.02%	90.23%
DP	93	0.00%	0.00%	65.12%	90.09%	97.63%	101.20%	102.52%	102.52%	87.94%	87.82%
DP	1	0.00%	0.00%	0.00%	93.38%	99.29%	99.40%	99.22%	99.10%	98.23%	98.29%
DP	2	0.31%	88.21%	94.84%	98.45%	99.79%	99.88%	99.81%	99.68%	98.54%	98.60%
DP	3	0.24%	96.95%	94.34%	98.16%	99.79%	99.88%	99.81%	99.58%	98.60%	98.64%
DP	76	0.27%	79.41%	93.60%	98.98%	101.32%	101.75%	100.93%	100.93%	97.43%	99.74%
DP	77	0.10%	77.30%	92.52%	98.88%	101.02%	101.65%	100.93%	100.93%	97.51%	100.01%
DP	78	0.00%	0.00%	66.29%	84.39%	91.64%	93.76%	93.86%	93.86%	95.45%	96.36%
DP	52	0.00%	0.00%	0.80%	96.66%	100.49%	101.79%	101.10%	101.21%	101.13%	100.51%
DP	12	0.00%	0.00%	0.00%	95.77%	99.49%	100.83%	101.40%	101.41%	100.43%	100.35%
DP	13	0.00%	0.00%	0.00%	95.47%	99.09%	101.02%	101.60%	101.69%	100.27%	100.33%
DP	36	0.00%	0.50%	93.04%	97.96%	100.09%	100.64%	101.10%	101.21%	100.02%	100.01%
DP	37	0.10%	78.27%	93.04%	97.96%	95.30%	101.12%	101.10%	100.73%	99.96%	100.02%
DP	38	0.24%	9.64%	93.34%	97.96%	100.09%	100.83%	100.61%	100.73%	99.82%	99.91%
DP	72	0.00%	0.00%	0.49%	96.88%	99.53%	100.74%	101.53%	101.53%	100.30%	100.31%
DP	73	0.10%	0.00%	91.83%	97.68%	99.82%	101.38%	101.53%	101.53%	100.43%	100.31%
DP	74	0.00%	0.00%	0.20%	95.88%	99.33%	101.10%	101.23%	101.23%	100.43%	100.42%
DP	65	0.10%	78.45%	93.01%	98.08%	99.82%	100.46%	100.83%	100.83%	100.23%	100.26%
DP	66	0.00%	72.50%	92.81%	97.38%	99.82%	100.92%	100.73%	100.73%	100.00%	100.04%
DP	67	0.00%	82.78%	92.12%	97.38%	99.82%	100.46%	101.03%	101.03%	100.18%	100.26%
FO	4	0.00%	0.00%	34.42%	63.55%	84.92%	90.80%	99.12%	98.53%	98.75%	98.98%
FO	5	0.00%	0.00%	12.81%	73.00%	88.91%	90.22%	99.32%	99.10%	99.76%	100.13%
FO	6	0.00%	0.00%	4.10%	69.12%	79.03%	88.12%	99.02%	98.82%	98.84%	99.11%
FO	61	0.00%	0.00%	14.14%	69.41%	86.55%	96.97%	99.93%	99.93%	99.49%	99.63%
FO	68	0.00%	0.00%	1.08%	75.80%	83.25%	97.25%	99.34%	99.34%	100.14%	100.21%
FO	105	0.00%	0.00%	82.40%	79.40%	92.94%	98.35%	99.44%	99.44%	99.63%	99.81%
MJ	46	0.00%	0.00%	0.70%	87.52%	97.79%	97.20%	99.61%	100.45%	99.45%	99.22%
MJ	30	0.00%	0.00%	0.00%	0.00%	0.00%	92.04%	97.43%	99.30%	97.27%	97.29%
MJ	31	0.00%	0.00%	58.03%	89.01%	101.09%	99.88%	100.80%	100.93%	99.03%	99.24%
MJ	91	0.00%	0.00%	49.60%	92.58%	100.82%	101.38%	100.23%	100.23%	100.87%	101.03%
MJ	86	0.00%	0.00%	0.20%	93.68%	102.32%	100.92%	101.33%	101.33%	100.63%	100.53%
MJ	87	0.00%	0.00%	64.04%	96.88%	99.82%	100.46%	101.82%	101.82%	100.32%	100.05%
MJ	39	0.00%	0.00%	77.04%	98.45%	97.99%	101.31%	101.40%	101.21%	100.18%	100.14%
MJ	40	0.00%	0.00%	72.83%	95.47%	96.80%	100.55%	100.90%	100.45%	100.86%	100.93%
MJ	41	0.00%	0.00%	69.03%	95.17%	97.10%	100.64%	100.90%	99.97%	100.20%	100.17%
MJ	55	0.00%	0.67%	76.51%	95.88%	98.83%	99.09%	99.34%	99.34%	99.72%	100.20%
MJ	56	0.00%	0.29%	72.68%	95.08%	97.13%	98.35%	99.73%	99.73%	99.69%	99.78%
MJ	57	0.00%	0.00%	72.19%	95.58%	99.03%	99.73%	100.03%	100.03%	99.14%	99.34%

(continued)

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Table A.6 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
MJ	49	0.00%	21.16%	76.24%	103.73%	101.09%	100.83%	100.70%	100.93%	89.76%	89.67%
MJ	50	0.07%	61.78%	94.74%	102.73%	99.29%	99.88%	99.71%	99.87%	96.56%	96.99%
MJ	51	0.07%	0.00%	83.54%	99.45%	97.99%	99.30%	99.52%	99.20%	96.36%	97.06%
MJ	22	0.03%	0.00%	94.74%	102.13%	104.28%	103.61%	102.09%	101.89%	98.66%	98.36%
MJ	23	0.00%	0.00%	82.64%	98.95%	102.88%	102.55%	100.21%	99.58%	98.54%	98.65%
MJ	24	0.00%	0.00%	91.84%	100.44%	102.98%	102.55%	99.91%	99.30%	99.30%	99.61%
MJ	94	0.00%	0.00%	90.65%	101.87%	102.92%	101.84%	99.73%	99.73%	101.67%	102.74%
MJ	95	0.00%	0.00%	82.79%	97.88%	100.72%	100.64%	98.84%	98.84%	99.22%	99.50%
MJ	96	0.00%	0.00%	77.59%	97.18%	100.92%	100.46%	98.84%	98.84%	99.95%	98.87%
MJ	79	0.00%	38.22%	91.04%	102.07%	101.42%	100.55%	100.23%	100.23%	100.03%	100.22%
MJ	80	0.00%	10.27%	74.35%	99.87%	99.92%	99.73%	100.33%	100.33%	98.15%	99.22%
MJ	81	0.00%	51.85%	90.95%	99.28%	98.63%	97.62%	97.94%	97.94%	96.68%	97.74%
MJ	29	0.00%	0.00%	88.54%	100.24%	98.79%	101.50%	100.61%	100.25%	99.71%	99.67%
MJ	47	0.10%	0.00%	87.54%	98.45%	100.29%	101.69%	101.30%	100.73%	100.13%	100.13%
MJ	48	0.00%	0.00%	90.24%	98.75%	100.29%	102.27%	102.09%	100.25%	99.31%	99.20%
MJ	7	0.07%	0.00%	80.44%	95.97%	98.49%	103.03%	101.50%	99.97%	99.55%	99.67%
MJ	14	0.00%	0.50%	83.74%	97.46%	99.59%	103.03%	101.89%	101.02%	99.54%	99.46%
MJ	21	0.00%	0.30%	69.03%	95.27%	97.59%	100.64%	99.71%	99.30%	99.38%	99.47%
MJ	100	0.00%	0.00%	77.39%	92.58%	95.83%	97.25%	97.25%	97.25%	95.44%	95.46%
MJ	101	0.00%	51.37%	88.39%	95.38%	97.33%	97.53%	97.34%	97.34%	95.66%	95.65%
MJ	102	0.00%	0.67%	84.76%	96.38%	100.02%	100.92%	100.73%	100.73%	97.65%	97.66%
ND	11	0.45%	88.70%	95.54%	99.95%	101.59%	101.60%	102.09%	101.21%	99.71%	99.67%
ND	53	0.52%	90.39%	96.04%	100.24%	101.59%	102.46%	102.39%	99.97%	99.76%	99.65%
ND	54	81.51%	95.36%	98.05%	100.74%	101.49%	103.22%	101.60%	100.73%	99.63%	99.60%
ND	103	0.00%	0.19%	98.02%	100.67%	101.82%	102.57%	100.73%	100.73%	99.35%	99.45%
ND	104	1.23%	86.90%	95.56%	99.38%	101.12%	101.84%	101.23%	101.23%	99.37%	99.49%
ND	75	12.76%	94.39%	99.69%	100.87%	101.82%	102.48%	100.33%	100.33%	99.08%	99.17%
ND	28	0.17%	34.77%	92.74%	99.45%	99.99%	101.12%	101.60%	100.73%	98.85%	99.23%
ND	35	13.48%	79.76%	90.24%	96.96%	99.99%	101.02%	101.60%	101.21%	99.26%	99.10%
ND	42	0.38%	72.21%	87.74%	96.47%	99.79%	100.83%	101.10%	101.21%	98.89%	98.80%
ND	69	45.56%	80.66%	90.36%	96.08%	99.53%	101.20%	101.03%	101.03%	99.54%	99.50%
ND	70	0.23%	67.22%	84.27%	93.38%	97.83%	99.82%	100.73%	100.73%	99.13%	99.10%
ND	71	27.83%	75.86%	89.37%	96.08%	99.53%	100.92%	101.33%	101.33%	99.31%	99.30%
ND	15	0.10%	0.00%	95.24%	97.76%	100.09%	101.31%	101.60%	100.25%	99.38%	99.27%
ND	16	78.15%	91.88%	96.54%	99.45%	100.29%	100.83%	100.80%	100.73%	99.47%	99.60%
ND	17	80.82%	91.88%	97.35%	99.45%	100.79%	101.31%	101.40%	100.73%	99.33%	99.30%
ND	97	0.66%	84.70%	92.62%	97.88%	100.12%	100.00%	100.33%	100.33%	99.80%	99.79%
ND	98	53.91%	84.02%	95.76%	98.58%	100.32%	101.65%	100.73%	100.73%	99.61%	99.65%
ND	99	31.05%	84.02%	94.28%	98.08%	99.33%	101.20%	100.83%	100.83%	99.63%	99.60%
SJ	32	0.01%	0.00%	89.59%	95.00%	98.14%	100.02%	99.71%	100.35%	99.18%	99.35%
SJ	33	0.28%	2.55%	93.19%	98.31%	97.39%	99.08%	98.95%	100.06%	99.33%	99.54%
SJ	34	0.47%	1.42%	96.34%	98.57%	98.79%	100.91%	100.33%	100.54%	99.86%	100.08%
SJ	88	0.13%	62.82%	92.01%	100.29%	99.26%	100.00%	99.66%	99.66%	100.18%	100.29%
SJ	89	0.00%	0.48%	81.79%	96.00%	97.93%	98.90%	99.16%	99.16%	98.68%	98.76%
SJ	90	0.00%	0.00%	73.66%	92.56%	97.13%	98.81%	99.88%	99.88%	98.67%	98.76%
SJ	18	0.00%	0.20%	91.24%	99.65%	101.19%	101.89%	103.38%	102.84%	100.77%	100.67%
SJ	19	0.10%	81.05%	96.34%	99.95%	101.49%	103.13%	104.07%	103.13%	101.29%	101.13%
SJ	20	0.10%	5.26%	96.54%	100.05%	100.19%	104.18%	104.77%	103.13%	99.45%	99.30%
SJ	82	0.00%	0.29%	20.33%	100.27%	100.72%	99.82%	101.43%	101.43%	101.16%	101.04%
SJ	83	0.00%	0.00%	98.21%	102.37%	101.92%	101.38%	103.12%	103.12%	103.33%	103.23%
SJ	84	0.20%	81.43%	97.43%	99.58%	99.33%	98.72%	100.73%	100.73%	99.63%	99.54%
TU	25	0.00%	0.00%	0.00%	70.81%	95.80%	100.55%	101.60%	101.50%	101.54%	101.61%
TU	26	0.00%	0.00%	0.00%	0.20%	74.14%	94.62%	99.12%	101.21%	101.34%	101.54%
TU	27	0.00%	0.00%	0.00%	0.30%	47.90%	90.03%	98.62%	100.06%	101.00%	101.02%
TU	58	0.00%	0.00%	0.00%	0.20%	85.35%	96.79%	99.53%	99.53%	101.36%	101.44%
TU	59	0.00%	0.00%	17.68%	87.59%	99.82%	103.21%	102.52%	102.52%	101.16%	101.01%
TU	60	0.00%	0.00%	0.00%	0.50%	83.05%	96.52%	99.04%	99.04%	100.34%	100.40%

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Table A.7
Raw data for 3/4-inch meters at 0.25 life

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
DP	8	0.16%	76.53%	93.32%	97.19%	99.16%	101.84%	100.06%	100.94%	99.17%	99.08%
DP	9	0.00%	7.22%	88.50%	97.00%	99.46%	100.84%	101.02%	100.64%	99.20%	99.08%
DP	10	0.06%	0.77%	86.77%	95.55%	98.46%	101.04%	100.83%	100.69%	99.32%	99.28%
DP	62	0.00%	0.00%	83.41%	95.06%	99.40%	100.67%	100.74%	100.28%	99.01%	98.86%
DP	63	0.09%	48.01%	86.91%	96.46%	99.21%	100.17%	100.99%	100.63%	98.91%	98.77%
DP	64	0.31%	80.51%	93.90%	98.34%	101.40%	102.17%	100.34%	100.28%	98.96%	98.96%
DP	43	0.06%	0.00%	1.18%	87.06%	96.67%	101.84%	103.39%	102.94%	90.38%	89.31%
DP	44	0.00%	0.00%	60.09%	90.92%	99.16%	100.84%	102.25%	102.44%	83.73%	82.32%
DP	45	0.06%	0.00%	26.86%	87.83%	96.47%	99.84%	100.83%	102.07%	82.21%	81.13%
DP	85	0.00%	0.00%	0.50%	89.16%	94.92%	100.37%	101.49%	101.62%	83.52%	82.85%
DP	92	0.00%	0.00%	35.66%	88.67%	96.51%	100.87%	102.39%	101.12%	89.29%	88.66%
DP	93	0.00%	0.00%	0.50%	89.74%	96.41%	100.67%	102.09%	102.51%	87.28%	86.89%
DP	1	0.25%	85.58%	94.96%	98.45%	99.56%	99.74%	99.30%	99.24%	98.25%	98.29%
DP	2	0.19%	88.27%	95.78%	98.64%	99.56%	100.14%	99.78%	99.51%	98.32%	98.26%
DP	3	0.25%	89.04%	95.78%	98.45%	99.46%	99.84%	99.59%	99.56%	98.34%	98.36%
DP	76	0.06%	2.20%	83.01%	94.00%	98.01%	100.47%	100.49%	100.33%	99.67%	99.70%
DP	77	0.06%	0.00%	84.51%	93.92%	99.40%	100.77%	101.29%	101.17%	99.94%	99.89%
DP	78	0.00%	0.00%	72.33%	87.77%	92.92%	95.68%	93.29%	93.08%	96.22%	96.25%
DP	52	0.00%	0.00%	0.46%	94.78%	98.66%	100.84%	101.49%	101.57%	100.73%	100.74%
DP	12	0.00%	0.00%	3.46%	95.07%	98.46%	101.54%	101.78%	101.69%	99.60%	99.68%
DP	13	0.00%	0.00%	0.46%	90.24%	93.68%	95.35%	98.92%	99.31%	99.42%	99.33%
DP	36	0.06%	0.96%	90.86%	96.23%	98.96%	99.54%	101.30%	100.39%	99.90%	99.93%
DP	37	0.06%	0.48%	88.77%	95.84%	98.16%	99.64%	100.35%	100.44%	99.95%	99.93%
DP	38	0.06%	0.00%	85.85%	94.30%	97.97%	98.84%	99.87%	100.37%	99.68%	99.75%
DP	72	0.00%	0.00%	0.50%	95.31%	99.21%	100.37%	101.09%	100.92%	99.67%	99.43%
DP	73	0.00%	0.00%	0.50%	95.88%	99.21%	100.67%	96.74%	97.20%	99.08%	99.25%
DP	74	0.00%	0.00%	0.00%	93.59%	97.51%	99.67%	101.24%	97.90%	99.03%	99.04%
DP	65	0.00%	46.21%	90.71%	96.13%	98.41%	98.57%	99.49%	100.13%	99.91%	99.89%
DP	66	0.00%	0.00%	89.11%	95.72%	97.71%	97.07%	98.39%	99.29%	99.55%	99.56%
DP	67	0.00%	1.30%	89.91%	97.11%	99.21%	100.57%	100.64%	100.53%	99.74%	99.68%
FO	4	0.00%	0.00%	1.82%	80.11%	76.84%	95.45%	98.83%	98.44%	98.58%	98.87%
FO	5	0.00%	0.00%	0.00%	91.11%	84.61%	96.85%	99.21%	99.21%	99.46%	99.68%
FO	6	0.00%	0.00%	0.00%	76.73%	88.80%	97.25%	99.02%	98.96%	98.61%	98.91%
FO	61	0.00%	0.00%	54.84%	82.94%	91.63%	98.27%	99.99%	98.54%	99.41%	99.59%
FO	68	0.00%	0.00%	68.33%	81.79%	89.23%	98.27%	100.09%	98.79%	99.99%	100.06%
FO	105	0.00%	0.00%	53.14%	84.49%	93.32%	97.67%	99.74%	98.74%	100.02%	100.14%
MJ	46	0.00%	0.00%	61.64%	92.17%	97.47%	98.84%	98.64%	98.81%	98.86%	98.58%
MJ	30	0.00%	0.00%	0.00%	0.00%	79.93%	93.15%	97.21%	98.44%	97.60%	97.60%
MJ	31	0.00%	0.00%	79.66%	95.55%	99.46%	99.34%	99.59%	99.39%	99.07%	98.99%
MJ	91	0.00%	0.00%	62.74%	95.47%	102.20%	101.07%	100.24%	100.78%	101.53%	101.15%
MJ	86	0.00%	0.00%	0.00%	95.72%	102.40%	101.37%	100.49%	101.02%	100.72%	100.54%
MJ	87	0.00%	0.00%	65.43%	95.47%	99.40%	100.17%	99.59%	99.93%	99.99%	99.68%
MJ	39	0.06%	0.00%	67.83%	95.84%	96.67%	101.34%	101.30%	100.99%	100.25%	100.27%
MJ	40	0.00%	0.00%	64.91%	94.59%	97.47%	100.84%	100.83%	100.19%	100.98%	100.99%
MJ	41	0.00%	0.00%	58.09%	93.81%	98.46%	100.54%	100.35%	100.27%	100.37%	100.27%
MJ	55	0.00%	0.00%	2.20%	91.62%	97.71%	99.07%	99.39%	99.63%	99.96%	100.09%
MJ	56	0.00%	0.00%	0.00%	86.05%	94.22%	97.87%	99.39%	99.39%	99.58%	99.68%
MJ	57	0.00%	0.00%	0.00%	89.57%	96.41%	98.87%	99.74%	99.68%	99.18%	99.19%
MJ	49	0.00%	0.00%	2.09%	99.99%	99.26%	99.34%	98.73%	98.84%	87.74%	87.29%
MJ	50	0.00%	0.48%	89.22%	100.96%	100.36%	99.54%	99.59%	99.64%	95.72%	95.82%
MJ	51	0.00%	0.00%	66.28%	95.75%	98.06%	98.54%	98.92%	98.76%	95.69%	96.15%

(continued)

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Table A.7 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
MJ	22	0.00%	0.77%	90.77%	100.28%	103.55%	103.34%	101.97%	101.27%	98.50%	98.49%
MJ	23	0.00%	0.00%	88.22%	100.19%	102.75%	102.44%	100.35%	99.39%	98.21%	98.27%
MJ	24	0.00%	0.00%	49.80%	93.33%	99.56%	101.44%	99.97%	98.56%	99.15%	99.37%
MJ	94	0.00%	0.00%	88.71%	100.88%	102.10%	101.97%	100.64%	99.58%	101.35%	100.97%
MJ	95	0.00%	0.00%	77.02%	95.88%	99.70%	100.07%	98.04%	97.05%	98.08%	98.09%
MJ	96	0.00%	0.00%	79.02%	97.11%	100.40%	100.57%	98.64%	97.60%	99.96%	99.92%
MJ	79	0.00%	0.00%	81.32%	98.75%	99.70%	99.77%	100.09%	99.98%	99.86%	99.93%
MJ	80	0.00%	0.00%	73.42%	98.75%	99.50%	99.37%	100.14%	100.28%	99.39%	99.82%
MJ	81	0.00%	0.00%	84.31%	97.52%	97.81%	97.47%	97.54%	97.80%	97.32%	97.72%
MJ	29	0.00%	0.00%	74.66%	97.00%	99.96%	101.54%	101.59%	101.19%	100.28%	100.32%
MJ	47	0.00%	0.00%	8.38%	93.62%	98.36%	101.14%	101.97%	101.32%	100.33%	100.46%
MJ	48	0.00%	0.00%	77.11%	96.81%	101.15%	101.84%	102.54%	101.99%	99.69%	99.78%
MJ	7	0.00%	87.79%	101.51%	101.15%	98.86%	100.44%	99.78%	99.39%	99.27%	99.32%
MJ	14	33.12%	90.77%	101.97%	101.63%	100.36%	100.64%	100.06%	100.06%	99.49%	99.43%
MJ	21	0.09%	84.42%	100.33%	100.86%	99.16%	99.44%	99.11%	98.99%	99.23%	99.29%
MJ	100	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MJ	101	0.00%	0.00%	0.00%	91.95%	96.01%	97.67%	97.49%	97.30%	96.77%	96.63%
MJ	102	0.00%	0.00%	66.23%	92.44%	98.41%	100.07%	100.64%	100.53%	99.43%	99.43%
ND	11	76.32%	91.74%	97.87%	100.38%	100.86%	102.14%	101.97%	100.77%	99.82%	99.78%
ND	53	77.67%	90.00%	97.14%	99.90%	100.16%	101.34%	101.97%	100.39%	99.86%	99.98%
ND	54	71.89%	89.04%	97.14%	99.41%	100.86%	101.64%	101.49%	100.19%	99.89%	100.10%
ND	103	0.31%	87.51%	96.40%	99.33%	101.50%	101.17%	100.99%	100.53%	99.01%	99.16%
ND	104	7.53%	84.71%	95.20%	99.82%	101.40%	102.37%	100.59%	100.28%	99.06%	99.19%
ND	75	55.14%	92.21%	98.40%	100.97%	101.20%	101.87%	100.39%	100.13%	98.78%	98.79%
ND	28	0.31%	67.38%	85.76%	93.62%	98.16%	100.14%	101.30%	101.07%	99.15%	99.22%
ND	35	0.00%	68.06%	85.13%	93.62%	97.47%	100.54%	101.59%	100.74%	99.80%	99.68%
ND	42	0.25%	75.28%	90.13%	96.23%	99.46%	101.34%	101.78%	100.82%	99.59%	99.48%
ND	69	41.30%	72.81%	88.41%	96.05%	99.40%	101.67%	101.49%	101.27%	100.19%	100.01%
ND	70	3.78%	68.51%	87.71%	96.05%	99.40%	101.67%	101.74%	101.62%	99.82%	99.90%
ND	71	8.67%	71.81%	89.11%	97.52%	100.00%	101.67%	101.74%	101.42%	99.72%	99.58%
ND	15	1.40%	87.40%	94.41%	97.48%	98.36%	100.34%	100.16%	100.49%	99.60%	99.34%
ND	16	0.31%	86.35%	93.59%	97.19%	98.66%	101.04%	100.64%	100.44%	99.73%	99.64%
ND	17	65.34%	86.15%	93.96%	98.25%	98.46%	101.04%	100.83%	100.44%	99.60%	99.29%
ND	97	66.52%	84.81%	94.40%	98.51%	99.90%	100.67%	101.24%	101.12%	99.98%	99.88%
ND	98	20.45%	78.01%	90.21%	96.13%	98.91%	100.57%	100.89%	100.53%	99.68%	99.69%
ND	99	0.25%	78.51%	90.11%	95.64%	99.70%	100.67%	100.99%	101.37%	99.70%	99.54%
SJ	32	0.00%	1.25%	87.86%	97.69%	98.56%	99.39%	99.09%	100.24%	99.20%	99.22%
SJ	33	0.00%	53.81%	90.59%	98.71%	97.52%	98.41%	98.64%	99.51%	99.44%	99.35%
SJ	34	0.00%	67.67%	92.47%	100.70%	98.49%	99.96%	99.78%	99.83%	99.76%	99.83%
SJ	88	0.00%	1.05%	82.71%	97.25%	96.66%	98.15%	99.92%	99.26%	100.54%	100.19%
SJ	89	0.08%	60.71%	90.88%	99.28%	96.74%	98.43%	99.67%	99.46%	98.90%	98.52%
SJ	90	0.00%	0.60%	78.15%	94.20%	97.71%	98.07%	98.59%	99.32%	98.05%	99.44%
SJ	18	0.00%	0.00%	83.40%	97.77%	99.26%	99.84%	101.21%	101.37%	100.38%	100.15%
SJ	19	0.00%	62.18%	94.96%	101.05%	100.66%	99.74%	101.30%	101.47%	100.81%	100.55%
SJ	20	0.00%	51.21%	94.87%	99.90%	100.26%	99.74%	100.64%	100.79%	99.85%	99.51%
SJ	82	0.00%	0.00%	49.55%	100.47%	100.50%	99.67%	101.19%	102.56%	100.82%	100.63%
SJ	83	0.00%	0.00%	83.91%	98.92%	99.90%	99.77%	102.09%	3.77%	18.36%	15.52%
SJ	84	0.09%	67.11%	97.10%	100.23%	99.70%	98.77%	100.54%	101.27%	100.02%	99.91%
TU	25	0.00%	0.00%	0.27%	0.00%	80.03%	98.34%	101.30%	101.19%	101.62%	101.53%
TU	26	0.00%	0.00%	0.00%	0.00%	71.75%	94.85%	99.87%	100.87%	101.62%	101.38%
TU	27	0.00%	0.00%	0.00%	0.00%	25.41%	88.36%	98.64%	100.19%	101.12%	101.06%
TU	58	0.00%	0.00%	0.00%	0.16%	76.07%	94.38%	98.64%	99.63%	101.19%	101.24%
TU	59	0.00%	0.00%	0.00%	0.16%	88.74%	100.37%	101.14%	101.27%	100.85%	100.96%
TU	60	0.00%	0.00%	0.00%	0.00%	63.61%	91.08%	97.39%	99.19%	100.06%	100.26%

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Table A.8
Raw data for 3/4-inch meters at 0.5 life

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
DP	8	0.00%	79.36%	93.87%	98.02%	100.65%	100.16%	101.64%	100.29%	99.16%	99.03%
DP	9	0.00%	2.00%	88.37%	96.22%	100.45%	100.44%	100.65%	100.54%	99.19%	99.14%
DP	10	0.00%	0.20%	75.06%	91.32%	97.95%	99.79%	100.35%	100.54%	99.31%	99.27%
DP	62	0.00%	0.00%	80.41%	94.29%	98.90%	100.34%	100.91%	100.56%	99.02%	98.98%
DP	63	0.00%	0.91%	83.79%	94.99%	99.64%	100.84%	100.91%	101.33%	98.97%	98.90%
DP	64	0.00%	81.34%	94.30%	97.78%	101.21%	101.14%	101.40%	101.33%	98.97%	98.95%
DP	43	0.00%	0.50%	4.80%	86.02%	95.95%	100.91%	103.32%	102.68%	90.45%	89.39%
DP	44	0.00%	0.50%	73.56%	91.52%	98.25%	101.37%	102.13%	102.53%	83.48%	82.10%
DP	45	0.00%	0.00%	15.21%	87.82%	96.45%	99.69%	100.94%	101.79%	82.62%	81.45%
DP	85	0.00%	0.00%	6.57%	88.49%	96.13%	100.64%	102.10%	102.96%	85.07%	75.00%
DP	92	0.00%	0.00%	68.96%	87.69%	96.41%	100.64%	102.10%	100.56%	90.22%	89.76%
DP	93	0.00%	0.00%	6.10%	90.19%	98.26%	100.64%	102.60%	102.19%	89.03%	88.77%
DP	1	0.26%	86.26%	95.17%	98.42%	99.75%	99.32%	98.96%	98.69%	98.20%	98.26%
DP	2	0.00%	87.16%	94.97%	98.52%	99.95%	100.07%	99.66%	99.29%	98.28%	98.24%
DP	3	0.00%	89.27%	95.17%	98.12%	99.55%	99.79%	99.26%	99.24%	98.31%	98.32%
DP	76	0.00%	0.18%	84.35%	94.99%	99.36%	100.14%	100.41%	100.95%	99.86%	99.71%
DP	77	0.00%	1.19%	80.88%	93.49%	99.18%	100.14%	101.40%	101.23%	98.95%	99.85%
DP	78	0.00%	0.00%	40.53%	65.79%	84.60%	85.26%	87.88%	94.63%	96.64%	96.59%
DP	52	0.00%	0.00%	0.20%	94.02%	98.75%	100.91%	101.34%	101.69%	100.67%	100.58%
DP	12	0.00%	0.30%	0.50%	95.02%	98.95%	100.16%	99.66%	99.94%	99.01%	99.44%
DP	13	0.00%	0.00%	0.50%	94.52%	98.75%	98.76%	97.49%	98.39%	99.82%	99.70%
DP	36	0.00%	24.72%	90.87%	96.72%	99.25%	100.25%	100.15%	100.04%	99.91%	99.93%
DP	37	0.00%	0.20%	87.07%	95.02%	98.45%	99.51%	100.15%	100.19%	99.93%	99.93%
DP	38	0.00%	2.00%	85.07%	94.02%	97.95%	98.76%	99.95%	100.39%	99.69%	99.70%
DP	72	0.00%	0.00%	0.19%	96.99%	99.46%	100.34%	100.91%	101.04%	99.50%	99.37%
DP	73	0.00%	0.00%	2.35%	91.19%	96.69%	98.34%	99.12%	98.46%	99.08%	99.27%
DP	74	0.00%	0.00%	0.28%	93.99%	97.98%	99.84%	101.40%	100.76%	99.36%	99.32%
DP	65	0.00%	2.46%	90.36%	96.49%	98.53%	99.84%	100.91%	100.28%	100.02%	99.89%
DP	66	0.00%	1.82%	86.98%	94.29%	98.26%	99.54%	100.21%	98.17%	99.74%	99.80%
DP	67	0.00%	1.82%	86.13%	94.69%	98.26%	100.34%	99.91%	100.85%	100.17%	100.07%
FO	4	0.00%	0.00%	1.20%	82.92%	82.56%	86.14%	95.89%	98.09%	98.54%	98.55%
FO	5	0.00%	0.00%	1.20%	93.52%	82.66%	85.77%	97.08%	98.59%	99.56%	99.56%
FO	6	0.00%	0.00%	0.00%	91.62%	85.26%	87.64%	97.08%	98.54%	98.49%	98.54%
FO	61	0.00%	0.00%	1.69%	84.59%	85.52%	98.84%	100.01%	98.84%	99.03%	99.03%
FO	68	0.00%	0.00%	1.50%	82.39%	85.43%	97.84%	100.21%	98.65%	99.66%	99.76%
FO	105	0.00%	0.00%	1.78%	86.79%	93.09%	98.64%	100.11%	99.03%	99.42%	99.60%
MJ	46	0.00%	0.50%	56.54%	89.32%	97.95%	98.10%	98.17%	98.89%	98.87%	98.97%
MJ	30	0.00%	0.00%	0.00%	0.00%	70.27%	93.43%	97.18%	98.29%	97.49%	97.47%
MJ	31	0.00%	0.00%	73.56%	93.02%	99.95%	99.51%	99.16%	99.04%	98.99%	98.99%
MJ	91	0.00%	0.00%	61.74%	94.69%	101.76%	101.34%	100.71%	101.04%	101.47%	101.36%
MJ	86	0.00%	0.00%	30.96%	94.79%	103.05%	102.53%	100.91%	100.85%	101.09%	100.89%
MJ	87	0.00%	0.00%	1.41%	87.99%	98.72%	100.34%	99.71%	100.08%	100.10%	99.87%
MJ	39	0.00%	0.00%	56.54%	93.72%	97.75%	101.09%	101.44%	101.04%	100.34%	100.45%
MJ	40	0.00%	0.00%	56.34%	92.02%	97.95%	100.44%	100.85%	99.94%	101.25%	101.28%
MJ	41	0.00%	0.00%	32.73%	90.32%	97.95%	99.97%	100.65%	99.89%	100.42%	100.49%
MJ	55	0.00%	0.00%	64.27%	92.49%	97.52%	98.84%	99.42%	99.61%	99.98%	100.12%
MJ	56	0.00%	0.00%	60.99%	91.99%	95.95%	98.84%	99.42%	99.61%	99.60%	99.57%
MJ	57	0.00%	0.00%	59.30%	93.49%	97.33%	99.34%	99.42%	100.37%	99.24%	99.18%
MJ	49	0.00%	1.80%	87.37%	100.62%	99.95%	99.23%	98.66%	98.79%	88.40%	87.98%
MJ	50	0.00%	47.53%	93.37%	101.92%	100.85%	99.79%	99.66%	99.69%	96.01%	96.28%
MJ	51	0.00%	0.20%	64.95%	95.52%	98.15%	98.38%	98.66%	98.69%	96.32%	96.84%

(continued)

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Table A.8 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
MJ	22	0.00%	0.30%	87.77%	99.62%	103.45%	103.43%	102.43%	101.79%	98.66%	98.69%
MJ	23	0.00%	0.50%	85.67%	99.62%	102.65%	102.40%	100.05%	99.24%	98.31%	98.35%
MJ	24	0.00%	0.20%	54.54%	92.92%	100.25%	101.47%	99.26%	98.19%	99.37%	99.50%
MJ	94	0.00%	0.00%	75.06%	98.48%	102.13%	102.23%	100.91%	100.08%	100.70%	100.63%
MJ	95	0.00%	0.00%	62.11%	93.99%	99.46%	100.34%	98.52%	97.50%	97.58%	97.60%
MJ	96	0.00%	0.00%	84.73%	98.88%	101.02%	100.84%	99.32%	98.17%	99.44%	99.77%
MJ	79	0.00%	0.55%	88.39%	100.38%	100.75%	100.34%	100.11%	100.08%	99.66%	99.79%
MJ	80	0.00%	0.00%	78.72%	99.98%	100.56%	99.54%	100.11%	100.37%	99.33%	99.78%
MJ	81	0.00%	0.55%	80.41%	97.19%	98.16%	97.74%	97.73%	97.69%	97.30%	97.59%
MJ	29	0.00%	0.30%	63.35%	92.22%	99.45%	101.56%	101.44%	100.89%	100.74%	100.57%
MJ	47	0.00%	0.30%	2.70%	89.32%	98.65%	101.37%	101.64%	101.54%	100.67%	100.74%
MJ	48	0.00%	0.20%	74.06%	96.32%	100.95%	102.78%	101.94%	102.04%	100.11%	100.05%
MJ	7	1.27%	92.87%	102.08%	101.02%	100.15%	101.84%	100.25%	99.54%	99.41%	99.43%
MJ	14	1.95%	93.07%	102.08%	101.72%	100.75%	101.56%	100.45%	100.29%	99.73%	99.68%
MJ	21	2.35%	84.76%	99.88%	100.52%	99.45%	100.25%	99.46%	98.64%	99.20%	99.34%
MJ	100	0.00%	0.00%	0.19%	82.99%	93.92%	97.64%	97.63%	97.50%	96.48%	96.45%
MJ	101	0.00%	0.00%	0.47%	86.99%	94.57%	97.64%	97.63%	97.88%	96.65%	96.67%
MJ	102	0.00%	0.00%	47.85%	91.99%	99.18%	100.84%	100.41%	101.04%	99.82%	99.77%
ND	11	57.08%	91.87%	98.08%	100.02%	101.95%	101.84%	101.64%	100.69%	99.71%	99.79%
ND	53	76.01%	89.27%	95.27%	99.52%	102.25%	100.91%	101.34%	100.44%	99.76%	99.89%
ND	54	3.19%	89.77%	96.08%	99.02%	102.25%	100.16%	101.44%	100.14%	99.86%	99.86%
ND	103	17.31%	89.36%	97.11%	99.48%	101.76%	101.83%	100.91%	100.28%	99.15%	99.09%
ND	104	62.24%	88.00%	96.17%	98.98%	101.02%	101.54%	100.41%	99.80%	99.06%	99.13%
ND	75	5.00%	91.19%	97.58%	100.28%	101.67%	101.34%	100.91%	100.28%	98.74%	98.97%
ND	28	0.00%	65.85%	85.07%	92.72%	99.45%	100.63%	100.15%	100.94%	99.47%	99.42%
ND	35	0.00%	73.85%	88.57%	96.02%	99.45%	100.63%	100.45%	101.04%	99.71%	99.76%
ND	42	0.07%	80.56%	92.57%	96.82%	99.95%	101.37%	101.44%	100.64%	99.51%	99.43%
ND	69	44.53%	72.95%	88.20%	95.79%	98.90%	101.63%	101.40%	101.52%	100.47%	100.30%
ND	70	11.71%	64.74%	86.32%	94.19%	98.99%	101.04%	101.90%	101.71%	100.10%	100.03%
ND	71	17.31%	73.41%	90.83%	96.99%	100.29%	102.13%	101.60%	101.52%	100.33%	100.18%
ND	15	73.37%	90.87%	95.88%	98.22%	99.95%	100.72%	101.14%	100.14%	99.73%	99.58%
ND	16	0.00%	82.56%	91.77%	97.32%	99.45%	100.63%	99.95%	100.54%	99.73%	99.66%
ND	17	0.00%	83.56%	92.27%	96.82%	98.65%	99.79%	100.85%	99.94%	99.63%	99.51%
ND	97	6.00%	81.43%	91.95%	95.19%	98.26%	100.14%	100.61%	100.56%	100.17%	100.16%
ND	98	0.00%	75.41%	88.95%	94.29%	98.90%	100.34%	100.41%	101.04%	99.83%	99.91%
ND	99	0.00%	70.21%	87.92%	93.99%	98.07%	100.34%	101.20%	101.23%	99.80%	99.74%
SJ	32	0.00%	1.58%	80.51%	95.44%	97.55%	99.51%	98.93%	99.86%	99.41%	99.40%
SJ	33	0.00%	0.35%	13.91%	97.19%	96.68%	98.10%	99.61%	99.38%	99.40%	99.48%
SJ	34	0.00%	55.61%	87.97%	99.07%	98.30%	99.86%	100.17%	99.83%	99.63%	99.74%
SJ	88	0.00%	2.05%	87.78%	98.78%	98.12%	99.04%	99.98%	100.28%	100.09%	99.94%
SJ	89	0.00%	16.46%	87.75%	99.58%	98.58%	98.54%	100.56%	99.70%	98.61%	98.40%
SJ	90	0.00%	0.87%	77.27%	94.79%	97.10%	93.82%	102.61%	99.67%	98.84%	98.63%
SJ	18	0.13%	1.60%	86.87%	97.22%	99.15%	100.16%	101.34%	101.39%	99.94%	99.75%
SJ	19	0.13%	2.00%	89.47%	99.02%	99.95%	100.16%	101.44%	101.64%	99.99%	99.82%
SJ	20	0.00%	1.70%	87.67%	66.51%	64.67%	3.74%	7.54%	7.73%	8.88%	9.92%
SJ	82	0.00%	0.00%	89.70%	99.28%	99.73%	98.84%	100.21%	100.76%	99.64%	99.54%
SJ	83	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.18%	5.64%	7.12%
SJ	84	0.00%	2.74%	2.06%	16.80%	8.30%	1.20%	0.40%	0.77%	14.45%	13.99%
TU	25	0.00%	0.00%	0.00%	1.70%	92.76%	99.69%	100.94%	100.89%	101.64%	101.52%
TU	26	0.00%	0.00%	0.00%	0.00%	3.00%	83.62%	96.98%	99.39%	101.57%	101.57%
TU	27	0.00%	0.00%	0.00%	0.00%	2.00%	93.43%	99.46%	100.64%	101.14%	101.17%
TU	58	0.00%	0.00%	0.00%	3.00%	70.12%	92.05%	97.73%	99.61%	101.42%	101.29%
TU	59	0.00%	0.00%	0.00%	46.79%	86.91%	100.64%	101.60%	101.81%	100.99%	101.11%
TU	60	0.00%	0.00%	0.00%	37.79%	85.80%	97.54%	99.42%	99.41%	100.27%	100.30%

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Table A.9
Raw data for 3/4-inch meters at 0.75 life

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
DP	8	0.00%	56.29%	91.60%	98.35%	101.09%	100.64%	100.61%	101.17%	99.00%	99.00%
DP	9	0.00%	2.74%	89.98%	96.93%	99.61%	101.14%	101.31%	99.98%	99.07%	99.03%
DP	10	0.00%	1.96%	82.82%	93.56%	98.35%	100.14%	101.01%	99.98%	99.10%	99.08%
DP	62	0.16%	0.16%	86.34%	95.93%	99.05%	100.57%	101.00%	100.73%	99.12%	99.12%
DP	63	0.00%	0.26%	84.72%	94.37%	99.25%	101.56%	100.90%	101.53%	99.04%	99.02%
DP	64	0.47%	82.23%	93.76%	98.27%	101.43%	102.56%	100.90%	101.69%	98.99%	99.10%
DP	43	0.00%	0.49%	35.81%	86.73%	96.65%	101.93%	103.81%	102.46%	88.63%	87.30%
DP	44	0.00%	0.49%	70.29%	90.28%	98.13%	101.34%	102.81%	102.95%	81.83%	81.10%
DP	45	0.00%	0.20%	43.87%	87.18%	96.87%	100.64%	101.61%	102.16%	82.04%	81.03%
DP	85	0.00%	0.00%	71.01%	90.07%	97.40%	101.07%	102.19%	101.92%	82.45%	81.68%
DP	92	0.00%	0.16%	62.94%	88.81%	96.27%	101.27%	102.33%	101.53%	88.02%	87.27%
DP	93	0.00%	0.00%	40.34%	90.76%	97.93%	101.27%	103.38%	102.95%	84.83%	85.07%
DP	1	0.18%	82.63%	94.46%	98.00%	99.76%	100.24%	99.42%	99.09%	98.27%	98.25%
DP	2	0.97%	85.96%	94.82%	98.44%	100.13%	100.84%	99.81%	99.78%	98.15%	98.09%
DP	3	0.30%	84.00%	94.46%	98.17%	99.69%	99.64%	99.52%	99.98%	98.31%	98.17%
DP	76	0.00%	0.16%	46.96%	80.51%	98.13%	96.39%	98.62%	99.94%	100.21%	100.06%
DP	77	0.00%	0.00%	87.39%	93.49%	98.72%	101.07%	101.71%	101.21%	101.12%	99.18%
DP	78	0.00%	0.16%	62.37%	78.07%	82.38%	85.33%	87.80%	95.97%	96.36%	96.35%
DP	52	0.00%	0.78%	0.00%	94.00%	98.50%	100.64%	101.31%	101.76%	100.56%	100.51%
DP	12	0.00%	0.00%	0.63%	91.79%	97.76%	100.44%	99.81%	100.18%	99.22%	99.33%
DP	13	0.00%	1.17%	0.00%	91.79%	97.54%	100.64%	99.32%	98.99%	99.19%	99.33%
DP	36	0.09%	4.11%	88.02%	95.60%	98.65%	99.94%	100.31%	100.18%	99.98%	99.92%
DP	37	0.00%	1.17%	83.54%	93.74%	97.61%	98.65%	100.11%	100.18%	100.01%	99.92%
DP	38	0.00%	2.74%	82.82%	93.83%	97.76%	98.15%	99.81%	99.68%	99.71%	99.69%
DP	72	0.00%	0.32%	10.89%	96.91%	99.38%	100.57%	101.33%	101.13%	99.39%	99.43%
DP	73	0.00%	0.00%	30.66%	93.98%	98.06%	100.07%	100.76%	99.94%	99.21%	99.22%
DP	74	0.00%	0.00%	0.40%	94.66%	99.05%	100.57%	101.62%	101.53%	99.41%	99.41%
DP	65	0.16%	0.16%	89.32%	95.64%	98.46%	100.27%	100.66%	101.13%	100.06%	100.08%
DP	66	0.00%	0.32%	86.10%	93.69%	97.60%	98.88%	99.19%	100.34%	99.88%	99.86%
DP	67	0.09%	1.94%	87.95%	95.15%	98.06%	99.08%	100.76%	101.37%	100.23%	100.18%
FO	4	0.00%	0.00%	58.20%	80.88%	79.02%	93.26%	96.42%	98.00%	98.81%	98.90%
FO	5	0.00%	0.00%	42.80%	88.68%	86.50%	94.46%	96.92%	98.40%	99.64%	99.74%
FO	6	0.00%	0.00%	54.17%	81.06%	83.91%	95.96%	96.32%	98.50%	98.72%	98.79%
FO	61	0.00%	0.00%	1.29%	94.47%	88.47%	99.77%	100.62%	100.18%	98.71%	98.91%
FO	68	0.00%	0.00%	0.00%	90.27%	89.26%	99.57%	100.38%	98.27%	99.36%	99.56%
FO	105	0.00%	0.00%	0.00%	94.27%	90.78%	99.27%	100.24%	98.99%	99.02%	99.18%
MJ	46	0.00%	0.20%	0.90%	82.03%	94.28%	96.65%	97.82%	98.99%	98.66%	98.62%
MJ	30	0.00%	0.00%	0.00%	0.00%	79.84%	93.17%	97.32%	98.20%	97.38%	97.32%
MJ	31	0.00%	0.00%	45.22%	89.13%	97.39%	97.65%	98.82%	99.98%	98.82%	98.87%
MJ	91	0.00%	0.06%	45.43%	90.07%	101.04%	101.27%	100.19%	100.73%	101.44%	101.47%
MJ	86	0.00%	0.16%	49.22%	95.34%	102.56%	101.07%	100.90%	101.29%	100.91%	100.75%
MJ	87	0.00%	0.06%	43.81%	90.47%	99.58%	99.87%	100.04%	99.54%	100.01%	99.80%
MJ	39	0.00%	0.00%	54.62%	93.38%	97.02%	101.34%	101.31%	100.97%	100.58%	100.62%
MJ	40	0.00%	0.29%	67.33%	93.83%	98.57%	100.64%	100.41%	100.28%	101.37%	101.29%
MJ	41	0.00%	0.29%	0.00%	88.42%	97.54%	100.34%	99.91%	100.38%	100.35%	100.25%
MJ	55	0.00%	0.06%	65.60%	92.90%	98.59%	99.08%	99.47%	100.34%	100.22%	100.39%
MJ	56	0.00%	0.00%	59.15%	91.25%	96.60%	98.08%	99.81%	99.78%	99.68%	99.62%
MJ	57	0.00%	0.16%	65.60%	93.49%	98.06%	99.57%	99.81%	99.94%	99.28%	99.28%
MJ	49	0.00%	0.39%	87.93%	99.68%	99.83%	99.34%	99.02%	99.29%	88.65%	88.35%
MJ	50	0.00%	0.29%	83.27%	98.88%	99.98%	99.34%	99.42%	100.18%	95.58%	95.76%
MJ	51	0.00%	0.20%	69.75%	96.04%	92.58%	98.84%	98.82%	98.79%	95.65%	96.22%

(continued)

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Table A.9 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
MJ	22	0.00%	0.49%	86.22%	99.15%	103.17%	103.43%	101.71%	100.97%	98.40%	98.41%
MJ	23	0.00%	0.20%	76.73%	98.17%	102.43%	103.13%	100.31%	99.49%	98.13%	98.13%
MJ	24	0.00%	0.20%	65.63%	93.56%	98.87%	101.63%	99.32%	98.50%	99.08%	99.34%
MJ	94	0.00%	0.10%	74.64%	96.91%	101.83%	102.16%	100.71%	95.50%	100.63%	100.65%
MJ	95	0.00%	0.13%	42.28%	95.44%	100.24%	100.87%	99.19%	97.88%	97.52%	97.58%
MJ	96	0.00%	0.10%	53.98%	92.90%	99.32%	100.37%	99.00%	97.80%	99.27%	99.47%
MJ	79	0.00%	0.16%	82.71%	98.96%	100.71%	100.37%	100.43%	100.34%	99.53%	99.73%
MJ	80	0.00%	0.10%	0.00%	94.86%	99.71%	99.57%	100.28%	100.34%	98.54%	99.35%
MJ	81	0.09%	0.16%	84.32%	97.98%	99.25%	98.48%	98.09%	101.92%	96.70%	97.50%
MJ	29	0.00%	0.00%	0.45%	88.51%	97.98%	100.14%	101.81%	101.66%	100.63%	99.67%
MJ	47	0.00%	0.00%	0.45%	80.70%	96.65%	101.34%	101.31%	101.76%	100.74%	100.72%
MJ	48	0.00%	0.00%	0.45%	88.68%	99.39%	101.63%	103.01%	101.96%	99.91%	99.94%
MJ	7	0.00%	76.36%	98.49%	100.66%	99.98%	101.34%	99.81%	99.49%	99.28%	99.27%
MJ	14	0.00%	0.69%	83.99%	99.33%	100.35%	101.44%	100.31%	99.98%	99.80%	99.65%
MJ	21	0.00%	1.17%	90.25%	98.88%	98.87%	100.64%	99.81%	98.69%	98.98%	99.11%
MJ	100	0.00%	0.00%	0.24%	84.41%	94.62%	98.08%	98.00%	97.56%	96.50%	96.46%
MJ	101	0.00%	0.16%	0.00%	85.39%	94.62%	97.08%	97.52%	97.80%	96.75%	96.63%
MJ	102	0.00%	0.16%	8.07%	87.34%	96.74%	100.37%	100.76%	100.97%	99.80%	99.67%
ND	11	71.54%	90.26%	97.15%	99.33%	100.57%	102.13%	101.51%	100.48%	99.69%	99.78%
ND	53	68.72%	88.60%	92.94%	98.17%	99.98%	100.84%	101.21%	100.97%	99.66%	99.76%
ND	54	6.20%	87.42%	92.85%	97.55%	99.09%	100.94%	100.61%	100.18%	99.67%	99.85%
ND	103	74.54%	88.54%	95.86%	100.52%	101.57%	102.06%	100.76%	101.53%	99.31%	99.22%
ND	104	76.36%	88.70%	96.83%	99.54%	100.71%	102.36%	100.62%	100.50%	99.22%	99.19%
ND	75	28.73%	90.81%	97.63%	100.22%	100.57%	101.86%	100.85%	101.13%	98.94%	99.04%
ND	28	0.15%	59.23%	80.58%	92.23%	96.87%	100.44%	100.81%	100.67%	99.40%	99.26%
ND	35	2.03%	74.40%	87.75%	94.45%	98.87%	100.34%	101.31%	100.28%	99.70%	99.52%
ND	42	0.00%	69.31%	87.03%	95.07%	99.02%	101.14%	100.81%	100.18%	99.43%	99.32%
ND	69	3.34%	70.90%	86.74%	95.83%	98.79%	101.37%	101.71%	102.32%	100.50%	100.36%
ND	70	0.25%	64.81%	85.53%	95.15%	99.58%	101.56%	102.19%	102.56%	100.26%	100.13%
ND	71	0.31%	71.87%	89.97%	97.59%	100.91%	101.56%	102.28%	102.32%	100.41%	100.18%
ND	15	0.00%	96.63%	93.39%	96.84%	99.39%	100.64%	100.81%	99.98%	99.68%	99.61%
ND	16	0.30%	81.75%	89.81%	95.96%	98.72%	101.14%	100.31%	100.48%	99.73%	99.73%
ND	17	0.51%	80.57%	90.88%	94.89%	99.61%	100.44%	100.81%	100.48%	99.58%	99.56%
ND	97	0.16%	74.30%	87.95%	94.95%	98.72%	100.07%	101.00%	101.53%	100.12%	100.25%
ND	98	0.06%	73.42%	88.36%	95.34%	98.79%	100.57%	101.47%	101.53%	99.94%	99.97%
ND	99	0.16%	62.16%	83.51%	93.20%	98.26%	100.07%	100.76%	100.97%	99.92%	99.77%
SJ	32	0.01%	0.29%	39.49%	94.63%	100.12%	98.88%	98.74%	100.26%	99.42%	99.06%
SJ	33	0.00%	1.49%	86.00%	98.08%	100.00%	98.01%	97.99%	99.57%	99.43%	99.51%
SJ	34	0.00%	7.59%	81.39%	96.51%	100.28%	99.79%	99.42%	99.88%	99.67%	99.72%
SJ	88	0.03%	0.45%	80.21%	94.36%	98.39%	99.09%	99.00%	100.22%	99.94%	100.00%
SJ	89	0.06%	0.13%	85.31%	97.57%	98.42%	98.92%	98.74%	99.52%	98.47%	98.47%
SJ	90	0.03%	0.13%	76.99%	92.61%	96.19%	98.48%	98.78%	101.94%	98.70%	98.68%
SJ	18	0.00%	8.13%	87.48%	91.97%	95.69%	19.53%	1.20%	17.22%	27.55%	51.91%
SJ	19	0.00%	0.39%	83.27%	97.55%	98.72%	98.65%	98.22%	101.56%	99.08%	98.98%
SJ	20	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	0.40%	11.02%	12.50%
SJ	82	0.00%	0.06%	5.16%	95.44%	98.32%	98.58%	99.85%	99.62%	99.43%	99.16%
SJ	83	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	8.17%	8.62%
SJ	84	0.00%	0.00%	44.70%	63.82%	58.62%	84.24%	16.01%	6.03%	10.83%	10.70%
TU	25	0.00%	0.00%	0.00%	17.12%	94.43%	101.63%	101.61%	100.97%	101.59%	101.57%
TU	26	0.00%	0.00%	0.18%	0.00%	1.85%	87.19%	97.82%	99.49%	101.49%	98.42%
TU	27	0.00%	0.00%	0.18%	0.18%	0.00%	3.49%	99.02%	100.77%	100.99%	101.05%
TU	58	0.00%	0.00%	0.00%	20.49%	79.20%	97.38%	99.57%	101.53%	101.61%	101.48%
TU	59	0.00%	0.00%	0.00%	86.85%	99.25%	104.55%	103.38%	104.06%	101.13%	101.14%
TU	60	0.00%	0.00%	0.00%	5.86%	81.39%	96.59%	99.57%	100.57%	100.45%	100.36%

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Table A.10
Raw data for 3/4-inch meters at 1.0 life

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
DP	8	0.55%	76.47%	91.41%	98.84%	100.41%	100.60%	100.79%	100.60%	98.84%	98.77%
DP	9	0.59%	0.70%	90.91%	96.87%	100.11%	100.89%	100.54%	100.55%	98.91%	98.83%
DP	10	0.49%	71.18%	90.91%	96.57%	0.00%	101.39%	100.94%	100.50%	98.88%	98.91%
DP	62	0.00%	61.55%	88.78%	96.55%	100.05%	101.27%	100.73%	100.64%	99.14%	99.09%
DP	63	0.00%	1.94%	87.80%	95.92%	100.05%	100.28%	101.20%	101.01%	98.99%	99.03%
DP	64	0.16%	81.00%	92.70%	99.72%	102.05%	100.28%	101.67%	99.88%	98.99%	99.02%
DP	43	0.33%	0.00%	2.00%	83.57%	94.92%	100.40%	102.29%	102.58%	90.00%	89.25%
DP	44	0.55%	0.00%	12.29%	89.18%	98.11%	101.39%	102.94%	101.39%	82.18%	81.05%
DP	45	0.39%	0.00%	28.27%	86.42%	96.42%	100.40%	101.69%	101.74%	82.46%	81.53%
DP	85	0.00%	0.19%	40.71%	90.31%	96.84%	100.28%	103.36%	102.14%	82.40%	81.82%
DP	92	0.00%	0.00%	54.25%	88.86%	97.74%	102.06%	102.14%	101.39%	88.43%	87.51%
DP	93	0.00%	0.00%	23.35%	92.03%	97.74%	101.57%	102.89%	103.26%	85.19%	84.78%
DP	1	0.49%	83.17%	93.61%	97.76%	99.61%	100.10%	99.30%	99.01%	98.26%	98.26%
DP	2	0.59%	83.67%	93.61%	97.66%	99.51%	100.10%	99.80%	99.46%	98.14%	98.04%
DP	3	0.55%	79.57%	93.11%	97.56%	99.41%	99.60%	99.55%	99.21%	98.23%	98.29%
DP	76	0.00%	0.49%	83.38%	85.15%	99.14%	99.99%	100.73%	100.86%	100.60%	100.58%
DP	77	0.00%	0.19%	77.01%	85.33%	100.05%	101.67%	101.57%	101.61%	100.47%	100.49%
DP	78	0.00%	0.19%	64.55%	79.18%	87.04%	91.29%	91.99%	91.47%	96.80%	96.91%
DP	52	0.49%	0.30%	0.00%	92.34%	98.71%	100.60%	101.29%	101.64%	100.51%	100.44%
DP	12	0.33%	0.30%	0.00%	91.35%	97.91%	99.90%	100.79%	101.00%	99.16%	99.07%
DP	13	0.39%	0.30%	0.00%	93.62%	98.41%	100.60%	101.54%	101.64%	99.19%	99.01%
DP	36	0.33%	0.20%	86.72%	94.80%	98.21%	100.10%	100.20%	100.10%	99.86%	99.86%
DP	37	0.42%	0.20%	86.92%	95.39%	98.61%	99.70%	100.29%	100.35%	99.83%	99.86%
DP	38	0.42%	0.20%	87.22%	95.29%	98.41%	99.40%	100.15%	83.38%	99.64%	99.65%
DP	72	0.00%	0.49%	0.78%	95.47%	99.54%	100.78%	101.01%	101.01%	99.77%	99.44%
DP	73	0.00%	0.68%	0.78%	92.03%	97.84%	100.28%	100.07%	98.38%	99.07%	98.89%
DP	74	0.00%	0.19%	0.98%	93.02%	98.84%	100.97%	101.76%	101.61%	99.10%	99.13%
DP	65	0.00%	0.49%	85.34%	94.74%	98.04%	100.78%	99.41%	100.64%	100.17%	100.02%
DP	66	0.00%	0.49%	83.58%	94.11%	93.84%	96.53%	99.13%	99.13%	100.09%	99.98%
DP	67	0.00%	0.97%	86.82%	95.01%	98.04%	99.00%	100.82%	100.64%	100.30%	100.21%
FO	4	0.29%	0.00%	90.31%	77.55%	77.83%	98.21%	99.95%	97.87%	99.01%	99.23%
FO	5	0.29%	0.00%	50.45%	88.10%	90.42%	98.51%	100.24%	98.27%	99.70%	99.97%
FO	6	0.29%	0.00%	79.62%	77.55%	83.03%	98.71%	100.44%	98.27%	98.90%	99.14%
FO	61	0.00%	0.00%	0.00%	72.84%	86.74%	99.20%	100.35%	98.68%	98.70%	98.79%
FO	68	0.00%	0.00%	0.00%	85.97%	85.84%	99.79%	100.73%	98.98%	99.84%	99.12%
FO	105	0.00%	0.00%	0.00%	91.03%	90.34%	99.10%	100.26%	99.36%	99.27%	99.43%
MJ	46	0.42%	0.00%	0.50%	83.76%	95.12%	97.22%	98.30%	98.37%	98.40%	98.43%
MJ	30	0.23%	0.00%	0.00%	0.00%	82.43%	93.44%	97.05%	98.22%	97.39%	97.31%
MJ	31	0.33%	0.20%	1.00%	87.21%	96.72%	98.11%	98.45%	98.76%	98.75%	98.69%
MJ	91	0.00%	0.00%	37.28%	88.68%	100.55%	101.27%	100.26%	100.64%	101.56%	101.43%
MJ	86	0.00%	0.00%	40.71%	94.74%	103.55%	101.27%	101.29%	101.01%	100.62%	100.50%
MJ	87	0.00%	0.19%	48.85%	92.75%	99.85%	99.49%	99.41%	99.13%	99.76%	99.56%
MJ	39	0.39%	0.00%	62.44%	94.11%	97.91%	101.39%	101.44%	101.24%	100.80%	100.91%
MJ	40	0.42%	0.20%	59.44%	93.62%	98.41%	100.40%	100.29%	100.00%	101.37%	101.37%
MJ	41	0.33%	0.00%	37.46%	91.15%	97.91%	99.90%	100.29%	100.15%	100.40%	100.34%
MJ	55	0.00%	0.29%	66.41%	92.75%	98.24%	99.10%	99.60%	99.88%	100.23%	100.12%
MJ	56	0.00%	0.29%	57.09%	90.49%	96.04%	98.01%	99.88%	99.13%	99.69%	99.66%
MJ	57	0.00%	0.00%	58.86%	92.93%	97.84%	99.29%	99.79%	99.51%	99.29%	99.27%
MJ	49	0.39%	0.80%	90.61%	100.51%	100.71%	100.10%	100.20%	100.70%	88.40%	88.22%
MJ	50	0.42%	0.50%	90.11%	99.82%	99.41%	98.91%	99.15%	99.51%	95.77%	96.05%
MJ	51	0.33%	0.20%	70.43%	95.39%	97.81%	98.31%	98.70%	98.56%	95.95%	96.53%

(continued)

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Table A.10 (Continued)

Meter type	Meter number	Percent registry (%)									
		1/32gpm	1/16gpm	1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	3gpm	25gpm	28gpm
MJ	22	0.39%	0.00%	66.84%	95.29%	101.81%	102.19%	101.44%	100.85%	98.20%	98.08%
MJ	23	0.36%	0.20%	78.23%	98.45%	103.91%	102.78%	100.10%	98.91%	98.10%	98.03%
MJ	24	0.39%	0.10%	67.64%	94.11%	99.91%	100.40%	98.90%	97.62%	99.02%	99.08%
MJ	94	0.00%	0.19%	75.14%	97.55%	102.25%	102.26%	101.01%	99.88%	100.39%	100.46%
MJ	95	0.00%	0.49%	41.40%	94.56%	99.44%	100.68%	98.85%	97.41%	97.34%	97.42%
MJ	96	0.00%	0.19%	58.76%	92.84%	99.74%	100.78%	99.13%	98.16%	99.05%	99.23%
MJ	79	0.00%	0.00%	81.13%	100.44%	101.55%	100.28%	100.26%	100.18%	99.52%	99.63%
MJ	80	0.00%	0.19%	75.53%	97.28%	100.55%	99.49%	100.35%	100.41%	97.44%	97.87%
MJ	81	0.00%	0.00%	78.97%	96.64%	98.54%	98.01%	98.00%	98.23%	96.83%	97.31%
MJ	29	0.39%	0.00%	0.50%	88.20%	98.41%	101.39%	101.44%	101.39%	100.71%	100.82%
MJ	47	0.33%	0.00%	0.00%	80.02%	96.42%	100.20%	101.44%	101.34%	100.80%	100.85%
MJ	48	0.39%	0.00%	0.50%	90.17%	99.41%	101.89%	101.94%	101.99%	100.08%	99.99%
MJ	7	1.14%	44.99%	101.40%	101.01%	99.61%	99.70%	99.80%	99.41%	99.45%	99.45%
MJ	14	0.42%	0.00%	3.00%	97.07%	98.91%	99.90%	100.15%	100.00%	99.81%	99.67%
MJ	21	0.65%	78.47%	97.41%	99.82%	98.91%	98.91%	98.90%	98.66%	99.17%	99.25%
MJ	100	0.00%	0.29%	0.20%	85.51%	94.24%	98.11%	97.72%	97.48%	96.36%	96.38%
MJ	101	0.00%	0.00%	0.49%	84.16%	94.04%	97.02%	97.53%	97.26%	96.58%	96.72%
MJ	102	0.00%	0.00%	42.18%	90.67%	98.84%	100.28%	101.20%	101.01%	99.54%	99.65%
ND	11	5.47%	85.47%	94.91%	99.23%	99.41%	101.89%	101.04%	100.40%	99.61%	99.50%
ND	53	71.68%	89.47%	93.91%	99.04%	100.61%	101.89%	100.64%	100.35%	99.58%	99.53%
ND	54	75.81%	89.97%	94.61%	99.04%	101.41%	101.39%	101.19%	100.85%	99.51%	99.71%
ND	103	71.64%	85.77%	95.45%	101.98%	101.35%	101.47%	100.82%	99.51%	99.31%	99.37%
ND	104	66.99%	88.68%	96.13%	100.44%	100.55%	102.06%	100.73%	100.26%	99.19%	99.22%
ND	75	76.69%	90.44%	96.63%	99.72%	100.75%	102.06%	100.54%	101.01%	98.93%	96.94%
ND	28	0.75%	66.98%	83.62%	92.63%	97.91%	100.40%	100.79%	100.75%	99.26%	99.08%
ND	35	2.70%	66.18%	83.42%	92.63%	97.91%	100.70%	101.64%	101.39%	99.65%	99.51%
ND	42	0.72%	73.28%	87.92%	95.29%	98.71%	100.40%	100.69%	100.50%	99.06%	99.42%
ND	69	0.16%	69.82%	85.54%	94.38%	99.04%	100.78%	102.14%	101.31%	100.56%	100.26%
ND	70	0.00%	66.42%	85.05%	94.11%	100.05%	101.76%	101.48%	101.39%	100.18%	99.94%
ND	71	0.16%	75.07%	90.05%	97.00%	100.85%	102.26%	101.67%	100.64%	99.96%	99.35%
ND	15	59.93%	87.27%	93.91%	97.56%	99.61%	99.90%	100.29%	100.25%	99.56%	99.53%
ND	16	0.65%	2.20%	92.71%	96.57%	98.11%	99.90%	100.44%	100.40%	99.68%	99.73%
ND	17	0.81%	83.17%	12.49%	93.12%	98.41%	100.40%	100.54%	100.15%	99.63%	99.48%
ND	97	0.16%	78.28%	89.76%	94.11%	99.24%	100.09%	101.01%	100.64%	100.27%	100.29%
ND	98	0.00%	77.79%	89.76%	94.56%	99.54%	100.28%	101.20%	101.01%	99.92%	99.90%
ND	99	0.00%	75.17%	88.78%	93.39%	100.05%	99.79%	100.54%	101.01%	99.83%	99.80%
SJ	32	0.73%	0.05%	78.26%	96.59%	97.11%	98.40%	100.16%	99.89%	99.25%	99.31%
SJ	33	0.40%	0.97%	86.50%	97.53%	96.77%	97.47%	99.34%	99.23%	99.49%	99.64%
SJ	34	0.49%	67.48%	90.56%	92.58%	104.31%	99.45%	99.99%	99.71%	99.66%	99.76%
SJ	88	0.00%	0.19%	83.31%	97.75%	98.04%	98.80%	99.22%	100.22%	100.20%	100.29%
SJ	89	0.00%	0.19%	86.08%	95.24%	97.84%	98.60%	98.66%	99.66%	98.67%	98.68%
SJ	90	0.00%	0.15%	72.49%	93.61%	98.60%	98.35%	98.66%	99.85%	98.78%	98.80%
SJ	18	0.33%	0.40%	82.92%	94.41%	94.32%	91.65%	66.46%	1.74%	29.85%	45.79%
SJ	19	0.39%	0.90%	88.62%	98.05%	97.91%	97.61%	99.25%	99.21%	98.42%	98.36%
SJ	20	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.94%	0.00%	10.02%	14.13%
SJ	82	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	88.08%	98.97%
SJ	83	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.13%	1.50%
SJ	84	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.80%	9.92%
TU	25	0.33%	0.00%	0.00%	1.77%	94.12%	101.19%	101.29%	100.90%	101.45%	101.26%
TU	26	0.26%	0.00%	0.00%	0.69%	68.94%	94.43%	99.80%	100.75%	101.27%	101.36%
TU	27	0.23%	0.00%	0.00%	0.00%	10.99%	97.42%	100.44%	101.00%	100.98%	100.86%
TU	58	0.00%	0.00%	0.20%	59.27%	92.34%	100.48%	100.82%	100.26%	101.56%	101.53%
TU	59	0.00%	0.19%	0.49%	48.86%	88.34%	102.75%	102.42%	101.01%	101.21%	101.18%
TU	60	0.00%	0.29%	0.49%	46.60%	89.24%	99.59%	100.54%	99.21%	100.26%	100.31%

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ACCURACY AND ENDURANCE TESTING 1-INCH METERS

Table A.11
Raw data for 1-inch meters at 0 life

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
DP	1	0.00%	93.24%	98.10%	100.22%	100.92%	101.52%	99.99%	100.13%
DP	2	0.45%	91.75%	99.10%	100.72%	101.49%	101.22%	100.08%	100.13%
DP	33	0.00%	87.19%	97.99%	100.92%	101.30%	101.35%	99.68%	99.69%
DP	34	0.00%	85.68%	97.49%	99.42%	101.30%	101.44%	99.59%	99.55%
DP	64	0.00%	88.84%	96.96%	99.03%	100.72%	101.07%	99.52%	99.50%
DP	65	0.00%	79.17%	91.96%	97.22%	101.41%	100.52%	99.36%	99.37%
DP	22	0.00%	84.00%	94.59%	97.77%	100.06%	100.39%	4.74%	2.25%
DP	10	0.00%	74.25%	91.05%	96.58%	100.06%	100.10%	99.45%	98.92%
DP	42	0.00%	79.67%	93.02%	98.42%	100.50%	100.51%	100.16%	99.27%
DP	54	0.00%	0.50%	69.64%	81.43%	86.47%	86.68%	81.52%	2.71%
DP	73	0.00%	84.90%	93.96%	97.42%	100.72%	100.82%	99.90%	98.96%
DP	85	0.00%	84.90%	93.76%	98.23%	99.44%	99.67%	40.23%	99.18%
DP	17	0.00%	93.54%	97.59%	99.43%	99.90%	99.79%	98.50%	98.88%
DP	18	0.18%	97.40%	100.00%	100.92%	101.51%	101.44%	100.34%	100.26%
DP	49	0.05%	94.40%	99.28%	100.62%	101.42%	101.33%	100.18%	100.20%
DP	50	0.13%	92.80%	98.89%	100.32%	101.08%	100.98%	99.94%	99.92%
DP	80	0.00%	96.84%	99.66%	100.93%	101.21%	101.17%	99.82%	99.89%
DP	81	0.00%	95.56%	98.76%	99.73%	101.02%	100.92%	99.75%	99.77%
DP	32	0.00%	80.84%	95.59%	98.74%	100.79%	100.93%	100.10%	99.81%
DP	31	0.00%	2.48%	93.59%	98.74%	100.49%	100.63%	100.15%	99.89%
DP	25	0.00%	96.71%	100.10%	101.22%	100.59%	100.73%	99.51%	99.28%
DP	26	0.00%	95.22%	99.10%	100.72%	100.59%	100.63%	99.55%	99.32%
DP	62	0.13%	1.00%	95.01%	98.42%	100.80%	100.98%	100.47%	100.45%
DP	63	0.00%	0.00%	94.51%	98.42%	100.82%	100.79%	99.84%	100.11%
DP	92	0.00%	17.77%	95.46%	98.43%	100.72%	100.77%	100.26%	100.08%
DP	93	0.00%	48.37%	94.16%	97.93%	99.73%	100.32%	99.36%	99.16%
DP	57	0.00%	97.21%	100.48%	100.42%	101.00%	100.88%	99.84%	99.87%
DP	58	0.13%	95.20%	99.48%	100.42%	101.00%	100.88%	99.99%	100.02%
DP	88	0.00%	96.25%	99.26%	100.23%	100.23%	100.67%	99.76%	99.58%
DP	89	0.00%	97.04%	99.66%	101.03%	100.52%	100.92%	99.71%	99.73%
MJ	3	0.00%	78.36%	99.20%	102.21%	100.61%	100.42%	99.69%	100.25%
MJ	4	0.00%	86.10%	100.05%	102.41%	101.44%	101.35%	101.20%	100.53%
MJ	35	0.00%	0.00%	95.11%	100.97%	100.93%	100.81%	98.30%	98.83%
MJ	36	0.00%	0.00%	74.76%	98.59%	99.85%	99.44%	97.47%	98.19%
MJ	66	0.00%	87.51%	100.33%	102.54%	100.72%	100.27%	99.24%	99.13%
MJ	67	0.00%	0.00%	0.00%	0.15%	101.86%	101.82%	100.68%	100.68%
MJ	19	0.00%	88.28%	100.10%	98.74%	100.59%	100.44%	99.87%	99.53%
MJ	20	0.00%	87.78%	99.10%	98.74%	100.69%	100.14%	99.14%	98.95%
MJ	51	0.00%	69.65%	96.50%	96.92%	99.61%	99.67%	98.54%	98.02%
MJ	52	0.00%	87.19%	99.48%	100.92%	100.90%	99.58%	98.59%	98.06%
MJ	82	0.00%	90.82%	100.26%	101.23%	101.21%	100.67%	100.22%	100.20%
MJ	83	0.00%	88.55%	100.16%	100.73%	101.21%	100.67%	99.51%	99.42%
MJ	30	0.00%	55.05%	88.59%	97.25%	98.60%	98.76%	99.92%	99.98%
MJ	29	0.00%	60.51%	89.59%	95.76%	98.20%	98.17%	98.50%	98.48%
MJ	60	0.00%	52.11%	85.75%	96.42%	98.11%	97.89%	99.45%	99.54%
MJ	61	0.00%	0.00%	81.58%	95.42%	98.11%	98.17%	100.04%	100.21%
MJ	90	0.00%	52.12%	88.26%	95.72%	98.25%	98.18%	100.45%	100.37%
MJ	91	0.00%	2.96%	87.46%	96.42%	99.24%	99.18%	100.18%	100.22%

(continued)

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Table A.11 (Continued)

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
MJ	12	4.97%	98.20%	97.09%	98.04%	100.53%	100.95%	99.63%	99.67%
MJ	11	37.86%	98.89%	97.19%	97.45%	100.41%	100.73%	98.03%	98.08%
MJ	43	15.45%	37.98%	99.28%	98.32%	100.76%	101.35%	98.17%	99.22%
MJ	44	0.00%	99.01%	98.29%	97.62%	100.22%	100.85%	100.02%	99.80%
MJ	74	0.00%	97.93%	97.46%	97.12%	100.03%	100.72%	99.70%	99.78%
MJ	75	19.79%	99.41%	98.16%	97.22%	100.33%	100.67%	99.03%	99.20%
MJ	24	0.00%	78.86%	99.10%	101.71%	100.39%	100.34%	100.17%	100.21%
MJ	23	0.00%	87.78%	98.60%	102.21%	101.99%	101.81%	99.97%	99.77%
MJ	28	0.00%	12.89%	87.08%	98.44%	99.06%	98.96%	98.71%	98.70%
MJ	27	0.00%	61.99%	93.09%	99.23%	99.40%	99.53%	99.00%	99.03%
MJ	59	0.00%	3.01%	94.01%	99.42%	100.00%	100.98%	99.60%	99.73%
MJ	55	0.00%	52.11%	98.49%	101.42%	101.99%	102.00%	100.95%	101.01%
MJ	56	0.00%	0.00%	92.52%	101.42%	101.70%	101.82%	100.28%	100.20%
MJ	86	0.00%	90.62%	101.26%	101.93%	101.71%	101.07%	99.29%	99.27%
MJ	87	0.00%	87.17%	99.96%	101.23%	101.02%	100.92%	98.98%	99.46%
ND	15	0.00%	93.24%	98.10%	99.73%	101.09%	101.22%	99.50%	99.60%
ND	16	0.90%	94.23%	98.10%	100.72%	100.89%	101.12%	99.90%	99.84%
ND	47	0.13%	89.69%	97.49%	99.92%	101.50%	101.54%	100.30%	100.23%
ND	48	0.00%	92.20%	98.49%	100.42%	101.00%	103.22%	99.78%	99.32%
ND	78	0.00%	92.50%	98.76%	99.43%	101.21%	101.07%	99.87%	99.97%
ND	79	0.00%	93.09%	98.66%	99.73%	101.02%	101.32%	100.00%	99.77%
ND	21	0.00%	80.84%	91.59%	95.26%	100.59%	100.14%	98.99%	98.95%
ND	9	0.90%	76.38%	91.09%	96.75%	100.29%	100.14%	98.80%	98.81%
ND	41	0.13%	83.68%	95.50%	99.92%	100.40%	99.58%	99.16%	98.89%
ND	53	0.25%	80.17%	93.51%	96.92%	100.50%	100.60%	98.93%	98.92%
ND	72	0.13%	83.41%	92.76%	97.52%	100.23%	100.42%	98.70%	98.94%
ND	84	0.00%	87.17%	94.96%	98.73%	100.42%	100.77%	98.58%	98.71%
ND	14	0.90%	92.74%	98.10%	100.72%	101.19%	100.93%	99.94%	99.99%
ND	13	0.90%	91.75%	97.59%	100.22%	101.19%	100.93%	99.90%	99.80%
ND	45	52.22%	91.69%	99.98%	102.92%	101.00%	100.79%	99.78%	99.84%
ND	46	2.01%	92.20%	100.48%	102.92%	100.70%	100.70%	100.02%	100.08%
ND	76	59.31%	95.06%	98.26%	99.53%	101.21%	100.92%	99.10%	99.14%
ND	77	0.00%	93.78%	98.96%	99.23%	101.41%	100.92%	100.02%	99.97%
SJ	6	0.00%	95.22%	99.10%	101.22%	100.49%	101.32%	100.57%	100.89%
SJ	5	0.90%	86.29%	99.10%	99.23%	99.70%	100.34%	99.40%	99.18%
SJ	37	0.00%	87.19%	98.49%	97.92%	99.31%	100.14%	99.57%	100.28%
SJ	38	0.00%	90.19%	99.48%	100.92%	99.90%	101.26%	100.74%	100.67%
SJ	68	0.00%	87.86%	95.26%	99.23%	99.73%	100.17%	100.09%	99.98%
SJ	69	0.00%	71.08%	99.96%	101.23%	99.73%	101.17%	100.00%	100.26%
TU	8	0.90%	0.00%	64.06%	92.78%	99.70%	99.65%	99.79%	100.03%
TU	7	0.00%	0.50%	0.00%	59.04%	99.80%	100.14%	100.47%	100.84%
TU	39	0.00%	0.00%	78.09%	94.92%	100.30%	100.23%	100.84%	100.76%
TU	40	0.00%	0.50%	0.00%	50.46%	99.21%	99.39%	98.00%	97.89%
TU	70	0.00%	0.00%	0.20%	79.48%	97.46%	98.18%	99.36%	99.23%
TU	71	0.00%	0.00%	0.50%	63.95%	97.26%	99.03%	100.73%	100.76%

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Table A.12
Raw data for 1-inch meters at 0.25 life

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
DP	1	0.00%	88.60%	97.98%	99.30%	101.31%	101.40%	100.13%	100.03%
DP	2	0.00%	93.35%	97.36%	100.66%	101.44%	101.30%	100.13%	100.08%
DP	33	0.00%	87.02%	97.84%	99.90%	101.00%	100.97%	99.72%	99.54%
DP	34	0.00%	88.60%	96.26%	100.99%	101.06%	100.97%	99.62%	99.53%
DP	64	0.00%	88.01%	96.84%	100.77%	101.78%	101.21%	99.88%	99.90%
DP	65	0.00%	87.51%	96.25%	100.07%	102.47%	100.96%	99.75%	99.77%
DP	22	0.00%	83.10%	95.18%	98.66%	100.23%	100.30%	2.55%	1.70%
DP	10	0.00%	0.37%	94.09%	97.45%	100.03%	100.34%	8.68%	2.76%
DP	42	0.00%	83.07%	93.79%	97.30%	100.36%	100.61%	100.12%	99.48%
DP	54	0.00%	1.48%	69.18%	80.93%	86.78%	86.81%	82.64%	2.31%
DP	73	0.00%	85.51%	94.79%	98.77%	100.69%	101.11%	6.63%	3.18%
DP	85	0.30%	81.21%	93.20%	97.47%	100.99%	100.71%	17.70%	6.19%
DP	17	0.00%	0.00%	97.66%	100.26%	102.74%	101.20%	98.36%	98.42%
DP	18	0.00%	93.21%	99.84%	101.25%	102.13%	100.92%	100.61%	98.36%
DP	49	0.20%	94.03%	98.93%	100.99%	101.86%	101.75%	100.55%	100.49%
DP	50	0.30%	91.96%	98.83%	100.99%	101.88%	101.89%	100.59%	100.49%
DP	80	0.40%	91.41%	99.30%	102.16%	102.97%	102.85%	101.46%	101.34%
DP	81	0.20%	88.51%	98.42%	101.66%	103.26%	103.10%	101.48%	46.39%
DP	32	0.00%	0.00%	94.78%	98.86%	100.93%	101.00%	100.10%	100.01%
DP	31	0.00%	0.00%	92.60%	97.66%	100.58%	100.74%	100.15%	100.10%
DP	25	0.00%	94.09%	99.14%	100.47%	100.62%	100.60%	99.42%	99.47%
DP	26	0.00%	94.09%	98.55%	100.36%	100.64%	100.70%	99.47%	99.47%
DP	62	0.00%	0.49%	95.37%	98.90%	100.78%	100.81%	100.46%	100.40%
DP	63	0.00%	0.59%	94.58%	98.40%	100.80%	100.91%	100.36%	100.20%
DP	92	0.00%	0.50%	95.55%	98.77%	100.99%	100.96%	100.23%	100.29%
DP	93	0.00%	0.00%	94.79%	99.07%	100.49%	100.71%	99.56%	99.44%
DP	57	0.80%	92.94%	98.93%	100.40%	100.56%	100.51%	99.72%	99.73%
DP	58	0.00%	93.34%	98.93%	99.90%	99.36%	99.53%	99.67%	99.77%
DP	88	0.50%	93.21%	97.89%	99.77%	100.99%	100.96%	99.77%	99.78%
DP	89	0.50%	92.71%	98.19%	101.07%	101.98%	100.81%	99.74%	99.75%
MJ	3	0.00%	60.22%	94.60%	104.02%	100.97%	100.70%	100.20%	100.20%
MJ	4	0.00%	0.04%	91.26%	103.92%	101.76%	101.42%	101.16%	101.07%
MJ	35	0.00%	0.00%	96.40%	103.24%	101.22%	101.03%	99.95%	100.14%
MJ	36	0.00%	0.00%	22.15%	90.23%	101.05%	100.75%	100.17%	100.21%
MJ	66	0.00%	86.03%	100.93%	107.95%	102.55%	101.90%	45.12%	70.41%
MJ	67	0.00%	0.00%	0.00%	0.00%	102.39%	101.88%	100.82%	100.98%
MJ	19	0.00%	85.67%	99.74%	99.50%	100.91%	100.70%	100.56%	100.69%
MJ	20	0.00%	85.67%	98.95%	99.66%	100.76%	100.80%	99.73%	99.96%
MJ	51	0.00%	79.31%	96.46%	96.90%	99.66%	100.07%	99.02%	98.92%
MJ	52	0.00%	85.93%	98.34%	100.00%	99.98%	99.95%	98.93%	98.84%
MJ	82	0.00%	86.31%	98.01%	99.57%	100.99%	100.86%	101.10%	101.26%
MJ	83	0.00%	85.01%	99.65%	101.26%	101.28%	100.96%	99.97%	99.97%
MJ	30	0.00%	0.00%	65.24%	96.35%	97.59%	97.81%	98.97%	98.93%
MJ	29	0.00%	48.83%	84.47%	97.66%	97.99%	98.01%	98.48%	98.44%
MJ	60	0.00%	0.00%	63.45%	92.51%	96.59%	96.42%	97.79%	97.79%
MJ	61	0.00%	0.00%	63.55%	91.41%	97.47%	97.55%	99.71%	99.67%
MJ	90	0.00%	0.00%	75.32%	95.28%	98.21%	98.72%	100.18%	100.14%
MJ	91	0.00%	0.00%	54.81%	91.99%	98.02%	97.87%	98.80%	98.77%

(continued)

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Table A.12 (Continued)

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
MJ	12	0.00%	97.67%	97.95%	98.86%	100.23%	100.66%	99.55%	99.45%
MJ	11	0.00%	95.26%	96.07%	98.46%	100.11%	100.24%	98.10%	24.80%
MJ	43	0.00%	96.99%	98.04%	98.10%	100.60%	101.35%	98.49%	50.96%
MJ	44	0.00%	97.49%	98.44%	97.50%	100.16%	100.97%	99.76%	28.89%
MJ	74	0.00%	94.41%	96.49%	97.07%	99.60%	100.36%	99.61%	32.30%
MJ	75	0.20%	97.61%	97.95%	96.97%	99.80%	100.31%	99.35%	99.39%
MJ	24	0.00%	0.73%	91.21%	101.66%	100.24%	100.60%	99.93%	99.86%
MJ	23	0.00%	0.00%	97.76%	103.17%	101.89%	101.85%	100.12%	100.18%
MJ	28	0.00%	92.18%	98.95%	101.96%	99.18%	99.01%	98.31%	98.39%
MJ	27	0.00%	95.37%	101.03%	100.96%	101.13%	99.30%	98.86%	98.93%
MJ	59	3.99%	95.41%	99.23%	101.09%	99.56%	99.55%	99.45%	99.53%
MJ	55	0.00%	2.86%	94.48%	101.39%	101.86%	101.97%	101.01%	101.13%
MJ	56	0.00%	0.00%	81.24%	99.40%	101.46%	101.47%	100.37%	100.36%
MJ	86	0.00%	58.21%	97.78%	102.56%	101.48%	101.70%	99.87%	99.89%
MJ	87	0.00%	81.31%	99.65%	102.76%	101.48%	101.31%	99.97%	100.04%
ND	15	0.00%	91.52%	97.56%	100.16%	100.99%	100.70%	99.33%	99.56%
ND	16	0.00%	91.52%	98.65%	99.96%	101.48%	101.14%	99.62%	100.03%
ND	47	0.00%	88.99%	97.05%	99.80%	101.06%	101.27%	99.92%	100.24%
ND	48	0.00%	92.35%	97.65%	99.60%	100.76%	100.67%	99.69%	99.71%
ND	78	0.30%	88.21%	96.60%	99.57%	101.18%	101.45%	100.17%	99.93%
ND	79	0.00%	88.51%	95.67%	99.27%	101.68%	100.81%	100.66%	100.27%
ND	21	0.00%	80.73%	90.32%	98.36%	100.32%	100.26%	98.85%	98.87%
ND	9	0.00%	82.72%	93.10%	97.65%	100.44%	100.50%	98.88%	98.94%
ND	41	0.00%	79.21%	91.81%	96.90%	100.28%	100.45%	98.71%	98.81%
ND	53	0.00%	79.02%	90.92%	96.50%	100.32%	100.61%	98.76%	98.68%
ND	72	0.80%	82.21%	92.03%	97.27%	100.99%	101.11%	99.16%	99.03%
ND	84	0.00%	79.81%	91.27%	96.97%	101.18%	100.86%	98.73%	98.79%
ND	14	0.00%	90.79%	98.15%	99.98%	100.93%	100.60%	99.62%	99.89%
ND	13	55.12%	90.79%	89.23%	100.16%	101.19%	100.90%	99.87%	100.03%
ND	45	35.55%	93.14%	98.53%	100.20%	100.92%	100.69%	99.64%	99.56%
ND	46	0.50%	89.39%	96.66%	99.90%	100.36%	100.49%	100.02%	100.01%
ND	76	0.30%	88.01%	96.13%	99.47%	100.49%	100.46%	99.51%	99.40%
ND	77	0.30%	89.51%	96.25%	100.77%	101.28%	100.96%	100.32%	100.26%
SJ	6	0.00%	95.92%	100.23%	102.16%	100.15%	101.00%	100.81%	100.77%
SJ	5	0.00%	93.72%	99.44%	101.16%	99.16%	100.00%	99.20%	98.99%
SJ	37	0.00%	100.75%	101.80%	99.80%	99.34%	99.57%	100.12%	100.17%
SJ	38	0.00%	95.81%	101.80%	101.79%	99.96%	100.77%	100.61%	100.46%
SJ	68	0.00%	98.01%	99.07%	99.77%	100.00%	100.46%	100.37%	100.21%
SJ	69	0.00%	100.01%	102.00%	101.76%	100.00%	101.45%	100.47%	100.41%
TU	8	0.00%	0.00%	53.24%	91.65%	99.62%	99.80%	100.05%	100.08%
TU	7	0.00%	0.00%	51.46%	86.44%	99.73%	100.20%	100.86%	100.72%
TU	39	0.00%	0.00%	0.00%	0.00%	99.36%	99.59%	100.72%	100.56%
TU	40	0.00%	0.00%	0.00%	0.00%	99.18%	99.35%	98.19%	97.98%
TU	70	0.00%	0.00%	0.00%	79.62%	97.03%	98.12%	99.51%	99.48%
TU	71	0.00%	0.00%	0.00%	0.00%	97.03%	99.47%	101.09%	101.18%

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Table A.13
Raw data for 1-inch meters at 0.5 life

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
DP	1	0.00%	88.85%	98.71%	100.30%	101.58%	101.70%	100.44%	100.31%
DP	2	0.00%	94.38%	99.51%	101.78%	101.68%	101.80%	100.42%	100.30%
DP	33	0.00%	87.68%	96.94%	99.27%	100.36%	101.32%	99.63%	99.40%
DP	34	0.00%	84.76%	95.34%	100.54%	100.76%	100.72%	99.54%	99.47%
DP	64	0.00%	88.83%	96.83%	100.31%	101.41%	101.44%	99.97%	99.92%
DP	65	1.19%	89.84%	96.53%	99.61%	102.88%	100.89%	99.76%	99.79%
DP	22	0.00%	85.84%	95.51%	98.92%	100.58%	101.04%	10.64%	0.89%
DP	10	0.00%	85.84%	94.51%	98.03%	100.28%	101.08%	1.53%	0.49%
DP	42	0.00%	80.68%	93.44%	97.42%	100.46%	100.62%	2.51%	1.70%
DP	54	0.00%	0.00%	66.96%	80.66%	86.00%	85.92%	82.70%	4.15%
DP	73	0.00%	87.13%	94.53%	99.11%	101.41%	101.12%	95.50%	7.17%
DP	85	0.00%	80.62%	93.03%	97.62%	99.94%	100.62%	12.04%	6.50%
DP	17	0.00%	0.70%	97.61%	100.80%	102.54%	100.54%	96.08%	97.61%
DP	18	0.00%	93.98%	100.21%	103.66%	102.18%	102.31%	97.47%	97.77%
DP	49	0.70%	95.55%	99.74%	101.22%	102.16%	101.96%	100.55%	100.26%
DP	50	0.40%	88.45%	98.64%	100.64%	102.06%	101.89%	100.55%	100.32%
DP	80	0.00%	96.14%	100.83%	102.50%	103.66%	103.64%	102.01%	101.82%
DP	81	0.09%	89.74%	98.23%	102.20%	104.45%	103.18%	102.37%	8.77%
DP	32	0.00%	1.00%	95.11%	99.41%	100.98%	101.14%	100.30%	100.15%
DP	31	0.00%	0.50%	92.51%	98.62%	100.68%	100.84%	100.35%	100.20%
DP	25	0.00%	92.87%	98.81%	100.99%	100.58%	100.74%	99.61%	99.41%
DP	26	0.00%	92.87%	98.61%	100.30%	99.47%	100.78%	99.61%	99.51%
DP	62	0.00%	0.00%	96.04%	99.04%	100.96%	100.99%	100.32%	100.32%
DP	63	0.00%	0.00%	94.34%	98.30%	100.76%	100.52%	100.22%	100.17%
DP	92	0.00%	0.00%	95.53%	98.91%	101.11%	100.95%	100.47%	100.31%
DP	93	10.29%	1.50%	96.03%	99.11%	100.63%	100.62%	99.76%	99.46%
DP	57	0.00%	93.61%	98.44%	100.14%	100.86%	100.62%	99.41%	99.47%
DP	58	0.00%	94.29%	97.94%	99.37%	100.26%	100.82%	99.48%	99.55%
DP	88	0.26%	92.84%	98.83%	99.61%	100.92%	100.53%	99.86%	99.84%
DP	89	0.94%	88.83%	98.33%	100.31%	101.21%	100.85%	99.79%	99.82%
MJ	3	0.00%	65.51%	98.58%	104.34%	101.66%	101.46%	100.71%	100.83%
MJ	4	0.00%	-0.05%	98.09%	105.56%	102.00%	101.90%	100.97%	101.06%
MJ	35	0.00%	76.89%	78.89%	100.73%	101.26%	101.10%	100.01%	99.97%
MJ	36	0.00%	0.00%	66.11%	96.27%	100.76%	100.42%	100.27%	100.11%
MJ	66	0.00%	0.00%	0.05%	88.97%	101.10%	101.33%	63.38%	101.12%
MJ	67	0.00%	0.00%	90.09%	103.33%	102.68%	102.02%	30.39%	100.45%
MJ	19	0.00%	63.75%	91.31%	97.23%	100.68%	101.14%	101.02%	100.91%
MJ	20	0.00%	71.79%	94.81%	98.32%	100.66%	100.94%	100.21%	100.17%
MJ	51	0.00%	76.40%	96.04%	97.13%	99.77%	99.99%	98.95%	98.76%
MJ	52	0.00%	82.04%	97.44%	99.37%	100.26%	99.82%	98.91%	98.74%
MJ	82	0.00%	84.13%	98.23%	99.91%	100.92%	100.79%	101.11%	100.98%
MJ	83	0.00%	71.61%	97.53%	100.61%	100.63%	100.62%	99.88%	99.85%
MJ	30	0.00%	0.00%	69.31%	93.28%	97.67%	99.74%	99.27%	99.27%
MJ	29	0.00%	0.50%	75.51%	94.46%	98.37%	99.04%	98.47%	98.43%
MJ	60	0.00%	0.00%	75.15%	94.01%	96.77%	96.66%	97.69%	97.67%
MJ	61	0.00%	0.00%	71.56%	92.65%	97.57%	97.66%	99.40%	99.53%
MJ	90	0.00%	0.50%	74.52%	94.63%	98.18%	98.17%	100.35%	100.24%
MJ	91	0.00%	0.00%	72.32%	93.83%	97.98%	97.67%	98.83%	98.78%

(continued)

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Table A.13 (Continued)

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
MJ	12	0.00%	78.61%	91.41%	96.25%	100.00%	100.88%	98.78%	98.88%
MJ	11	0.00%	93.47%	95.41%	96.34%	100.49%	100.34%	97.57%	15.38%
MJ	43	0.00%	52.78%	88.45%	95.08%	99.97%	100.72%	98.56%	64.48%
MJ	44	0.00%	97.11%	98.24%	97.32%	100.26%	100.86%	99.30%	83.21%
MJ	74	0.07%	91.44%	95.63%	96.82%	99.16%	99.74%	99.47%	10.47%
MJ	75	0.10%	95.24%	97.33%	96.92%	99.06%	99.71%	98.87%	98.94%
MJ	24	0.00%	2.51%	91.71%	100.80%	100.78%	101.14%	100.10%	100.12%
MJ	23	0.00%	73.79%	98.71%	102.18%	102.02%	102.15%	100.21%	100.17%
MJ	28	0.00%	92.37%	98.21%	100.80%	99.57%	99.92%	98.59%	98.41%
MJ	27	0.00%	95.68%	97.71%	100.80%	99.47%	99.30%	98.95%	99.00%
MJ	59	1.99%	94.48%	99.14%	101.04%	100.07%	99.52%	100.18%	99.30%
MJ	55	0.00%	17.01%	93.29%	101.71%	101.86%	101.82%	100.99%	100.96%
MJ	56	0.00%	0.00%	79.35%	98.30%	100.86%	101.79%	100.17%	100.00%
MJ	86	0.00%	68.60%	98.53%	102.10%	101.90%	101.44%	99.86%	99.83%
MJ	87	0.00%	78.82%	99.33%	102.10%	101.90%	101.18%	100.10%	100.36%
ND	15	0.00%	89.86%	96.91%	100.10%	101.14%	101.12%	100.06%	100.41%
ND	16	0.00%	92.37%	97.71%	100.00%	101.38%	101.36%	99.96%	100.12%
ND	47	0.30%	87.19%	96.74%	99.84%	100.76%	100.92%	99.29%	99.75%
ND	48	0.00%	88.45%	96.84%	99.84%	101.26%	100.49%	98.93%	99.84%
ND	78	0.00%	85.33%	94.03%	98.12%	101.21%	100.69%	100.16%	100.35%
ND	79	0.09%	87.93%	95.53%	98.62%	101.41%	100.95%	100.45%	100.73%
ND	21	0.00%	74.30%	91.81%	96.94%	100.56%	100.64%	99.13%	98.89%
ND	9	0.00%	77.71%	93.01%	97.53%	100.40%	100.74%	98.82%	99.03%
ND	41	0.00%	78.93%	90.94%	94.79%	100.17%	100.62%	98.97%	98.60%
ND	53	0.00%	80.39%	89.94%	96.35%	101.06%	100.82%	98.84%	98.70%
ND	72	0.26%	80.82%	92.03%	95.93%	100.92%	100.69%	99.08%	99.25%
ND	84	0.00%	81.32%	92.53%	97.12%	100.72%	100.53%	98.75%	98.74%
ND	14	0.00%	86.85%	96.21%	100.30%	101.08%	100.94%	99.92%	99.94%
ND	13	56.07%	87.35%	97.11%	100.30%	101.28%	101.38%	100.20%	100.26%
ND	45	1.39%	92.25%	97.14%	99.37%	101.76%	101.16%	99.64%	99.50%
ND	46	0.00%	90.40%	95.64%	99.24%	100.52%	100.52%	99.97%	99.94%
ND	76	0.17%	89.13%	96.23%	98.42%	100.63%	100.95%	99.52%	99.48%
ND	77	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SJ	6	0.00%	91.36%	99.01%	100.89%	100.18%	101.34%	100.49%	100.39%
SJ	5	0.00%	83.33%	96.01%	97.93%	99.57%	99.94%	99.11%	98.62%
SJ	37	0.00%	89.43%	91.94%	93.22%	98.77%	99.66%	99.97%	100.27%
SJ	38	0.00%	98.18%	98.94%	98.40%	100.76%	100.66%	100.07%	99.89%
SJ	68	0.17%	98.15%	102.03%	99.61%	98.96%	99.97%	99.78%	100.20%
SJ	69	0.17%	101.15%	103.03%	102.60%	100.92%	100.95%	100.46%	100.65%
TU	8	0.00%	0.10%	62.30%	90.80%	99.77%	100.14%	100.44%	100.28%
TU	7	0.00%	0.00%	47.00%	88.04%	100.34%	100.54%	101.07%	100.89%
TU	39	0.00%	0.00%	0.00%	0.00%	97.77%	98.72%	100.46%	100.48%
TU	40	0.00%	0.00%	42.87%	95.33%	99.77%	99.66%	97.94%	97.93%
TU	70	0.00%	0.00%	1.70%	85.67%	98.76%	98.33%	99.44%	99.47%
TU	71	0.00%	0.00%	0.00%	0.70%	97.98%	98.82%	101.19%	101.15%

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Table A.14
Raw data for 1-inch meters at 0.75 life

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
DP	1	0.00%	87.51%	97.46%	100.53%	101.68%	101.72%	100.46%	100.53%
DP	2	0.00%	91.91%	99.94%	101.33%	101.62%	101.72%	100.47%	100.48%
DP	33	0.00%	87.01%	96.38%	99.28%	100.69%	101.08%	99.45%	99.28%
DP	34	0.00%	89.63%	95.60%	99.08%	100.84%	101.15%	99.48%	99.35%
DP	64	0.00%	88.44%	96.23%	100.74%	101.38%	101.51%	99.95%	100.03%
DP	65	0.00%	89.20%	97.52%	101.44%	101.38%	101.01%	99.87%	99.98%
DP	22	0.00%	83.60%	94.99%	98.77%	101.14%	101.11%	5.25%	2.82%
DP	10	0.00%	83.11%	94.50%	98.17%	101.05%	100.91%	4.34%	1.87%
DP	42	0.00%	83.27%	93.40%	97.33%	100.02%	99.92%	2.57%	1.30%
DP	54	0.00%	0.28%	64.93%	79.32%	85.53%	85.80%	79.77%	4.91%
DP	73	0.00%	87.59%	96.23%	99.24%	101.05%	101.36%	7.16%	2.64%
DP	85	0.00%	82.51%	92.76%	97.25%	100.18%	99.76%	8.68%	5.01%
DP	17	0.00%	2.44%	95.49%	100.93%	103.14%	103.02%	94.89%	100.25%
DP	18	0.00%	91.91%	99.44%	102.03%	102.59%	102.50%	100.86%	97.98%
DP	49	0.00%	94.49%	99.19%	101.51%	102.43%	102.35%	100.53%	100.17%
DP	50	0.00%	38.55%	94.90%	100.44%	102.79%	102.68%	100.82%	100.55%
DP	80	0.00%	92.85%	99.81%	103.23%	104.03%	104.02%	102.55%	102.38%
DP	81	0.00%	0.17%	95.64%	101.54%	104.12%	104.12%	102.55%	35.08%
DP	32	0.00%	2.44%	94.50%	99.28%	101.05%	101.11%	100.36%	100.26%
DP	31	0.00%	2.44%	94.00%	98.42%	100.86%	100.91%	100.43%	100.36%
DP	25	0.00%	86.05%	96.97%	100.28%	100.67%	100.51%	99.75%	99.64%
DP	26	0.50%	90.93%	96.48%	99.58%	100.57%	100.81%	99.61%	99.58%
DP	62	0.00%	0.47%	95.40%	98.79%	101.20%	100.52%	100.33%	100.29%
DP	63	0.00%	0.47%	94.60%	98.59%	100.94%	100.58%	100.16%	100.05%
DP	92	0.00%	0.42%	95.24%	99.24%	101.05%	101.01%	100.46%	100.35%
DP	93	0.00%	0.85%	96.23%	98.95%	100.81%	100.76%	99.76%	99.45%
DP	57	0.00%	94.21%	98.69%	99.47%	100.53%	100.42%	99.25%	99.32%
DP	58	0.00%	91.69%	96.89%	99.08%	100.33%	100.42%	99.25%	99.39%
DP	88	0.00%	91.15%	97.72%	99.94%	100.76%	100.66%	99.83%	101.83%
DP	89	0.00%	94.38%	98.71%	99.94%	100.90%	100.86%	99.89%	99.84%
MJ	3	0.00%	11.49%	78.32%	100.23%	101.96%	101.78%	100.75%	100.80%
MJ	4	0.00%	0.00%	0.00%	83.71%	102.08%	102.01%	100.55%	100.84%
MJ	35	0.00%	0.00%	92.95%	99.62%	100.56%	101.38%	99.88%	99.91%
MJ	36	0.00%	0.00%	0.05%	85.75%	100.35%	100.32%	99.91%	99.76%
MJ	66	0.00%	0.00%	0.00%	75.92%	102.19%	102.07%	101.05%	101.12%
MJ	67	0.00%	0.00%	78.03%	100.87%	102.68%	102.28%	99.61%	100.04%
MJ	19	0.00%	77.73%	95.49%	99.43%	100.84%	101.29%	100.90%	101.04%
MJ	20	0.00%	60.62%	93.01%	99.13%	100.28%	100.45%	100.13%	100.26%
MJ	51	0.00%	78.78%	95.70%	95.87%	99.14%	99.65%	98.65%	98.48%
MJ	52	0.00%	83.08%	97.89%	98.98%	99.40%	99.58%	98.57%	98.51%
MJ	82	0.00%	85.22%	98.42%	100.04%	100.66%	100.76%	101.00%	101.24%
MJ	83	0.00%	82.08%	98.22%	100.94%	100.66%	100.76%	99.98%	99.97%
MJ	30	0.00%	1.47%	75.70%	94.71%	98.00%	98.20%	99.35%	99.30%
MJ	29	0.00%	30.31%	82.13%	95.41%	98.09%	97.90%	98.38%	98.33%
MJ	60	0.00%	0.00%	81.41%	94.41%	96.83%	96.68%	97.56%	97.38%
MJ	61	0.00%	0.00%	73.92%	92.46%	97.45%	97.51%	99.34%	99.52%
MJ	90	0.00%	0.00%	68.75%	93.96%	98.98%	99.11%	100.29%	100.23%
MJ	91	0.00%	0.00%	64.49%	92.96%	98.16%	98.25%	98.72%	98.72%

(continued)

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Table A.14 (Continued)

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
MJ	12	0.00%	87.32%	95.68%	96.42%	99.41%	100.33%	98.63%	98.87%
MJ	11	0.00%	91.42%	94.99%	95.61%	99.56%	100.03%	97.24%	23.54%
MJ	43	0.00%	79.71%	90.40%	94.90%	100.38%	101.25%	78.10%	22.20%
MJ	44	0.00%	73.54%	90.10%	96.36%	100.69%	101.65%	50.70%	32.47%
MJ	74	0.00%	89.46%	95.44%	96.75%	99.27%	99.96%	11.81%	7.78%
MJ	75	0.00%	44.09%	83.83%	92.56%	99.17%	99.91%	100.11%	98.23%
MJ	24	0.00%	2.93%	91.03%	99.58%	100.86%	100.75%	100.09%	100.07%
MJ	23	0.00%	65.51%	96.97%	101.48%	102.13%	102.24%	100.17%	100.25%
MJ	28	0.70%	90.84%	98.06%	100.58%	99.71%	99.37%	98.78%	98.91%
MJ	27	2.79%	94.16%	101.62%	101.08%	99.50%	99.47%	99.21%	99.24%
MJ	59	0.00%	93.74%	99.19%	100.74%	99.76%	99.68%	99.24%	99.32%
MJ	55	0.00%	0.00%	90.20%	100.44%	101.87%	101.92%	100.66%	100.79%
MJ	56	0.00%	0.00%	79.21%	98.01%	101.61%	101.25%	100.12%	30.25%
MJ	86	0.00%	61.73%	97.72%	102.24%	101.86%	101.51%	99.87%	99.82%
MJ	87	0.00%	65.29%	97.42%	101.74%	101.53%	101.26%	100.01%	100.09%
ND	15	0.00%	90.45%	97.96%	100.38%	101.41%	100.95%	99.83%	100.43%
ND	16	0.00%	91.91%	97.96%	100.03%	101.45%	101.13%	99.83%	100.16%
ND	47	0.00%	85.14%	94.40%	98.01%	101.56%	101.08%	99.03%	99.60%
ND	48	0.00%	88.13%	96.39%	97.82%	101.20%	100.75%	98.86%	99.65%
ND	78	0.00%	86.49%	94.25%	99.24%	101.38%	101.36%	99.07%	99.57%
ND	79	0.00%	87.17%	95.74%	99.24%	101.29%	101.26%	100.46%	100.39%
ND	21	0.00%	75.29%	90.54%	98.27%	101.83%	99.87%	99.19%	98.93%
ND	9	0.00%	70.89%	94.00%	97.27%	100.28%	100.41%	98.89%	99.09%
ND	41	0.00%	78.87%	90.60%	96.65%	100.69%	100.42%	99.62%	99.33%
ND	53	0.00%	79.99%	91.70%	95.58%	100.79%	100.58%	98.75%	98.70%
ND	72	0.00%	76.32%	88.99%	94.26%	98.89%	101.01%	99.37%	99.06%
ND	84	0.00%	81.23%	92.46%	97.25%	100.52%	100.91%	98.80%	98.82%
ND	14	0.00%	92.40%	97.96%	100.58%	101.41%	101.13%	99.90%	100.04%
ND	13	1.99%	88.98%	96.97%	100.33%	101.62%	101.53%	100.19%	100.28%
ND	45	0.00%	92.90%	97.39%	99.28%	101.46%	101.08%	99.55%	99.51%
ND	46	0.00%	91.22%	96.39%	100.25%	101.20%	100.75%	99.97%	99.65%
ND	76	0.00%	89.71%	95.74%	99.24%	100.90%	101.26%	99.56%	99.48%
ND	77	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SJ	6	0.00%	89.96%	98.95%	100.33%	99.90%	100.71%	100.18%	100.48%
SJ	5	0.00%	0.00%	0.00%	96.82%	99.33%	99.91%	98.54%	98.24%
SJ	37	0.00%	76.72%	91.90%	93.44%	99.14%	99.42%	100.02%	99.89%
SJ	38	0.00%	92.62%	98.89%	100.25%	99.14%	100.75%	99.63%	99.99%
SJ	68	0.00%	96.67%	99.21%	99.74%	98.98%	99.76%	99.46%	100.17%
SJ	69	0.00%	100.06%	102.19%	101.74%	99.46%	100.76%	100.25%	100.36%
TU	8	0.00%	1.47%	54.92%	89.04%	100.21%	100.49%	100.54%	100.42%
TU	7	0.00%	0.49%	50.46%	88.19%	100.06%	100.15%	101.22%	101.02%
TU	39	0.00%	0.28%	63.63%	90.81%	99.56%	99.82%	100.47%	100.52%
TU	40	0.00%	0.28%	66.93%	91.98%	99.30%	99.08%	97.68%	97.57%
TU	70	0.00%	0.00%	0.30%	71.52%	97.20%	98.35%	99.59%	99.51%
TU	71	0.00%	0.00%	0.00%	0.20%	97.40%	98.90%	101.33%	101.30%

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Table A.15
Raw data for 1-inch meters at 1.0 life

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
DP	1	0.00%	89.73%	97.88%	100.28%	101.58%	101.60%	100.45%	100.42%
DP	2	0.00%	90.23%	97.37%	100.78%	101.58%	101.41%	100.45%	100.46%
DP	33	0.00%	88.22%	95.17%	100.07%	100.44%	101.68%	99.47%	99.45%
DP	34	0.00%	86.92%	96.97%	101.07%	102.19%	101.49%	99.47%	99.47%
DP	64	0.00%	88.56%	97.16%	99.56%	101.11%	101.54%	99.90%	99.85%
DP	65	0.00%	89.76%	97.06%	100.55%	99.92%	101.79%	99.80%	99.78%
DP	22	0.00%	81.20%	92.86%	98.27%	100.78%	101.03%	5.75%	5.54%
DP	10	0.00%	77.70%	94.36%	97.27%	100.68%	100.64%	8.64%	4.04%
DP	42	0.00%	81.23%	91.19%	97.78%	99.71%	99.57%	0.80%	0.49%
DP	54	0.00%	0.00%	63.78%	79.32%	84.27%	84.25%	81.62%	80.26%
DP	73	0.00%	88.26%	95.58%	99.26%	101.41%	101.04%	27.13%	5.66%
DP	85	0.00%	82.06%	91.92%	96.58%	98.82%	99.70%	9.07%	5.99%
DP	17	0.00%	0.90%	93.86%	100.78%	103.14%	102.93%	95.64%	92.30%
DP	18	0.00%	92.13%	99.78%	102.08%	102.78%	102.63%	101.29%	97.60%
DP	49	0.00%	87.92%	97.36%	101.27%	102.47%	102.64%	100.75%	100.54%
DP	50	0.00%	0.00%	94.17%	100.67%	103.20%	103.11%	100.88%	100.67%
DP	80	0.00%	7.01%	97.76%	102.04%	103.90%	103.74%	102.61%	102.44%
DP	81	0.00%	86.56%	97.16%	101.74%	104.40%	104.39%	102.61%	81.05%
DP	32	0.00%	0.50%	94.36%	98.77%	101.18%	101.22%	100.41%	100.39%
DP	31	0.00%	0.50%	92.86%	98.27%	100.80%	101.03%	100.46%	100.34%
DP	25	0.50%	92.23%	98.38%	100.28%	100.58%	100.64%	99.76%	99.70%
DP	26	0.50%	94.24%	98.38%	99.27%	100.58%	100.45%	99.71%	99.70%
DP	62	0.00%	0.00%	94.37%	98.48%	100.90%	101.49%	100.31%	100.26%
DP	63	0.00%	0.00%	94.17%	98.58%	100.44%	101.29%	100.16%	100.13%
DP	92	0.00%	0.30%	94.69%	98.96%	101.11%	100.94%	100.34%	100.20%
DP	93	0.00%	0.30%	95.38%	98.96%	100.61%	100.79%	99.68%	99.38%
DP	57	0.00%	93.22%	87.20%	99.77%	100.35%	100.24%	99.00%	99.01%
DP	58	0.00%	93.22%	97.16%	99.77%	100.44%	100.34%	99.12%	99.19%
DP	88	0.00%	93.57%	97.66%	99.46%	100.91%	100.79%	99.77%	99.67%
DP	89	0.00%	97.07%	100.33%	95.29%	100.91%	100.64%	99.68%	99.72%
MJ	3	0.00%	0.15%	92.76%	104.69%	102.08%	101.69%	100.73%	100.84%
MJ	4	0.00%	0.00%	0.00%	73.00%	101.55%	101.59%	100.44%	100.40%
MJ	35	0.00%	0.00%	0.03%	88.55%	100.63%	100.72%	99.55%	99.76%
MJ	36	0.00%	0.00%	1.81%	96.71%	100.95%	100.58%	99.71%	99.80%
MJ	66	0.00%	0.00%	0.00%	0.00%	100.47%	101.35%	101.30%	101.26%
MJ	67	0.00%	0.00%	68.75%	99.61%	102.79%	102.24%	99.91%	99.94%
MJ	19	0.00%	70.18%	94.86%	98.27%	100.78%	100.74%	101.09%	101.00%
MJ	20	0.00%	50.63%	90.35%	97.77%	100.18%	100.26%	100.35%	100.22%
MJ	51	0.00%	76.63%	95.97%	96.58%	99.25%	100.05%	98.27%	98.28%
MJ	52	0.00%	77.13%	96.67%	98.98%	99.89%	99.57%	98.17%	98.09%
MJ	82	0.00%	89.06%	98.35%	99.56%	102.11%	101.04%	101.12%	101.06%
MJ	83	0.00%	85.56%	98.65%	100.75%	102.41%	100.79%	99.90%	99.85%
MJ	30	0.00%	0.00%	69.27%	93.76%	97.67%	97.59%	99.36%	99.31%
MJ	29	0.00%	0.50%	79.81%	95.26%	97.97%	97.88%	98.61%	98.37%
MJ	60	0.00%	0.00%	68.76%	92.79%	96.95%	98.14%	98.06%	97.89%
MJ	61	0.00%	0.00%	71.05%	92.49%	98.15%	97.66%	99.10%	99.01%
MJ	90	0.00%	0.70%	76.60%	93.31%	98.12%	99.15%	100.14%	100.15%
MJ	91	0.00%	0.30%	77.10%	95.29%	97.62%	98.30%	98.75%	98.68%

(continued)

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Table A.15 (Continued)

Meter type	Meter number	Percent registry (%)							
		3/64gpm	3/16gpm	3/8gpm	3/4gpm	3gpm	4gpm	40gpm	50gpm
MJ	12	0.00%	92.03%	96.77%	97.07%	99.36%	100.43%	98.73%	98.78%
MJ	11	0.00%	88.32%	93.86%	95.66%	99.38%	100.07%	97.12%	27.79%
MJ	43	0.00%	93.52%	96.67%	97.08%	100.99%	102.25%	97.74%	23.74%
MJ	44	0.00%	71.94%	89.59%	96.18%	100.81%	101.49%	98.62%	57.44%
MJ	74	0.00%	85.36%	92.91%	95.99%	100.31%	100.15%	13.72%	9.32%
MJ	75	0.00%	95.87%	86.88%	93.60%	100.41%	100.15%	99.03%	99.08%
MJ	24	0.00%	0.00%	85.33%	99.27%	100.58%	100.64%	100.20%	100.02%
MJ	23	0.00%	2.01%	96.37%	100.78%	102.08%	102.07%	100.40%	100.36%
MJ	28	0.00%	86.22%	97.57%	100.48%	99.56%	99.21%	99.06%	99.01%
MJ	27	0.00%	84.41%	100.18%	100.78%	99.48%	99.50%	99.31%	99.21%
MJ	59	0.00%	92.42%	99.46%	100.77%	99.89%	100.05%	99.22%	99.24%
MJ	55	0.00%	0.50%	94.87%	101.07%	102.01%	102.44%	100.81%	100.83%
MJ	56	0.00%	0.00%	86.70%	99.97%	101.09%	101.20%	99.80%	3.66%
MJ	86	0.00%	58.54%	97.56%	101.55%	101.61%	101.39%	99.89%	99.83%
MJ	87	0.00%	58.74%	99.04%	102.04%	101.61%	101.29%	99.84%	99.85%
ND	15	0.50%	89.73%	97.37%	100.28%	101.18%	100.83%	100.32%	99.68%
ND	16	0.00%	88.02%	96.87%	99.27%	101.38%	101.21%	100.02%	100.00%
ND	47	0.00%	74.43%	88.49%	96.78%	100.90%	100.53%	98.49%	99.36%
ND	48	0.00%	81.43%	93.68%	99.28%	100.63%	100.24%	98.72%	98.63%
ND	78	0.00%	84.86%	93.70%	95.79%	100.31%	101.19%	99.17%	99.89%
ND	79	0.00%	88.36%	95.88%	98.57%	101.11%	101.04%	99.76%	100.19%
ND	21	0.00%	72.18%	89.34%	96.26%	100.38%	100.55%	100.25%	99.25%
ND	9	0.00%	74.69%	89.84%	97.27%	100.58%	100.83%	99.21%	99.08%
ND	41	0.00%	76.93%	89.09%	96.28%	100.63%	101.77%	99.30%	99.16%
ND	53	0.00%	77.93%	90.39%	96.48%	100.63%	101.01%	98.65%	98.66%
ND	72	0.00%	79.36%	86.49%	95.49%	101.31%	101.04%	99.20%	98.96%
ND	84	0.00%	80.86%	91.23%	96.98%	100.41%	100.79%	98.76%	98.76%
ND	14	0.00%	89.23%	97.37%	99.77%	100.98%	100.64%	99.97%	100.00%
ND	13	0.00%	89.23%	96.37%	100.28%	101.78%	101.50%	100.37%	100.23%
ND	45	11.49%	91.42%	96.67%	99.77%	101.09%	100.72%	99.40%	99.31%
ND	46	0.00%	88.62%	95.97%	99.28%	100.90%	100.72%	99.79%	99.70%
ND	76	0.00%	92.07%	95.68%	98.96%	101.11%	101.19%	99.42%	99.46%
ND	77	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SJ	6	0.00%	98.25%	102.39%	102.28%	99.78%	100.45%	100.01%	99.98%
SJ	5	0.00%	92.23%	100.38%	99.27%	99.18%	99.31%	98.03%	97.68%
SJ	37	0.00%	92.92%	99.66%	98.78%	97.41%	98.71%	99.47%	99.65%
SJ	38	0.00%	100.91%	101.65%	100.77%	100.17%	100.53%	99.37%	99.35%
SJ	68	0.00%	103.07%	97.86%	98.27%	99.14%	100.79%	99.21%	99.49%
SJ	69	0.00%	105.08%	102.80%	101.25%	100.13%	102.29%	99.70%	99.87%
TU	8	0.00%	0.00%	58.22%	88.74%	100.08%	100.55%	100.60%	100.22%
TU	7	0.00%	0.00%	57.72%	89.25%	99.88%	99.98%	101.14%	100.85%
TU	39	0.00%	0.00%	66.77%	92.79%	99.98%	100.24%	100.76%	100.73%
TU	40	0.00%	0.00%	73.25%	93.49%	99.89%	100.53%	97.76%	97.84%
TU	70	0.00%	0.00%	0.20%	84.17%	98.42%	98.30%	99.52%	99.37%
TU	71	0.00%	0.00%	0.00%	0.00%	98.12%	98.90%	101.24%	101.28%

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ACCURACY AND ENDURANCE TESTING 1 1/2-INCH METERS

Table A.16
Raw data for 1 1/2-inch meters at 0 life

Meter type	Meter number	Percent registry (%)								
		3/32gpm	3/16gpm	3/8gpm	3/4gpm	1 1/2gpm	5gpm	8gpm	50gpm	110gpm
DP	5	0.00%	0.11%	88.18%	96.89%	99.94%	101.15%	100.95%	99.17%	99.15%
DP	6	0.00%	0.00%	75.21%	92.83%	98.74%	101.35%	101.63%	100.76%	8.55%
DP	7	0.00%	0.00%	80.26%	93.84%	98.44%	101.15%	100.85%	100.12%	99.38%
MJ	13	0.00%	0.00%	73.11%	93.13%	100.63%	101.05%	100.66%	100.36%	100.06%
MJ	14	0.00%	0.00%	54.32%	95.06%	102.23%	101.05%	100.66%	102.51%	103.06%
MJ	10	0.00%	51.80%	78.58%	91.21%	100.93%	100.64%	99.20%	99.65%	99.30%
MJ	2	0.00%	0.00%	93.23%	105.00%	102.63%	98.84%	98.71%	99.57%	99.91%
ND	1	0.32%	91.07%	93.23%	100.64%	100.93%	101.65%	101.14%	99.97%	99.52%
ND	11	0.53%	55.63%	83.76%	97.09%	100.44%	102.05%	101.63%	99.73%	99.17%
ND	4	75.89%	89.47%	94.84%	103.48%	103.43%	100.64%	99.88%	99.89%	99.76%
SJ	12	71.43%	90.33%	101.01%	100.74%	100.73%	100.84%	100.07%	100.28%	100.38%
TU	9	0.00%	0.17%	0.70%	0.00%	80.65%	101.85%	101.14%	99.73%	99.10%
TU	8	0.00%	0.00%	0.35%	63.71%	90.14%	96.53%	97.74%	98.93%	98.61%
TU	3	0.00%	0.00%	0.00%	0.00%	0.30%	101.05%	103.87%	101.71%	103.01%

Table A.17
Raw data for 1 1/2-inch meters at 0.25 life

Meter type	Meter number	Percent registry (%)								
		3/32gpm	3/16gpm	3/8gpm	3/4gpm	1 1/2gpm	5gpm	8gpm	50gpm	110gpm
DP	5	0.29%	0.00%	88.36%	97.60%	99.55%	100.62%	99.62%	99.45%	99.31%
DP	6	0.29%	0.00%	77.47%	93.31%	98.24%	100.62%	101.22%	100.02%	5.57%
DP	7	0.00%	0.00%	82.11%	93.82%	99.04%	101.12%	100.42%	100.25%	99.26%
MJ	13	0.29%	0.00%	62.98%	89.45%	99.24%	99.62%	99.42%	99.29%	99.62%
MJ	14	0.29%	0.00%	0.00%	0.00%	94.24%	101.42%	100.22%	101.54%	102.92%
MJ	10	0.10%	34.48%	76.05%	87.73%	98.84%	100.82%	99.62%	98.67%	98.41%
MJ	2	0.00%	0.00%	77.47%	99.75%	102.05%	99.42%	99.12%	100.23%	100.64%
ND	1	0.20%	76.29%	90.64%	97.26%	99.85%	101.32%	101.22%	99.96%	99.90%
ND	11	0.69%	0.00%	59.86%	77.08%	63.83%	93.85%	97.72%	99.51%	98.78%
ND	4	0.98%	69.23%	89.50%	95.71%	99.04%	100.62%	100.22%	99.66%	99.96%
SJ	12	70.41%	94.32%	101.72%	100.35%	99.75%	100.72%	100.32%	100.11%	100.24%
TU	9	0.20%	0.00%	0.00%	78.54%	97.54%	101.42%	102.62%	99.71%	99.18%
TU	8	0.29%	0.00%	6.44%	70.13%	90.74%	96.44%	97.72%	98.21%	98.48%
TU	3	0.00%	0.00%	0.00%	0.00%	61.03%	103.41%	104.11%	99.32%	99.54%

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Table A.18
Raw data for 1 1/2-inch meters at 0.5 life

Meter type	Meter number	Percent registry (%)								
		3/32gpm	3/16gpm	3/8gpm	3/4gpm	1 1/2gpm	5gpm	8gpm	50gpm	110gpm
DP	5	0.00%	0.00%	89.38%	97.25%	99.71%	101.18%	100.05%	99.68%	99.14%
DP	6	0.16%	0.00%	0.00%	92.35%	97.96%	101.00%	101.35%	99.98%	4.80%
DP	7	0.00%	0.00%	81.94%	94.25%	98.83%	101.18%	101.85%	100.24%	99.63%
MJ	13	0.00%	0.00%	64.25%	89.24%	97.96%	99.86%	98.54%	98.41%	98.58%
MJ	14	0.00%	0.00%	0.00%	0.00%	96.82%	102.49%	101.35%	102.24%	103.20%
MJ	10	0.00%	9.06%	75.08%	88.64%	98.39%	100.74%	100.15%	98.71%	98.18%
MJ	2	0.00%	0.00%	79.52%	99.25%	101.46%	98.99%	99.85%	100.31%	100.77%
ND	1	0.25%	80.28%	91.98%	96.75%	100.14%	101.62%	101.35%	100.24%	100.04%
ND	11	0.00%	0.00%	13.82%	67.83%	81.08%	86.46%	96.64%	99.58%	98.08%
ND	4	0.00%	82.69%	93.24%	97.85%	99.71%	101.18%	100.35%	99.48%	100.00%
SJ	12	0.00%	94.36%	101.65%	100.75%	100.06%	100.65%	100.65%	100.11%	100.33%
TU	9	0.00%	0.10%	0.29%	6.30%	94.20%	101.79%	101.35%	99.68%	99.16%
TU	8	0.00%	0.51%	65.22%	90.54%	96.91%	97.67%	98.04%	98.35%	98.37%
TU	3	0.00%	0.00%	0.00%	0.00%	0.70%	104.68%	105.17%	102.41%	100.25%

Table A.19
Raw data for 1 1/2-inch meters at 0.75 life

Meter type	Meter number	Percent registry (%)								
		3/32gpm	3/16gpm	3/8gpm	3/4gpm	1 1/2gpm	5gpm	8gpm	50gpm	110gpm
DP	5	0.00%	0.14%	87.78%	95.57%	100.24%	100.39%	101.05%	98.94%	99.23%
DP	6	0.00%	0.00%	0.30%	87.24%	94.97%	100.39%	101.55%	100.22%	6.01%
DP	7	0.00%	0.00%	82.78%	93.84%	98.45%	101.48%	101.45%	100.47%	99.53%
MJ	13	0.00%	0.00%	54.75%	87.34%	99.61%	100.69%	99.75%	99.79%	99.58%
MJ	14	0.00%	0.00%	0.00%	0.00%	93.81%	101.48%	101.25%	102.34%	103.01%
MJ	10	0.00%	40.72%	77.07%	88.24%	99.17%	100.79%	99.75%	98.60%	98.08%
MJ	2	0.00%	0.15%	77.57%	98.05%	101.58%	99.69%	99.25%	100.22%	100.72%
ND	1	0.00%	78.12%	90.79%	96.54%	99.61%	101.68%	100.55%	100.22%	100.15%
ND	11	0.00%	0.25%	48.35%	72.23%	90.95%	102.48%	101.75%	98.69%	99.00%
ND	4	0.00%	77.11%	90.29%	95.54%	99.88%	101.19%	100.75%	98.94%	99.80%
SJ	12	45.01%	92.94%	101.10%	100.45%	99.88%	100.49%	100.15%	99.79%	99.99%
TU	9	0.00%	0.00%	1.50%	77.04%	98.27%	102.18%	101.05%	100.64%	99.64%
TU	8	0.00%	0.00%	43.34%	86.04%	95.58%	96.90%	97.56%	98.94%	98.36%
TU	3	0.00%	0.00%	0.00%	0.00%	57.62%	105.47%	105.74%	102.34%	99.46%

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Table A.20
Raw data for 1 1/2-inch meters at 1.0 life

Meter type	Meter number	Percent registry (%)								
		3/32gpm	3/16gpm	3/8gpm	3/4gpm	1 1/2gpm	5gpm	8gpm	50gpm	110gpm
DP	5	38.51%	0.00%	88.06%	95.80%	100.38%	100.09%	100.35%	99.32%	99.37%
DP	6	0.00%	0.00%	0.50%	89.87%	96.54%	100.59%	101.04%	100.01%	6.53%
DP	7	0.00%	0.00%	82.37%	94.12%	99.14%	101.59%	101.04%	100.17%	99.54%
MJ	13	0.00%	0.00%	60.90%	90.17%	100.58%	100.59%	99.86%	99.59%	99.73%
MJ	14	0.00%	0.00%	0.30%	0.00%	95.29%	101.29%	100.64%	102.29%	103.04%
MJ	10	0.00%	40.38%	79.37%	89.87%	100.29%	100.29%	99.36%	98.31%	97.92%
MJ	2	0.00%	0.00%	75.58%	99.06%	100.86%	99.09%	98.58%	100.54%	99.81%
ND	1	0.00%	76.82%	89.06%	95.30%	99.23%	100.79%	100.55%	100.01%	99.97%
ND	11	0.00%	0.00%	48.92%	65.97%	71.76%	90.11%	96.91%	99.75%	98.92%
ND	4	0.00%	0.00%	88.86%	95.60%	98.94%	100.99%	100.15%	99.37%	99.64%
SJ	12	63.82%	93.22%	100.64%	100.14%	99.52%	100.39%	99.76%	99.64%	99.73%
TU	9	0.00%	0.00%	0.00%	46.71%	96.06%	101.99%	101.63%	99.75%	99.42%
TU	8	0.00%	0.00%	45.43%	83.75%	95.77%	97.30%	97.89%	98.68%	98.92%
TU	3	0.00%	67.63%	0.00%	0.00%	5.28%	103.28%	105.76%	102.40%	99.37%

ACCURACY AND ENDURANCE TESTING 2-INCH METERS

Table A.21
Raw data for 2-inch meters at 0 life

Meter type	Meter number	Percent registry (%)									
		1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	4gpm	8gpm	15gpm	100gpm	150gpm
DP	5	79.16%	88.65%	95.60%	99.81%	101.09%	101.26%	100.47%	100.83%	99.44%	98.69%
DP	1	0.00%	0.00%	63.71%	89.37%	97.82%	99.28%	100.96%	100.83%	100.45%	100.13%
DP	9	0.00%	0.00%	4.25%	90.34%	98.83%	100.27%	101.70%	101.31%	100.49%	100.35%
MJ	13	0.00%	50.40%	75.88%	94.22%	98.33%	98.03%	97.25%	96.19%	101.11%	100.27%
MJ	4	0.00%	0.00%	77.08%	94.47%	101.59%	100.76%	99.48%	99.61%	98.08%	97.65%
MJ	8	49.88%	75.64%	87.09%	95.00%	103.59%	104.14%	102.25%	100.39%	98.35%	98.80%
MJ	16	0.00%	67.03%	95.10%	104.42%	102.09%	100.76%	98.98%	98.63%	98.18%	98.21%
ND	15	0.00%	80.64%	92.09%	97.62%	101.34%	101.76%	101.46%	100.34%	100.00%	99.87%
ND	17	0.00%	0.00%	25.13%	89.61%	98.83%	101.26%	102.69%	101.80%	100.17%	100.20%
ND	14	0.00%	82.01%	91.09%	96.90%	98.83%	100.27%	99.73%	99.61%	99.63%	99.54%
PR	10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	74.46%	106.49%	106.76%
SJ	12	0.00%	97.17%	98.18%	97.14%	101.34%	100.96%	100.76%	101.44%	100.54%	100.39%
SJ	6	62.71%	93.74%	99.90%	99.37%	102.44%	101.16%	100.86%	100.19%	100.45%	100.69%
TU	19	0.09%	0.00%	18.02%	84.51%	101.09%	101.26%	100.71%	98.87%	99.59%	99.72%
TU	11	0.00%	0.00%	0.00%	0.00%	80.77%	96.30%	98.98%	99.61%	100.61%	99.84%
TU	18	0.00%	0.00%	0.00%	64.11%	103.59%	100.76%	98.49%	98.14%	99.29%	98.61%
TU	3	0.00%	0.00%	0.00%	0.00%	101.09%	101.76%	101.70%	101.31%	101.37%	101.24%
TU	7	0.00%	0.00%	2.00%	1.21%	75.00%	99.03%	101.46%	102.05%	99.51%	99.30%
TU	2	0.00%	0.00%	0.00%	0.00%	67.22%	95.80%	100.96%	102.78%	103.36%	102.88%

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Table A.22
Raw data for 2-inch meters at 0.25 life

Meter type	Meter number	Percent registry (%)									
		1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	4gpm	8gpm	15gpm	100gpm	150gpm
DP	5	76.29%	88.48%	95.67%	99.07%	99.82%	101.09%	99.55%	100.90%	99.05%	99.10%
DP	1	0.00%	0.00%	61.34%	86.30%	95.02%	100.09%	100.54%	99.41%	100.10%	15.43%
DP	9	0.00%	0.00%	3.51%	89.35%	96.52%	100.09%	101.04%	101.40%	100.36%	100.25%
MJ	13	0.00%	0.00%	77.80%	94.29%	98.02%	97.58%	97.06%	97.91%	95.83%	96.58%
MJ	4	0.00%	0.00%	57.82%	88.44%	100.02%	101.09%	100.54%	100.90%	99.56%	99.20%
MJ	8	0.00%	56.78%	82.82%	95.20%	104.23%	102.79%	101.74%	100.01%	98.07%	98.61%
MJ	16	0.00%	0.00%	86.44%	103.43%	102.02%	100.09%	98.55%	97.91%	97.68%	97.70%
ND	15	0.00%	2.51%	87.74%	96.19%	99.02%	101.09%	101.54%	99.91%	99.84%	100.61%
ND	17	0.00%	0.00%	10.54%	83.17%	96.02%	102.09%	103.03%	102.40%	100.86%	100.67%
ND	14	0.00%	77.06%	89.85%	97.09%	98.52%	99.59%	101.54%	99.91%	99.91%	99.36%
PR	10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	84.42%	107.30%	106.34%
SJ	12	0.00%	91.50%	97.59%	96.76%	98.47%	100.19%	100.09%	101.00%	100.15%	100.19%
SJ	6	0.00%	85.01%	98.18%	99.64%	96.32%	101.19%	101.04%	100.30%	100.23%	100.31%
TU	19	0.00%	0.00%	4.42%	83.59%	98.52%	101.59%	100.04%	100.40%	99.61%	99.81%
TU	11	0.00%	0.00%	0.00%	0.00%	58.01%	96.08%	96.56%	99.91%	99.50%	98.77%
TU	18	0.00%	0.00%	0.00%	1.15%	86.52%	97.08%	98.05%	98.41%	98.75%	98.67%
TU	3	0.00%	0.00%	0.00%	0.00%	79.32%	99.59%	100.54%	100.90%	101.57%	101.30%
TU	7	0.00%	0.00%	0.00%	0.00%	79.82%	99.59%	102.83%	101.60%	99.23%	98.93%
TU	2	0.00%	0.00%	0.00%	0.00%	13.00%	98.59%	99.55%	103.90%	103.00%	102.27%

Table A.23
Raw data for 2-inch meters at 0.5 life

Meter type	Meter number	Percent registry (%)									
		1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	4gpm	8gpm	15gpm	100gpm	150gpm
DP	5	80.16%	90.61%	96.19%	99.33%	100.23%	100.90%	101.12%	100.54%	99.27%	99.07%
DP	1	0.00%	0.00%	68.71%	90.46%	96.98%	100.40%	101.62%	100.29%	99.95%	8.43%
DP	9	0.00%	0.00%	2.10%	87.59%	95.99%	100.15%	101.12%	100.79%	100.37%	100.24%
MJ	13	0.00%	4.71%	78.72%	93.59%	97.23%	96.39%	96.91%	96.29%	96.94%	94.88%
MJ	4	0.00%	0.00%	69.41%	91.24%	100.72%	100.90%	100.38%	100.79%	99.87%	99.54%
MJ	8	0.00%	54.20%	83.38%	95.31%	103.62%	102.95%	101.42%	99.99%	98.32%	98.52%
MJ	16	0.00%	0.00%	89.67%	103.50%	102.47%	99.90%	98.65%	97.79%	98.30%	98.40%
ND	15	0.00%	0.00%	87.81%	95.68%	99.23%	101.40%	101.12%	100.04%	99.77%	100.55%
ND	17	0.00%	0.00%	1.86%	83.34%	95.51%	102.47%	103.59%	102.28%	100.40%	100.84%
ND	14	0.00%	61.24%	87.57%	94.11%	98.23%	99.90%	100.63%	99.79%	99.93%	99.57%
PR	10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	68.27%	107.32%	106.32%
SJ	12	0.00%	90.66%	98.54%	97.58%	99.24%	100.45%	100.27%	101.41%	100.25%	100.13%
SJ	6	0.00%	87.00%	98.57%	98.75%	99.73%	101.05%	100.73%	99.84%	99.77%	99.94%
TU	19	0.00%	0.00%	19.33%	86.29%	97.73%	99.65%	100.63%	98.79%	99.54%	99.59%
TU	11	0.00%	0.00%	0.00%	0.00%	68.31%	93.14%	96.17%	98.54%	99.61%	98.95%
TU	18	0.00%	0.00%	0.70%	8.60%	92.25%	98.39%	98.65%	98.04%	98.48%	98.86%
TU	3	0.00%	0.00%	0.00%	37.02%	100.72%	100.90%	101.37%	101.79%	101.59%	101.44%
TU	7	0.00%	0.00%	0.00%	1.04%	96.98%	98.64%	102.36%	101.29%	99.17%	98.56%
TU	2	0.00%	0.00%	0.00%	0.26%	56.10%	96.14%	103.11%	103.79%	103.23%	102.26%

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Table A.24
Raw data for 2-inch meters at 0.75 life

Meter type	Meter number	Percent registry (%)									
		1/8gpm	1/4gpm	1/2gpm	1gpm	2gpm	4gpm	8gpm	15gpm	100gpm	150gpm
DP	5	83.66%	91.26%	94.79%	99.29%	101.26%	98.75%	100.73%	99.78%	98.92%	98.92%
DP	1	0.00%	0.20%	67.05%	90.26%	96.26%	100.45%	100.73%	100.97%	99.62%	15.21%
DP	9	0.18%	0.80%	4.79%	86.08%	95.96%	99.45%	101.23%	100.48%	99.94%	100.11%
MJ	13	0.00%	3.52%	80.52%	94.45%	97.16%	97.75%	97.75%	97.99%	96.63%	96.97%
MJ	4	0.00%	0.20%	78.82%	103.57%	100.66%	100.75%	100.73%	100.97%	100.66%	100.11%
MJ	8	0.00%	53.02%	85.61%	101.24%	104.75%	102.45%	101.23%	99.98%	98.51%	98.67%
MJ	16	0.00%	0.20%	80.12%	100.50%	100.76%	99.15%	98.25%	97.99%	97.98%	97.85%
ND	15	0.44%	1.21%	85.81%	95.57%	99.46%	100.95%	100.93%	99.78%	99.86%	100.22%
ND	17	0.00%	1.21%	0.80%	80.03%	95.96%	101.95%	103.21%	101.17%	100.30%	100.15%
ND	14	0.18%	73.45%	91.30%	97.71%	99.76%	100.45%	100.43%	99.48%	99.79%	99.94%
PR	10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	74.91%	106.26%	106.54%
SJ	12	0.00%	81.77%	94.09%	100.31%	98.81%	100.00%	100.28%	100.58%	99.84%	99.92%
SJ	6	0.00%	50.21%	96.78%	106.45%	99.66%	100.55%	100.23%	99.68%	99.46%	99.73%
TU	19	0.00%	1.01%	0.80%	87.19%	97.66%	99.65%	100.23%	98.98%	99.38%	99.72%
TU	11	0.88%	0.00%	0.00%	38.62%	74.97%	93.95%	96.26%	98.49%	99.56%	99.96%
TU	18	0.00%	0.70%	0.20%	52.58%	90.96%	98.65%	98.55%	98.19%	97.89%	98.14%
TU	3	0.00%	0.30%	0.00%	94.45%	84.26%	99.45%	101.03%	100.48%	101.56%	101.27%
TU	7	0.26%	0.80%	0.00%	39.08%	83.96%	99.15%	101.52%	101.47%	99.06%	98.86%
TU	2	0.00%	0.00%	0.00%	0.00%	48.28%	92.15%	100.73%	103.26%	103.36%	102.18%

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APPENDIX B – PULLED METER DATA

PULLED METER ACCURACY AND DISASSEMBLY – 5/8X3/4-INCH METERS

Table B.1
Results for 5/8x3/4-inch DP meters

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Body Debris	Body Scale	Gaskets	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm													
	78.09	**91.94**	100.49	**97.39**		0			1	1	1	0	0	1	0	1	2	7
	0.00	**94.18**	**98.19**	**94.82**		2	50	2.03	1	2	2	3	3	2	0	1	2	16
	92.42	98.29	99.91	**97.10**	98.33	1	1		1		1	1	1	1	0	1	1	7
	78.81	**93.06**	100.68	**95.48**		0			0	1	2	3	2	1	0	1	1	11
		68.11	**88.61**	**97.08**	98.99	0			0	1	0	1	0	1	0	0	0	3
	8.78	**84.55**	101.27	98.96		1	2		1	1	1	1	1	1	1	1	1	9
	7.15	**68.92**	99.31	**97.74**		0			1	1	1	0	0	0	0	1	2	6
	8.00	**77.09**	99.31	**97.78**		0			1	1	0	1	2	1	0	0	1	7
	6.53	**62.88**	100.45	**98.14**		0			1	1	1	0	1	1	0	1	1	7
	78.40	**82.26**	**102.50**	98.60		0			1	1	0	0	0	1	0	2	2	7
	0.99	**86.80**	**103.74**	99.09		0			1	1	1	1	1	1	1	2	3	12
	90.31	**91.80**	**102.50**	**97.61**		0			1	1	1	0	0	1	0	1	3	8
	83.86	**86.35**	**102.75**	**98.20**		0			1	1	1	1	1	1	1	2	2	11
	89.32	**90.89**	**103.25**	**98.45**		0			2	2	0	0	0	2	0	2	3	11
	0.00	**0.00**	**95.04**	**94.62**		0			1	1	1	1	1	1	0	2	3	11
	8.00	**77.09**	100.94	99.14		0			0	1	1	1	2	0	0	1	1	7
	8.41	**81.00**	100.78	98.66		0			1	1	1	0	1	0	0	1	2	7
		0.00	**96.43**	**95.36**	95.21	0			1	1	1	1	2	1	0	1	1	9
		0.00	**87.60**	**88.74**	84.83	0			2	1	1	1	1	1	0	3	1	11
		89.63	99.34	98.61	98.64	0			1	1	1	1	0	1	0	1	1	7
		86.68	99.34	**98.16**	98.16	0			1	1	1	0	1	1	0	3	1	9
		92.09	101.30	99.60	99.55	0			1	1	1	0	1	1	0	2	1	8
	90.63	97.51	101.30	100.19	100.27	0			1	1	1	0	0	1	0	2	1	7
		87.66	98.85	**97.96**	97.97	0			1	1	1	0	1	1	0	2	1	8
		83.85	**102.19**	99.54	99.09	0			2	1	1	1	0	1	1	2	2	11
		91.73	101.07	99.49	99.09	0			2	1	2	2	1	1	0	2	2	13
		56.52	99.56	**98.42**	98.04	0			2	1	1	1	0	1	0	3	2	11
		87.10	101.44	99.35	99.09	0			2	1	1	1	0	1	0	2	2	10
		89.41	99.19	99.00	98.91	0			1	1	1	1	0	1	0	2	1	8
	85.39	97.75	100.69	99.99	100.01	0			1	1	1	1	1	1	0	2	1	9
		66.54	101.12	99.13	98.67	0			1	1	0	1	1	1	0	2	2	9
		70.04	101.22	99.16	98.98	0			2	1	0	1	2	1	0	2	3	12
		78.65	**102.12**	99.63	99.22	0			1	1	1	1	1	1	0	1	2	9
		80.55	**102.71**	99.82	99.47	0			1	1	0	1	2	1	0	2	3	11
		77.05	100.33	98.66	98.49	0			1	2	0	0	0	2	0	1	3	9
		4.50	101.12	**98.44**	98.53	0			1	1	1	1	1	1	1	1	2	10
		70.00	99.77	**98.37**	97.73	0			2	1	1	1	1	1	0	2	1	10
		0.00	**94.95**	**66.67**	74.87	0			1	1	0	1	2	1	0	2	1	9
		85.39	99.86	99.38	99.32	0			1	1	1	1	1	0	0	1	1	7
	0.00	**0.00**	**95.89**	99.12	98.85	0			1	1	1	1	1	1	0	2	2	10

(continued)

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Table B.1 (Continued)

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Body Debris	Body Scale	Gaskets	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm													
	0.00	**0.00**	**97.07**	99.14	98.85	0			1	1	1	1	1	1	0	1	2	9
	0.00	**89.91**	**101.52**	99.80	99.28	0			0	0	1	0	0	1	1	1	1	5
	0.00	**0.00**	**85.51**	**95.95**	95.45	0			1	1	1	2	1	1	0	1	2	10
	0.00	**0.00**	**97.87**	**98.14**	97.71	0			1	1	1	1	2	1	0	1	1	9
	0.00	**0.48**	**97.67**	99.67	99.40	0			0	2	1	1	1		0	1	3	9
0.00	0.00	**0.20**	**87.89**	**96.55**	98.58	0			1	2	1	2	1	1	0	1	2	11
0.00	56.09	**87.24**	101.45	99.78	99.43	0			1	1	1	1	1	1	0	1	1	8
0.00	0.00	**0.50**	**102.14**	100.87	100.13	0			2	1	1	1	1	1	0	2	1	10
0.00	63.47	**82.04**	**92.74**	98.63	98.60	0			1	1	1	1	0	1	1	1	1	8
0.00	0.20	**0.30**	**91.75**	98.98	98.88	2	3	0.15	1	1	1	1	0	1	1	1	2	9
0.00	0.00	**0.00**	99.97	100.71	100.65	1			1	2	1	2	2	1	0	2	1	12
	89.85	97.11	**101.54**	100.26	100.26	0			1	1	1	1	0	1	0	1	1	7
	83.90	95.13	101.04	100.40	100.26	0			1	1	1	0	0	1	0	1	1	6
	90.74	96.32	100.63	98.66	98.91	0			0	1	0	0	0	1	0	1	2	5
	88.72	96.42	100.04	100.07	99.76	1	1	0.09	1	1	1	0	0	1	0	0	1	5
	83.29	95.67	101.12	100.02	99.95	0			1	1	1	1	1	1	0	1	1	8
		86.89	100.39	99.77	99.57	0			1	1	0	1	1	1	0	1	0	6
		44.10	**101.61**	100.53	100.28	0			2	1	1	1	1	1	0	2	1	10
	93.23	97.99	100.82	100.48	100.43	0			1	1	0	1	1	1	0	1	1	7
	86.02	**92.98**	101.49	99.75	99.56	0			1	1	0	1	1	0	0	2	1	7
0.00	0.32	**76.73**	**92.44**	**92.66**	97.76	2	3	0.1	1	3	1	1	1	2	2	1	1	13
0.00	0.00	**0.00**	**98.40**	100.41	100.08	0			1	2	1	2	1	1	0	1	1	10
0.00	70.17	**83.80**	**94.93**	98.97	98.55	0			1	2	1	0	0	1	0	2	2	9
0.00	0.32	**87.67**	101.09	99.84	99.67	0			1	1	1	1	1	1	2	1	2	11
0.00	0.13	**70.50**	**102.88**	99.51	99.36	0			1	1	1	1	1	1	0	1	2	9
0.00	0.00	**0.07**	**94.73**	**95.56**	95.07	0			1	3	1	1	2	3	0	1	2	14
	0.00	**66.54**	**103.50**	100.92	100.42	1	10	0.43	1	1	0	2	1	2		2	2	11
	0.00	**72.56**	**96.33**	98.72	98.28													0
	0.00	**14.08**	**92.35**	**98.17**	97.88													0
	0.00	**72.17**	98.52	**97.47**	97.76	0			2	1	1	1	1	1	0	1	1	9
	0.00	**76.45**	**98.32**	**96.82**	96.55				1	1	0	1	1	1		1	3	9
	0.00	**72.08**	**103.30**	100.70	100.03				2	1	0	0	1	1		2	3	10
	0.00	**0.00**	**96.09**	100.11	100.60				1	1	1	1	1	2		2	3	12
	0.00	**49.78**	**91.31**	**98.04**	97.55	1	5	0.46	2	2	1	1	0	1		1	2	10
	0.00	**0.00**	**95.59**	100.08	99.74				1	1	2	1	2	1		1	1	10
	0.00	**81.52**	98.58	99.71	99.46				2	1	1	1	1	1		3	1	11
	37.53	**89.40**	**102.37**	**98.50**	98.58				1	2	2	1	1	1		1	1	10
	0.00	**0.30**	99.28	99.86	99.64				1	0	2	1	0	0		1	1	6
0.70	4.50	**69.23**	**97.65**	99.17	98.41						1	1	1	1		2	1	7
0.00	0.00	**0.30**	**94.02**	**97.65**	97.66	0			1	1	1	1	0	1	0	1	1	7
1.00	68.36	**88.12**	100.68	99.57	99.57	0			1	1	0	1	0	1	0	2	1	7
0.50	41.04	**82.92**	100.59	98.95	99.13	0			1	1	0	0	0	1	0	2	2	7
1.00	77.07	**88.91**	101.07	99.50	99.29	0			1	1	0	0	0	1	0	1	1	5
0.30	0.00	**3.50**	**102.54**	100.20	100.16	0			2	1	0	1	0	1	0	1	2	8
	0.40	**0.50**	**102.18**	99.00	98.72													0
	0.64	**70.74**	100.69	98.81	98.75	0			1	2	0	0	0	1	0	1	2	7
	0.00	**80.54**	**102.88**	99.89	99.76													0
	0.56	**0.30**	**101.59**	99.47	99.12													0
	0.16	**46.52**	**102.88**	99.70	99.34	0			1	1	1	1	1	1	0	2	1	9

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Table B.1 (Continued)

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Body Debris	Body Scale	Gaskets	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm													
	0.00	**12.01**	**102.38**	99.13	98.85				2	2	1	1	1	0		1	2	10
	0.00	**32.32**	**102.58**	100.22	99.90				2	1	1	1	1	1		2	1	10
	0.00	**37.52**	**102.08**	99.60	99.17				2	1	0	1	1	0		1	2	8
	0.00	**1.50**	**101.58**	100.22	99.90				1	0	1	1	1	1		1	1	7
	0.00	**1.00**	**89.46**	**95.87**	95.26	1	4	0.2	2	3	1	2	3	3	2	1	1	18
	0.00	**82.04**	**102.88**	100.32	99.92				2	1	1	1	1	1		1	2	10
	0.00	**1.20**	**91.25**	**92.38**	92.02				2	3	0	2	2	3	3	1	0	16
	0.20	**0.77**	101.12	**98.09**	99.55				1	2	1	1	1	2		1	2	11
	0.00	**3.87**	99.15	98.94	98.69	1	2	0.15	1	3	1	1	1	2	0	1	2	12
	0.70	**63.93**	**95.23**	99.51	98.48				1	1	0	1	1	1		2	3	10
	0.30	**81.85**	**101.81**	99.56	99.58	0			2	1	0	1	0	1	0	2	2	9
	0.00	**0.19**	98.96	98.77	98.47	0			1	1	0	1	1	1	0	1	2	8
	0.30	**66.06**	**94.25**	99.34	98.91	0			1	1	0	1	1	1	0	2	2	9
	60.07	**76.93**	100.95	**97.80**	99.11	0			1	2	1	0	0	1	0	1	2	8
	0.50	**71.45**	**92.99**	**98.04**	99.08													0
	0.00	**76.63**	**95.48**	100.64	100.21	0			2	1	1	1	1	1	0	2	2	11
	0.00	**75.63**	**95.98**	99.89	99.68	0			1	1	1	1	0	1	0	1	2	8
	0.00	**76.63**	**103.14**	100.22	99.61	0			1	1	1	0	1		0	1	2	7
	3.30	**87.57**	**102.15**	99.89	100.04	0			2	1	1	0	1	1	0	2	2	10
	34.04	**91.75**	**102.03**	99.93	99.86				2	1	0	1	1	0		3	2	10
	42.35	**88.05**	**101.93**	99.68	99.84				2	0	0	1	1	0		1	3	8
	74.38	**91.25**	**102.03**	100.13	100.09				2	1	1	1	1	1		2	1	10
	0.00	**57.23**	**92.56**	98.75	98.74				1	1	0	1	1	1		1	2	8
	0.20	**71.34**	100.23	99.88	99.69				1	1	0	1	1	1		1	1	7
	0.00	**14.31**	**97.74**	98.93	98.76				2	1	0	1	1	2		2	1	10
	44.66	**79.45**	**98.00**	**96.43**	97.95	1	1	0.5	1	1	0	1	1	1		1	2	8
	0.00	**75.41**	100.47	98.79	98.67	1		3.55	1	3	1	2	2	3	0	1	2	15
	0.00	**66.03**	100.97	99.93	99.34				2	0	1	1	1	0		1	2	8
	66.71	**87.58**	100.47	99.88	99.64				1	1	0	1	1	1		2	1	8
	0.00	**64.64**	**97.70**	99.41	98.64				2	0	0	2	1	1		2	1	9
	0.00	**62.21**	101.16	100.78	100.15	0			1	1	0	2	1	2	0	1	1	9
	0.00	**0.00**	99.72	100.39	100.11	3	30	3.61	1	2	1	1	1	2		1	2	11
	0.67	**70.49**	**97.83**	99.54	99.66	1	2	0.33	1	1	1	1	2	1		1	1	9
	79.45	**93.69**	100.51	99.42	99.58				1	1	0	1	1	1		2	2	9
	0.67	**82.99**	101.31	99.39	99.23				2	1	1	1	2	1		2	2	12
	42.22	**79.19**	**103.50**	100.37	99.90				1	1	1	1	1	1		2	1	9
	0.67	**76.99**	**103.00**	100.37	99.98				2	1	0	1	1	1		2	2	10
	84.09	**94.12**	**101.71**	100.27	99.72				1	1	0	1	1	0		1	1	6
	1.30	**83.22**	**101.71**	99.41	98.95				2	1	0	1	1	1		2	2	10
	49.55	**90.20**	101.42	100.27	99.87				1	1	0	1	2	1		2	2	10
	0.30	**68.41**	100.73	99.81	99.17				1	0	1	1	1	0		1	2	7
	0.20	**0.26**	**102.21**	**101.52**	101.19	0			1	1	0	1	1	1	0	1	1	7
	3.30	**89.50**	99.25	100.07	99.69	0			1	1	0	0	1	0	0	1	2	6
	0.76	**89.42**	101.04	100.15	99.85	0			2	1	0	1	1	1	0	1	2	9
	0.19	**86.82**	**102.49**	100.51	100.20				2	0	0	0	1	0		1	2	6
	4.57	**84.41**	99.30	99.56	99.43				1	2	1	1	2	2		1	2	12
	58.83	**88.75**	101.43	100.64	100.63	0			0	1	0	1	1	1	0	1	2	7
	0.19	**65.40**	100.75	100.49	100.17	0			1	1	0	2	2	1	0	1	2	10
	0.19	**38.39**	100.46	100.12	99.90	0			1	1	0	1	0	1	0	2	2	8

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Table B.1 (Continued)

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Body Debris	Body Scale	Gaskets	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm													
	90.40	97.46	100.87	100.09	100.01	0			1	1	0	0	0	1	0	2	1	6
	71.64	**89.90**	99.38	**98.45**	98.44	1	7	0.44	2	1	1	1	1	1	0	1	1	9
	0.00	**0.17**	**87.43**	**97.68**	97.82				1	0	0	2	2	1		1	1	8
	0.00	**64.83**	**97.79**	**97.75**	97.50				2	1	0	1	2	1		1	2	10
	0.00	**82.00**	**102.27**	99.52	98.56				2	0	0	1	1	0		1	3	8
	0.27	**3.01**	**84.34**	**96.93**	96.56				2	1	1	1	1	1		1	3	11
1.29	0.00	**76.54**	**96.16**	**95.18**	96.87				2	1	0	1	1	0		1	2	8
0.50	0.50	**62.51**	100.13	**98.41**	98.10				1	1	0	1	2	2	0	1	1	9
80.49	93.65	98.21	100.83	99.84	99.65	0			1	2	0	1	0	1	0	1	1	7
69.73	90.96	97.43	100.03	99.41	99.40	0			1	2	1	1	0	1	0	2	1	9
73.52	92.15	97.43	100.83	99.86	99.89	0			2	1	1	1	1	1	0	1	1	9
77.40	92.45	97.59	99.63	99.46	97.39	0			0	1	1	1	1	1	0	2	1	8
	78.00	**93.63**	**103.25**	98.80	99.12	1	10	0.45	2	2	1	1	1	2	0	1	1	11
	89.77	98.40	99.01	100.14	100.07				1	1	0	1	2	1		1	2	9
	0.00	**79.52**	98.52	**98.08**	97.67				2	1	0	2	1	0	1	2	2	11
	89.27	96.91	100.69	100.08	100.07				1	1	1	1	1	1		1	1	8
	86.58	95.62	100.78	99.71	99.87				1	1	1	1		1			2	7
	88.37	95.02	100.43	99.12	99.08	0			1	1	0	1	0	1	0	1	1	6
	82.38	**93.73**	100.85	**97.48**	101.43				2	1	1	2	1	1		1	1	10
	74.69	**87.48**	100.43	99.17	99.15	0			1	1	1	1	2	1	0	1	1	9
	76.09	**92.54**	101.27	99.84	99.77	0			1	0	1	0	1	0	0	2	1	6
	76.39	**89.47**	99.83	**98.38**	98.27	0			1	3	1	1	2	3	0	2	2	15
	80.88	**93.73**	101.10	99.61	99.38	0			1	1	1	1	1	1	0	1	2	9
	82.68	**93.73**	100.43	99.49	99.38				0	1	1	1	1	1		2	2	9
	78.38	**91.95**	100.43	99.58	99.37	0			1	1	1	0	1	1	0	2	2	9
	76.39	**90.26**	100.00	99.47	99.45	0			0	2	1	1	0	1	0	1	2	8
	77.58	**90.76**	100.26	100.26	100.03	0			1	1	0	0	0	1	0	2	1	6
	78.58	**92.74**	100.85	99.21	99.54				1	1	1	1	1	1		1	1	8
	77.18	**91.45**	100.68	99.30	99.15	0			1	2	1	1	1	1	0	1	1	9
	75.39	**92.24**	101.02	99.89	99.67	0			1	1	1	0	0	1	0	2	2	8
	80.68	**89.27**	100.60	99.50	99.27	0			1	1	0	1	0	1	0	2	1	7
	79.18	**92.24**	101.27	100.37	100.29	0			1	2	0	1	1	0	0	1	2	8
	78.88	**92.44**	100.85	100.12	99.83	0			1	1	2	2	0	1	0	1	1	9
	77.88	**91.25**	101.02	99.87	99.66	0			0	2	0	1	1	1	0	1	2	8
	78.68	**91.95**	100.85	99.57	99.40	0			0	1	0	1	1	1	0	1	2	7
	77.38	**89.76**	99.58	98.67	98.57													0
	44.63	**74.19**	100.43	100.71	100.70													0
	0.00	**71.61**	100.43	99.59	99.58	0			1	3	1	1	2	2	0	2	2	14
	81.38	**92.44**	100.85	99.27	99.23	0			0	1	1	1	1	1	0	1	2	8
	82.68	**92.24**	101.10	100.60	100.50	0			1	1	1	1	1	0	0	1	1	7
	82.58	**93.53**	100.85	99.31	99.67				1	2	1	1	1	1		1	1	9
	81.88	**94.23**	100.85	99.59	99.52	0			0	2	1	1	1	1	0	1	2	9
	83.38	**91.45**	100.85	99.82	99.70	0			0	2	1	1	1	1	0	1	2	9
	24.66	**25.29**	**56.36**	**7.53**	30.44	0			0	2	1	1	1	1	0	1	2	9
	75.89	**91.25**	100.68	99.96	99.67	0			0	2	0	1	1	1	0	2	2	9
	61.11	**85.80**	99.83	99.51	99.89	0			1	1	1	1	1	1	0	2	1	9
	0.30	**91.75**	100.85	100.19	100.07	0			0	2	0	0	1	0	0	1	2	6
	79.43	**93.85**	99.43	100.04	99.86	0			0	1	1	1	1	1		2	1	8

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Table B.1 (Continued)

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Body Debris	Body Scale	Gaskets	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm													
	73.66	**93.08**	100.90	100.39	100.32	0			0	2	0	0	0	1		1	1	5
	32.85	**80.86**	**98.25**	**98.27**	98.45	0			2	2	1	1	1	1	1	2	2	13
	80.62	**91.93**	100.11	99.69	99.51	0			1	2	1	1	0	1		1	2	9
	79.63	**92.70**	101.39	100.58	100.34	0			1	1	1	1	1	1		1	2	9
	79.93	**94.53**	100.90	99.99	99.81	0			0	2	1	0	1	1	0	1	2	8
	80.62	**93.37**	100.41	99.91	99.61	1			1	1	1	2	1	1		1	2	10
	82.32	**93.37**	100.90	99.73	99.59				0	1	1	2	0	1		1	2	8
	81.82	**94.05**	99.92	98.95	98.84				2	1	1	1	1	1		1	1	9
	87.29	95.49	100.41	99.64	99.52				1	2	1	2	1	1		1	2	11
	82.61	**94.33**	100.41	99.90	99.96				1	1	1	2	3	1		1	2	12
	84.11	95.01	100.41	99.90	99.79				2	2	1	2	1	2	1	1	1	13
	81.32	**93.66**	99.72	**98.50**	98.48	2	9	0.72	2	2	1	2	1	2		1	1	12
	66.19	**87.60**	98.64	**98.15**	98.13				1	3	1	2	1	2		1	2	13
	50.46	**89.33**	100.41	99.49	99.42				1	1	1	1	1	2		2	2	11
	85.60	**94.82**	100.41	99.95	99.85				0	1	1	2	1	1		0	1	7
	85.10	**94.82**	100.21	99.85	99.71													0
	72.96	**91.45**	100.60	99.61	99.52													0
	82.51	**93.85**	100.90	100.00	99.75													0
	66.39	**90.77**	100.90	99.98	99.90	0			1	1	1	0	0	0	0	2	1	6
	83.11	**93.37**	101.19	99.76	99.64	0			1	1	0	0	0	1	0	1	2	6
	81.42	**91.93**	99.43	99.61	99.56	1	2	0.2	1	1	1	1	1	1		1	1	8
	79.33	**93.66**	101.09	100.79	100.78				0	1	1	2	2	2		1	1	10
	84.61	95.30	100.90	99.77	99.70													0
	86.30	95.97	101.09	99.67	99.58	0			1	2	0	0	1	1	0	1	1	7
	83.01	**94.62**	100.11	99.77	99.80	0			1	1	1	0	0	1	0	1	2	7
	85.30	95.78	100.41	99.97	99.84													0
	82.61	**94.33**	99.43	99.40	99.49				1	2	1	1	1	1		1	1	9
	73.86	**90.00**	99.43	99.13	98.95													0
	74.87	**90.87**	100.17	99.33	99.29	0			1	2	0	1	0	0	0	2	2	8
	84.17	**94.07**	100.36	99.71	99.61	0			1	1	0	0	0	1	0	2	1	6
	86.31	95.27	100.83	99.84	99.69	0			0	2	0	1	0	1	0	1	2	7
	0.00	**0.00**	99.88	99.90	99.75													0
	67.89	**90.07**	99.88	99.11	98.82	1			1	3	1	1	2	2		2	1	13
	87.89	95.57	100.36	99.44	99.46	0			0	1	1	1	0	1	0	1	2	7
	72.82	**90.77**	99.88	99.34	99.19				2	2	1	1	1	1		1	0	9
	64.82	**89.37**	100.36	99.70	99.53	0			1	2	1	0	0	1	0	1	2	8
	87.89	96.27	99.88	99.68	99.52	0			1	1	0	1	0	1	0	1	1	6
	80.91	**93.57**	100.83	99.86	99.68				0	1	1	1	2	1		1	0	7
	87.89	96.27	101.30	100.14	100.08				0	1	1	2	2	2		1	0	9
	85.28	95.37	100.36	99.81	99.72	0			1	1	0	0	0	1	0	1	1	5
	85.56	**94.57**	100.17	99.40	99.20	0			0	2	1	1	1	1		2	1	9
	88.35	95.37	100.36	99.50	99.33				0	1	1	2	1	1	1	1	0	8
	86.77	95.57	100.64	99.82	99.68				0	1	1	1	1	0		1	1	6
	44.64	**82.56**	100.55	99.95	99.93				0	2	1	1	2	1		1	1	9
	55.06	**83.36**	101.11	100.51	100.93				1	1	1	1	3	3		1	1	12
	87.42	95.07	100.17	99.91	99.81	0			1	2	1	1	0	1	0	2	1	9
	86.96	95.07	**98.46**	99.84	99.79				0	1	0	1	1	1		1	2	7
	84.63	95.07	99.88	99.81	99.81				0	1	1	2	1	1		1	2	9

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Table B.1 (Continued)

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Body Debris	Body Scale	Gaskets	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm													
	77.00	**93.57**	100.83	101.04	101.09				1	1	1	1	2	1		1	1	9
	89.28	96.07	100.36	99.83	99.86	0			0	2	1	1	1	1	0	1	2	9
	79.80	**94.07**	101.11	99.52	99.33	0			0	1	0	1	1	1		1	2	7
	85.56	96.78	**6.63**	99.90	99.80	0			0	2	0	1	1	0	0	1	1	6
	81.84	**93.07**	99.69	99.59	99.51				1	1	1	0	1	1	2	1	2	10
	86.03	**94.87**	101.30	100.30	99.71	0			1	1	1	1	1	1	0	1	2	9
	89.93	96.37	100.17	99.45	99.35	0			1	2	0	1	1		0	1	2	8
	78.59	**93.07**	100.36	99.60	99.60	0			0	1	0	1	1	1	0	1	2	7
	84.63	95.07	99.60	100.33	99.66	0			1	2	1	1	1	1		1	2	10
	77.19	**93.07**	100.36	99.82	99.94				1	2	1	1	1	1		1	1	9
	84.31	**93.51**	100.85	99.25	99.23				1	2	1	1	1	1		2	1	10
	84.40	96.16	**101.98**	**102.12**	102.00				1	2	1	1	3	3		1	1	13
	0.65	**1.99**	**0.00**	**6.09**	32.38				0	3	3	1	1	3		1	0	12
	83.42	95.49	101.13	**88.50**	85.70				2	2	3	1	1	1		2	0	12
	79.50	**92.65**	100.20	100.12	100.14				0	2	1	1	1	1		1	0	7
	89.54	95.78	101.04	100.23	100.16				1	1	1	1	1	1		1	0	7
	77.00	**93.57**	100.83	101.04	101.09				1	1	1	1	2	1		1	1	9
	89.28	96.07	100.36	99.83	99.86	0			0	2	1	1	1	1	0	1	2	9
	79.80	**94.07**	101.11	99.52	99.33	0			0	1	0	1	1	1		1	2	7
	85.56	96.78	**6.63**	99.90	99.80	0			0	2	0	1	1	0	0	1	1	6
	81.84	**93.07**	99.69	99.59	99.51				1	1	1	0	1	1	2	1	2	10
	86.03	**94.87**	101.30	100.30	99.71	0			1	1	1	1	1	1	0	1	2	9
	89.93	96.37	100.17	99.45	99.35	0			1	2	0	1	1		0	1	2	8
	78.59	**93.07**	100.36	99.60	99.60	0			0	1	0	1	1	1	0	1	2	7
	84.63	95.07	99.60	100.33	99.66	0			1	2	1	1	1	1		1	2	10
	77.19	**93.07**	100.36	99.82	99.94				1	2	1	1	1	1		1	1	9
	84.31	**93.51**	100.85	99.25	99.23				1	2	1	1	1	1		2	1	10
	84.40	96.16	**101.98**	**102.12**	102.00				1	2	1	1	3	3		1	1	13
	0.65	**1.99**	**0.00**	**6.09**	32.38				0	3	3	1	1	3		1	0	12
	83.42	95.49	101.13	**88.50**	85.70				2	2	3	1	1	1		2	0	12
	79.50	**92.65**	100.20	100.12	100.14				0	2	1	1	1	1		1	0	7
	89.54	95.78	101.04	100.23	100.16				1	1	1	1	1	1		1	0	7

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Table B.2
Results for 5/8x3/4-inch ND meters

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm															
	93.54	97.87	101.02	98.87	98.73	1	1	0.01	1	1	1	2	1	2	1	1	3	2		15
	93.54	98.86	**101.51**	99.17	99.03	0			1	1	1	2	2	1	1	0	2	2		13
	94.52	97.87	**101.51**	99.51	99.33	0			1	1	1	2	2	1	2	0	2	2		14
	87.63	96.37	**102.24**	99.86	99.78	0			2	2	1	2	1	1	1	0	2	2		14
	89.60	96.37	**101.51**	99.81	99.69	0			1	1	1	2	2	1	2	0	1	2		13
	87.63	95.37	**101.76**	98.83	98.71	0			1	2	1	2	2	1	1	0	2	2		14
	93.58	98.18	**101.70**	**108.20**	99.39	0			0	0	0	1	1	1	0	0	1	2		6
	0.00	**0.00**	**94.92**	**93.41**		1		0.01	1	1	3	2	1	1	3	0	1	2		15
	87.59	95.93	101.13	**106.99**	98.29	0			1	0	1	1	1	1	2	0	1	2		10
	0.00	**0.00**	**96.42**	**105.08**		0			0	1	2	1	1	1	3	0	1	2		12
	97.32	100.06	**101.70**	**108.61**	99.76	0			0	0	0	1	1	0	0	0	0	0		2
	0.75	**0.00**	**0.38**	**28.88**		0			1	0	3	1	1	1	2	1	1	2		13
94.36	98.40	99.63	100.19	98.77	99.29	0			0	1	1	2	2	1	1	1	1	2		12
	94.17	100.56	**97.95**	**98.43**	98.56	1	3	0.02	1	1	1	2	2	1	1	0	1	1		11
88.55	97.27	100.03	98.80	98.97	98.60	0			1	0	0	1	1	1	1	0	2	1		8
0.00	99.26	100.53	99.30	99.61	99.54	0			0	0	0	1	1	0	0	0	0	1		3
89.01	97.76	100.53	100.29	99.26	99.34	0			2	1	0	1	2	0	1	0	3	1		11
	93.28	99.03	98.80	**98.37**	99.00	0			1	1	0	1	1	0	1	0	3	1		9
87.16	97.76	**101.02**	100.79	100.10	100.23	1	1	0.1	3	1	1	2	2	1	1	0	3	1		15
	90.78	100.03	**98.31**	**97.19**	97.12	1	5	0.09	1	1	1	0	0	0	1	0	2	1		7
	94.59	100.21	**102.94**	99.24	99.42	1	3	0.02	3	1	0	1	1	1	1	0	3	1		12
	87.66	96.42	99.99	98.85	99.13	1	2	0.03	3	1	0	1	1	1	2	0	3	1		13
82.03	95.09	99.37	99.50	**97.53**	97.61	0			1	2	0	3	3	1	0	0	1	1		12
86.86	97.07	**101.05**	**102.45**	99.34	99.62	0			0	1	0	1	1	1	0	0	1	2		7
	94.10	100.21	**101.96**	99.78	99.77	0			1	0	0	1	1	1	1	0	2	1		8
		93.89	**95.56**	**95.71**	96.92	0			1	1	0	1	2	1	1	0	0	1		8
	92.49	98.13	99.03	**97.72**	97.78	1	7	0.32	1	1	0	2	2	1	1	0	1	3		12
	84.49	95.03	99.13	**98.18**	98.24	0			2	2	0	3	3	2	3	0	2	2		19
	89.99	96.53	99.53	98.83	99.12	0			2	1	0	2	2	1	2	0	1	2		13
	94.49	98.93	100.52	99.17	99.47	0			1	1	0	2	2	1	1	0	1	2		11
	0.00	**0.00**	**0.00**	**1.29**	2.23	0			1	3	3	3	3	3	3	1	1	3		24
	93.49	98.13	100.12	99.36	99.47	0			1	1	0	2	1	1	2	0	1	2		11
	91.65	97.64	101.38	99.59	99.38	1	2	0.04	0	0	0	1	1	1	0	0	0	1		4
	91.18	97.66	100.89	99.64	99.58	0			0	0	0	1	1	1	0	0	1	1		5
	91.65	98.15	**101.87**	99.93	99.82	1	1	0.01	1	0	1	1	0	0	0	0	1	1		5
	93.97	98.64	99.91	99.49	99.28	0			1	0	0	1	0	0	0	0	1	1		4
89.47	95.83	99.63	**101.87**	99.93	99.82	0			0	0	0	1	1	0	0	1	1	1		5
	93.04	98.64	100.89	100.32	100.26	0			0	0	0	1	1	1	1	0	1	1		6
88.55	96.44	99.88	**102.63**	100.33	100.43	0			1	0	0	1	1	1	1	0	1	1		7
	90.48	97.89	**101.66**	100.04	99.89	0			0	0	0	0	0	0	0	0	1	1		2
83.96	96.44	99.38	**101.66**	100.18	100.18	0			0	0	0	1	1	0	0	0	1	1		4
86.37	95.45	99.38	**102.63**	99.21	99.45	0			1	0	0	1	1	1	0	0	1	1		6
	89.48	98.89	**101.66**	99.84	99.89	0			1	0	1	1	1	1	1	0	1	1		8
	92.91	99.93	**102.63**	99.79	99.79	0			2	0	0	0	1	1	1	0	2	1		8
		0.00	**95.16**	**97.60**	97.58	0			2	1	2	1	1	1	2	0	2	2		14
		55.59	**97.13**	98.88	98.01	0			1	1	1	2	1	1	2	0	2	2		13
		86.64	98.72	**98.05**	98.28	0			0	1	0	1	1	1	0	0	0	1		5
		0.00	100.88	99.38	99.47	1	0	0	1	1	2	2	2	2	2	0	3	2		17

(continued)

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Table B.2 (Continued)

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm															
			0.00	**94.42**	79.97	1	1	0.05	2	1	1	2	1	1	2	0	2	1		13
			91.73	**95.48**	95.23	0			0	1	1	1	1	1	1	0	0	1		7
			90.99	**94.53**	47.98	0			2	1	1	2	1	1	2	1	2	1		14
		78.42	99.53	**98.34**	98.06	0			1	0	1	1	1	0	1	0	2	3	2	12
		0.00	**94.70**	**97.55**	97.42	0			1	0	1	1	1	1	2	0	2	3	1	13
		0.00	98.69	**97.93**	97.86	0			2	0	1	1	1	0	2	0	2	3	2	14
		5.86	**94.05**	**96.70**	96.61	0			2	1	1	1	1	1	2	0	2	3		14
		80.21	99.53	**97.93**	97.69	0			2	0	1	1	1	1	2	0	2	3		13
		88.45	99.99	**98.30**	98.23	0			2	1	1	1	1	1	2	0	2	3	1	15
	88.35	97.91	99.26	99.72	100.10	0			1	1	1	1	1	1	2	0	2	2		12
	92.03	97.22	100.63	99.36	99.61	0			1	0	1	1	1	1	2	0	1	2		10
	3.50	**75.96**	**97.69**	**96.97**	97.40	0			1	2	1	3	3	1	2	1	1	2		17
	94.88	97.37	100.82	100.38	100.46	0			2	1	1	2	1	1	1	0	2	2		13
		94.87	100.39	99.18	99.14	0			1	1	1	2	1	1	1	1	1	2	2	14
	88.89	96.87	100.39	99.51	99.57	0			2	1	1	1	1	1	2	0	1	2		12
	91.88	97.07	99.79	99.06	99.18	0			1	2	1	1	1	1	2	0	1	2		12
		0.00	99.77	99.60	99.62	0			0	0	0	0	1	0	0	0	0	0		1
89.28	95.50	98.81	101.25	100.80	100.86	0			2	1	1	1	1	1	1	0	2	2		12
	94.35	97.81	100.27	99.36	99.52	0			1	1	1	0	0	0	1	0	1	2		7
	93.11	97.01	101.06	99.87	100.05	0			2	1	1	1	1	1	2	0	1	2		12
	93.11	97.01	100.07	99.31	99.67	0			1	1	1	1	1	1	2	0	1	2		11
91.48	96.45	99.30	**101.75**	100.65	100.71	0			1	1	0	1	1	1	2	0	2	2		11
	93.86	98.79	100.08	100.39	100.31	0			1	1	0	0	0	1	2	0	1	2		8
	87.87	**94.50**	99.59	99.59	99.61	0			1	1	0	0	0	1	1	0	1	2		7
91.98	99.65	100.79	**101.77**	101.29	101.31	0			3	1	0	1	1	1	2	0	3	2		14
	91.86	95.80	101.07	99.69	99.73	0			1	1	0	0	0	1	1	0	0	2		6
94.28	96.35	98.79	100.88	100.61	100.61	0			2	2	0	1	1	1	2	0	3	2		14
	89.86	96.30	99.89	99.39	99.29	0			2	1	0	1	0	1	2	0	2	2		11
		0.00	100.11	99.32	99.16	0			0	1	0	1	1	0	0	0	0	0		3
	92.57	98.28	**98.49**	99.75	99.97	0			2	1	1	1	1	1	2	0	2	1		12
	93.65	97.18	100.79	99.45	99.48	0			2	1	1	2	2	2	2	0	2	2		16
93.68	97.97	99.49	**101.52**	99.80	100.04	0			1	1	1	2	1	1	2	0	1	1		11
86.56	95.50	97.78	100.49	99.82	99.98	0			2	1	1	2	2	1	2	0	1	2		14
	94.13	97.18	99.79	99.10	99.19	0			2	1	1	2	2	1	1	0	1	2		13
	92.37	97.18	100.49	99.53	99.61	0			2	1	1	1	1	1	1	0	2	2		12
	94.26	98.03	100.32	100.15	100.21	0			1	0	1	1	1	1	0	1	2	2		10
	42.11	**85.03**	98.83	98.50	98.32	0			0	0	2	3	2	0	0	3	2	3		15
	91.25	98.03	100.82	99.24	98.95	1	1	0.13	2	1	2	1	1	2	2	2	2	3		18
	92.25	100.23	101.32	100.04	99.88	0			1	1	2	1	1	1	1	0	1	2		11
	85.23	95.44	101.32	99.79	99.58	2	8	1.77	2	1	1	2	1	1	1	1	2	2		14
	84.43	99.03	**101.81**	100.03	99.99	0			2	2	1	1	1	1	2	1	2	2		15

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Table B.3
Results for 5/8x3/4-inch MJ meters

Registry (%)						Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index
1/16gpm	1/8 gpm	1/4 gpm	2 gpm	15 gpm	20 gpm															
		71.16	**90.44**	100.86	100.59	0			2	1		0	1	2		0	1	1		8
	43.91	**95.68**	**103.66**	**103.76**	103.47	0			2	2			2	2		0	2	1		11
		85.01	**101.88**	101.44	101.25	1	6	0.05	3			1	1	2		0	3	1		11
	0.00	**94.58**	**107.60**	**103.48**	103.60	0			3		1	1	1	1		1	2	1		11
		55.58	**98.21**	99.56	99.72	0			2			1	1	1		0	3	1		9
	0.00	101.33	100.58	**101.75**	101.52	0			2	1		1	1	1		0	2	1		9
		90.99	**98.49**	**95.10**	94.34	0			3	2		1	2	3		3	3	1		18
		80.26	100.98	99.95	99.80	0			0	0		0	0	0		0	1			1
		74.24	101.28	**101.83**	100.83	0			1	0		0	0	0		0	1	1		3
		93.18	**102.47**	100.39	100.33				0	0		0	0	0		0	1	1		2
		93.98	101.38	100.37	100.35	1	1	0	1	0		1	0	1		1	1	1		6
		41.79	100.59	100.55	100.59	0			1	0		0	0	0		1	1	1		4
		94.88	101.47	100.24	100.25	1	1	0	1	0		0	0	0		1	1	1		4
	0.00	97.09	**101.77**	100.69	100.71	0			0	0		1	0	0		1	1	1		4
		93.78	101.47	100.82	99.84	0			1	0		0	0	0		0	1	1		3
	80.52	97.38	101.18	99.95	99.03	1	2	0.02	1	0		1	0	0		0	1	1		4
	0.00	97.17	**102.46**	**102.33**	102.51	0			1	1		1	1	1		1	2	1		9
		90.63	101.08	101.12	101.53	0			1	0		0	0	1		0	1	0		3
		93.08	99.02	**104.28**	104.10	1	50	0.36	2	1		1	1	1		1	2	2		11
		66.49	101.18	101.37	101.35	0			1	1		1	1	1		0	2	1		8
	87.65	99.97	99.99	99.42	99.56	0			1	0		0	0	0		1	1	1		4
	94.26	**83.13**	101.22	100.58	100.58	0			1	0		1	0	1		1	2	1		7

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PULLED METER ACCURACY AND DISASSEMBLY – 3/4-INCH METERS

Table B.4
Results for 3/4-inch DP meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Body Debris	Body Scale	Gaskets	Problem Index	*Comment number
1/16 gpm	1/8 gpm	1/4 gpm	1/2 gpm	3 gpm	25 gpm	28 gpm														
		89.80	97.17	100.61	98.68	98.96	1	5	0.084	0	1	1	1	1	1	0	1	2	8	1
		81.98	94.57	101.92	99.30		0	1	0.019	1	1	0	0	0	0	0	1	2	5	
		79.28	92.63	94.73	96.83		0			1	1	1	0	1	1	0	0	2	7	2
		90.50	98.24	101.28	98.71	98.66	1			1	1	1	1	0	1	1	1	2	9	
		89.97	99.91	101.81	99.12		0			1	1	0	1	1	1	0	1	1	7	3
		88.32	96.43	101.77	99.37	98.77	0			1	1	1	0	1	1	0	1	2	8	4
		94.39	98.76	101.81	100.03		0			1	1	0	0	0	0	0	1	2	5	
		93.39	98.29	101.84	99.51	99.59	0			0	1	1	0	0	0	0	0	1	3	
		87.27	96.80	102.50	99.43	99.45	0			1	1	1	0	2	1	0	0	1	7	
		87.00	94.88	100.69	99.62	99.49	1	1	0.078	1	0	0	0	0		1	0	1	3	5
		85.83	98.24	101.28	98.84	98.97	1	2	0.016	1	1	0	0	0	1	0	1	2	6	6
		84.08	96.93	102.02	99.65	99.50	1	2	0.042	1	1	1	0	2	1	0	0	2	8	
		89.38	96.06	101.63	99.07	99.14	0			1	1	1	0	0	1	0	0	2	6	
			47.49	91.76	90.68	90.25	0			1	1	1	1	2	1	0	1	1	9	7
	0.00	84.91	95.11	100.81	100.09	100.08	1	1	0.04	0	1	1	0	0	0	0	1	2	5	8
		85.25	96.00	100.69	98.88	98.74	0			0	2	1	1	1	2	0	0	0	7	9
		88.75	97.68	101.28	99.42	99.10	0			0	1	0	0	0	1	0	0	0	2	
		85.55	99.52	99.67	98.88	99.07	0			0	1	1	0	0	1	0	0	0	3	
		95.50	100.29	101.14	99.82	99.80	0			0	1	1	0	0	0	1	1	1	5	
		93.29	100.29	100.33	99.86	99.62	0			0	2	0	0	0	1	0	1	0	4	
		88.48	94.62	99.66	98.68	98.55	2	5	1.815	1	2	0	1	0	1	0	1	1	7	10
		91.31	97.60	99.99	99.32	99.19	0			0	1	1	1	1	1	0	0	1	6	
	87.25	96.62	99.09	100.67	99.88	99.78	0			2	2	1	1	1	1	0	1	0	9	
		92.16	97.83	100.13	99.21	99.23	0			0	1	0	1	0	1	0	0	0	3	
	82.50	94.49	98.34	100.33	99.58	99.37	0			0	1	0	0	0	1	0	0	0	2	
		93.33	97.63	100.28	99.57	99.46	0			1	2	1	1	0	2	0	1	1	9	11
	85.97	95.96	99.28	101.02	99.77	99.78	0			0	1	0	1	0	1	0	0	0	3	
		89.28	101.41	100.42	99.50	99.38	0			0	1	1	0	1	1	0	1	1	6	
	85.67	94.85	98.34	100.67	99.55	99.45	0			0	1	0	1	0	1	0	0	0	3	
		92.99	96.59	100.28	98.51	98.41	0			1	2	0	1	0	2	0	1	0	7	
	90.84	97.34	99.31	100.84	100.08	100.09	0			1	1	1	1	1	1	0	1	1	8	
	81.71	94.51	98.59	99.98	99.19	99.22	0			0	2	0	1	0	2	0	0	0	5	
	0.00	95.56	99.46	101.01	100.00	99.89	0			0	1	0	0	0	0	0	0	0	1	
	88.13	95.62	99.68	101.56	99.72	99.68	0			0	1	1	0	0	1	0	1	1	5	
		93.47	98.25	100.65	99.58	99.63	0			0	1	0	0	0	1	0	1	0	3	
	6.00	31.97	65.24	99.16	100.13	100.07	0			1	1	1	1	1	1	0	1	2	9	

*See Table B.7 for comments according to comment number.

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Table B.5
Results for 3/4-inch ND meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Problem Index	*Comment number
1/16 gpm	1/8 gpm	1/4 gpm	1/2 gpm	3 gpm	25 gpm	28 gpm															
	91.80	97.34	98.72	100.90	99.18	99.10	0			0	0	0	0	0	0	0	0	0	0	0	12
	90.29	95.52	100.97	100.75	99.25	99.54	0			0	1	1	1	1	1	0	0	1	1	7	
	93.62	98.68	100.83	100.97	99.41	99.51	0			0	0	0	1	1	0	0	0	1	1	4	
81.56	95.91	99.67	101.33	101.26	99.74	99.68	0			0	0	0	1	1	0	1	0	1	2	6	
	62.94	98.18	99.83	101.46	99.48	98.91	0			0	0	1	1	1	1	0	0	0	2	6	
87.42	96.01	99.67	101.83	101.46	100.04	99.99	0			0	0	0	1	1	0	1	0	0	2	5	
	94.92	98.68	101.33	101.26	99.70	99.86	0			0	0	0	1	1	1	0	0	1	1	5	
	94.92	99.67	101.83	100.97	99.99	99.90	1			0	1	0	1	1	1	1	0	1	1	7	
87.42	95.49	100.00	101.73	101.15	99.90	99.91	0			1	1	1	1	1	1	2	0	1	2	11	
2.11	95.49	99.53	101.73	101.15	99.95	100.06	0			1	1	1	1	2	1	1	0	1	2	11	
	94.49	99.53	101.73	101.64	100.30	100.35	0			0	0	1	1	1	1	1	0	1	2	8	
	94.49	98.59	101.05	101.15	99.80	100.15	0			1	0	1	1	1	1	2	0	1	2	10	
	94.99	99.06	100.47	100.67	100.34	100.54	0			0	0	0	2	1	1	1	0	1	2	8	
88.86	97.49	100.00	100.76	101.64	100.25	100.35	0			1	1	1	1	1	1	1	0	1	2	10	
89.05	95.91	99.66	101.19	100.81	99.99	99.99	0			0	1	0	1	1	1	1	0	1	1	7	
	81.23	91.80	98.40	102.06	99.30	99.40	0			0	0	0	1	1	0	0	0	1	1	4	13
	90.92	96.07	99.39	100.19	99.20	99.25	1			0	0	1	1	1	0	0	0	0	1	4	
	86.03	94.13	98.60	101.61	100.24	100.34	0			0	0	1	1	0	0	1	0	0	1	4	
	74.09	90.15	96.61	99.83	98.60	98.61	1			1	2	1	3	3	1	2	0	0	1	14	
			68.63	93.73	94.59	94.77	0			2	2	1	2	2	1	2	0	2	2	16	
		0.00	0.00	96.99	99.84	99.81	0			0	1	1	1	2	1	2	0	1	1	10	14
	93.83	97.10	99.41	101.33	99.75	99.77	0			1	1	1	1	1	1		0	1	2	9	
88.03	96.53	98.90	100.80	100.94	99.89	100.02	0			1	0	0	1	1	0	1	0	1	1	6	
	93.03	98.10	100.10	101.14	99.70	99.52	0			1	1	1	2	1	0	1	0	0	0	7	15
	94.53	98.10	100.40	101.14	99.77	99.59	0			0	1	0	2	1	0	0	0	0	1	5	
85.53	97.23	100.20	101.80	102.12	100.16	100.14	1			2	2	1	2	2	1	2	0	2	2	16	16
92.51	98.60	100.57	101.21	101.96	100.02	100.02	1			1	1	1	1	1	0	1	0	0	2	8	
0.00	0.00	90.30	95.71	100.47	99.82	99.82	0			0	1	1	1	1	1	1	0	0	1	7	17
0.00	91.91	98.67	100.71	101.46	99.73	99.87	0			2	1	1	1	1	1	2	0	1	2	12	
86.81	95.35	98.86	101.01	101.16	100.89	100.82	3			1	1	1	1	1	1	1	0	1	3	11	18
							0			3	1	3	1	1	3	2	1	2	2	19	19
91.51	97.81	101.23	101.01	102.15	100.30	100.37	0			1	1	1	1	1	1	1	0	1	2	10	
			91.17	99.76	98.07	97.81	0			1	1	1	1	1	1	0	0	1	3	10	20

*See Table B.7 for comments according to comment number.

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Table B.6
Results for 3/4-inch MJ meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Problem Index	*Comment number
1/16 gpm	1/8 gpm	1/4 gpm	½ gpm	3 gpm	25 gpm	28 gpm															
			79.55	96.89	99.13	99.46	0			3	0		3	0	3		0	2	0	11	21

*See Table B.7 for comments according to comment number.

Table B.7
Disassembly comments

Comment number	Comment
1	Top side of the bottom gasket there was sand buld-up
2	O-ring is a 3
3	This meter has been sitting for a few months. Couldn't find its dissasemble sheet, so I did it again.
4	O ring was a 3
5	Strainer- Green deposit, Body- Small rock
6	Strainer - Debri was a cheese curd type texture
7	lower bearing was loose
8	Srtainer- Clay
9	Sand on the bottom (still inside) of meter
10	Green plastic shavings of PVC was in front of the strainer, also a plug looking piece.
11	Dirty inside, for example strainer had build up that came off on finger
12	Looks brand new.
13	Scale was bright blue with sandy texture.
14	Disc guide bearing was loose
15	Looks new except it is not clean, has hard water deposites
16	Strainer debris looked like spider web, but it was stiff teflon tape.
17	Meter very clean
18	Strainer was in really bad shape. There wasn't much left
19	Meter insides were very dirty, Debris found was two small rocks, Meter did not move in test bench so it was not tested
20	Gasket was easy to break
21	Metering device- the jet was broken free of the axel and the upper bearing was broke also

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PULLED METER ACCURACY AND DISASSEMBLY – 1-INCH METERS

Table B.8
Results for 1-inch DP meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index	*Comment number
3/32 gpm	3/16 gpm	3/8 gpm	3/4 gpm	4 gpm	40 gpm	50 gpm																
	85.68	97.06	96.04	100.26	98.89	98.92	0			0	1	1	1	1	1		0	1	1		7	
6.49	95.28	98.58	100.24	100.74	99.06	98.83	0	1	0.019	1	1	2	0	1	1		0	1	1		8	
1.49	86.28	95.88	99.43	100.33	98.8	98.7	0			0	1	1	1	1	0		0	2	1		7	
			91.15	101.01	98.66		1			1	1	1	0	1	1		0	1	1		7	1
			60.67	94.24	93.93		2			2	1	1	1	2	1		1	2	2		13	2
	0	86.11	94.77	102.72	99.07		0			1	1	1	1	2	1		1	2	1		11	
		93.67	98.28	101.53	100	99.95	0			1	1	1	1	1	1		1	1	2		10	
		0.5	61.36	96.26	95.98		0			1	1	1	0	1	1		0	2	3		10	3
							0			3	1	1	0	2	1		0	2	2		12	4
	0.5	0	71.99	96.03	92.09	91.75	2	1	0.078	0	1	2	1	1	1		0	1	1	1	9	5
							1	2	0.016	1	2	3	1	3	1		0	2	2		15	6
	0	0.75	83.86	101.3	97.79	97.54	1			2	1	1	1	2	1		0	2	2		12	7
				89.48	92.98	92.67	3			2	2	1	1	1	2		1	2	2		14	8
			91.65	99.99	98.13	97.97	0	1	0.04	0	1	0	1	1	1		0	1	2		7	
		89.8	97.39	102.04	99.63	99.51	1			2	1	0	1	1	1		1	1	2		10	9
		0	63.23	98.07	98.13	97.91	1			3	1	1	1	2	1		1	3	2		15	10
	0	93.71	98.15	101.43	99.95	99.95	0			1	1	1	1	1	1		0	2	2		10	
		84.89	93.29	100.84	99.16		0			1	1	1	1	2	1		0	2	2		11	11
	12.23	96.11	98.15	101.03	99.46	99.33	0			0	1	1	0	0	1		0	1	1		5	
			100.46	102.5	100.81		1	5	1.815	0	1	1	2	3	2		0	2	1		12	12
			94.87	100.49	99.01		0			1	1	2	1	3	1		0	1	2		12	13
	16.45	99.91	94.61	100.06	98.74	98.62	1			1	1	1	1	2	1		0	1	1		9	14
	89.36	97.66	99.85	101.16	99.82	99.69	0			1	1	1	0	1	1		0	1	1		7	
	93.79	98.61	98.29	101.12	99.5	99.46	0			0	1	0	0	0	1		0	1	0		3	
	93.49	98.61	99.73	101.12	99.61	99.43	1			2	0	0	1	1	1		0	2	1		8	
	92.54	98.24	100.08	100.75	99.95	99.9	0			1	1	1	1	1	1		0	1	1		8	
	93.47	98.79	100.97	102.26	101.83	101.68	1			1	1	1	3	1	2		1	1	1		12	15
	84.24	100.22	98.84	100.58	99.35	92.53	1			1	1	1	0	0	1		0	1	1		6	
	88.8	96.02	99.37	101.12	98.93	98.82	0			1	1	1	1	1	1		0	1	1		8	
		0	63.23	98.07	98.13	97.91	0			2	1	1	1	2	0		0	2	2		11	

*See Table B.11 for comments according to comment number.

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Table B.9
Results for 1-inch ND meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index	*Comment number
3/32 gpm	3/16 gpm	3/8 gpm	3/4 gpm	4 gpm	40 gpm	50 gpm																
			90.82	101.57	98.68	98.99	0			1	1	1	2	2	1	1	1	1	2		13	
	0	75.78	97.24	102.23	98.53		0			1	0	1	2	2	1	1	0	1	2		11	
	0	50.77	97.24	102.56	98.49		0			1	1	1	1	2	1	2	0	0	2		11	
			90.07	100.38	98.25	98.26	0			0	0	1	1	1	1	2	0	0	2		8	16
	86.59	98.31	100.62	100.37	98.54	98.79	1			2	1	1	2	1	1	3	0	3	1		15	
		87	94.4	100.45	98.49	98.73	0			1	1	1	2	1	1	1	0	1	2		11	
		90.3	96.39	100.65	99.42	99.66	0			1	1	1	1	1	1	1	0	1	2		10	
	84.01	93	98.13	100.62	99.51	99.24	0			0	0	0	0	0	0	0	0	0	0		0	17
							3			1	1		2	2	2	0	0	2			10	18
	86.02	93.72	98.87	100.4	99.35	99.22	0			0	2	1	2	2	1	1	0	2	2		13	
	86.72	94.22	100.83	100.15	98.88	98.67	0			1	2	2	2	1	1	1	1	2	1		14	19
	0	93.32	98.59	100.26	99.16	99.12	0			1	2	1	3	2	1	1	0	2	1		14	
	88.69	95.29	98.1	100.26	99.11	99.34	0			1	2	1	2	1	1	1	1	1	1		12	
	91.38	97.76	99.08	100.66	99.31	99.6	0			1	1	1	1	1	1	1	1	1	2		11	
	89.17	96.37	98.36	100.45	99.36	99.3	0			1	2	1	2	2	1	1	0	1	2		13	
	92.66	96.87	98.86	100.55	99.31	99.47	0			0	2	2	2	1	1	1	0	2	1		12	20
	92.18	96.28	98.1	100.21	98.77	98.41	0			0	1	1	1	1	1	2	0	1	1		9	21
	91.92	96.71	101.32	101.09	99.7	99.57	0			0	1	1	1	1	1	1	0	2	1		9	
	90.22	96.71	100.34	100.5	99.21	99.14	0			1	1	2	2	1	1	1	0	1	1		11	
	88.67	96.87	98.86	100.55	98.97	98.93	0			0	1	2	2	1	1	1	0	2	1		11	
	93.65	97.87	99.65	100.85	99.65	99.57	0			1	2	1	2	1	1	1	0	1	1		11	
							0			2	2	3	2	2	2	1	0	2	1		17	22
90.04	97.09	100.26	101.78	100.95	100.46	100.62	1			1	1	1	1	2	1	1	0	1	2		11	23
77.87	93.08	98.66	100.48	101.43	100.03	100.21	0			2	1	2	2	2	1	0	0	3	1		14	
		0		93.11	99.21	99.37	0			1	1	1	2	1	1	1	0	2	1		11	
		1.6	80.49	95.77	95.92	96.02	0			0	1	1	2	1	1	1	0	2	1		10	
		87.18	95.48	100.26	97.72	97.93	0			1	1	1	2	1	1	2	0	2	1		12	24
							0			1	1	3	2	1	1	0	0	1	0		10	
	91.23	96.83	99.93	101.64	99.1	99.29	0			0	0	1	2	1	0	0	0	0	1		5	
87.05	95.36	98.63	100.33	101.44	99.63	99.73	0			0	0	0	1	1	0	1	1	1	1		6	25
	0	0	67.62	94.91	94.67	94.59	0			0	2	1	2	2	2	1	0	1	0		11	
	94.39	99.03	99.43	101.54	99.83	99.7	0			1	0	0	1	1	0	0	0	1	1		5	
	91.96	97.43	100.23	101.14	99.4	99.13	0			0	1	1	1	1	1	1	0	1	1		8	
	93.93	98.35	99.98	100.58	100.19	100.16	0			0	0	1	1	0	0	1	0	1	1		5	
87.45	95.63	98.55	99.98	100.49	99.77	99.75	0			0	0	0	1	1	0	0	0	1	1		4	
	92.43	97.85	99.88	100.49	99.66	99.8	0			1	1	1	2	1	1	0	0	1	1		9	
	49.41	77.12	88.38	101	100.18	98.29	0			0	0	1	1	1	0	0	0	1	1		5	
	93.43	97.75	99.78	100.82	99.58	99.71	0			1	0	1	2	1	0	0	0	1	1		7	
85.52	95.15	98.96	99.48	100.11	99.62	99.61	0			1	1	0	2	1	0	1	0	2	1		9	
	92.15	98.06	99.48	100.69	99.44	99.42	0			0	2	1	2	1	2	1	0	2	1		12	26
	94.95	98.56	100.08	100.88	99.64	99.8	0			0	1	1	2	1	1	2	0	2	1		11	
	88.65	95.67	99.48	100.69	99.07	99.06	0			0	2	1	2	2	1	1	0	2	1		12	27
	2	83.31	93.68	99.33	98.43	98.54	0			2	0	1	3	2	2	2	0	1	0		13	28
				92.43	93.32		0			1	2	2	3	2	2	3	0	2	1		18	29
			89.01	99.96	97.75	98.07	0			1	2	1	2	2	1	1	0	2	1		13	
	92.19	97.54	99.01	100.8	99.36	99.43	0			0	2	1	3	3	2	2	0	1	1		15	30
89.29	95.63	98.38	99.81	100.89	99.36	99.53	0			1	1	0	3	2	1	1	0	2	1		12	

(continued)

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Table B.9 (Continued)

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index	*Comment number
3/32 gpm	3/16 gpm	3/8 gpm	3/4 gpm	4 gpm	40 gpm	50 gpm																
							0			0	1	1	2	2	3	0	0	2	1		12	31
	93.27	97.36	98.78	101.26	99.81	99.78	0			0	1	1	2	1	1	0	0	1	1		8	
	93.76	98.29	98.88	100.48	99.4	99.25	0			0	1	1	2	1	0	1	0	1	1		8	
	94.16	98.1	99.16	100.77	99.62	99.65	0			0	1	1	2	1	0	1	0	2	1		9	
88.54	96.07	99.87	100.29	101.07	100.31	100.33	0			1	1	1	1	1	0	1	0	2	1		9	32
	88.16	96.87	96.8	99.69	99.42	99.29	0			2	1	1	0	1	0	1	0	2	1		9	
	91.57	97.97	99.79	101.07	99.48	99.54	0			2	1	1	1	1	0	1	0	2	2		11	33
	91.77	98.57	100.19	99.59	99.88	99.98	1			2	1	1	1	1	1	2	0	2	2		13	34
	94.04	97.94	99.88	100.83	99.96	99.96	0			2	1	1	1	1	1	0	0	1	1		9	
	94.04	98.94	99.78	100.83	99.71	99.63	0			0	1	0	1	1	1	1	0	1	1		7	
							0			0	0	0	0	0	0	3	0	1	1		5	35
	90.04	95.94	98.79	99.99	99.03	99.12	0			1	1	1	1	1	1	0	0	1	1		8	
89.86	95.86	98.79	100.29	100.78	100.36	100.33	0			2	1	1	1	1	1	1	0	1	1		10	
	94.76	98.88	100.19	100.58	100.11	100.19	0			2	1	1	1	1	1	2	0	3	2		14	
87.63	98.26	101.05	101.65	101.38	100.7	100.71	0			3	1	1	1	1	1	1	0	1	1		11	
	94.27	98.26	100.66	100.43	100.46	100.59	0			1	2	0	2	0	1	0	0	2	1		9	
	94.07	99.76	100.66	100.62	100.18	100.04	0			2	1	1	1	1	0	1	0	1	2		10	
	86.54	95.26	99.25	101.1	100.44	101.28	0			1	1	1	1	0	0	1	0	1	2		8	
90.39	95.35	98.75	99.95	100.91	100.2	100.25	1			2	1	1	2	2	1	1	1	1	1		13	
	84.34	94.46	99.06	100.61	99.19	99.06	0			1	1	1	0	1	0	1	0	2	2		9	
	94.55	98.25	100.25	101.6	100.04	100.11	0			2	1	1	1	1	1	1	0	1	2		11	
	7.34	97.06	97.24	101.06	98.38		3			1	1	1	1	1	0	2	0	1	3		11	36
	6.79	85.86	95.37	99.19	98.02		3			1	1	1	0	1	0	2	0	1	3	1	11	37

*See Table B.11 for comments according to comment number.

Table B.10
Results for 1-inch MJ meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index	*Comment number
3/32 gpm	3/16 gpm	3/8 gpm	3/4 gpm	4 gpm	40 gpm	50 gpm																
	92.37	99.25	102.43	101.61	100.71	100.29	1			2			1	1	1		0	2	2		9	38
	89.88	100.55	103.93	101.45	101.73	101.74	0			2			2	1	2		0	3	1		11	
		86.39	97.55	98.66	98.53	98.55	0			2	0	0	0	0	0		0	1	1		4	
			92.67	97.68	97.89	97.99	0			1	0	1	0		0		0	1	1		4	
			94.26	101.56	101.02	101.23	1			3	0	0	3	1	1		0	3	1		12	39
			94.26	99.35	99.13	98.98	0			3	0	1	3	0	3		0	3	1		14	
		91.11	96.56	100.84	100.89	15.23	0			0	0	0	0		1		0	1	1		3	
		77.55	95.69	101.54	101.32	101.45	1			1	0	0	0	0	1		0	1	1		4	40
		94.78	101.19	102.15	98.8	99.47	0			1	0	0	1		0		0	1	1		4	
		68.75	97.67	101.3	100.27	100.33	0			1	0	1	1		1		0	2	1		7	
		92.88	100.24	99.05	94.95		0			1	0	0	0		0		0	1	1		3	
		93.31	102.38	102.37	100.46	100.54	0			3	0	0	0		1		0	3	2		9	
		89.95	99.04	101.02	99.44	99.3	2			0	0	0	0		0		0	0	1		1	
		89.09	99.48	100.53	99.09	98.79	1			1	0	0	0		1		0	1	1		4	

*See Table B.11 for comments according to comment number.

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Table B.11
Disassembly comments

Comment number	Comment
1	Little rocks in strainer
2	Sand was at the bottom of meter a picture was taken
3	Gaskets- Main gasket was borken while opening and the other was falling apart
4	WAS NOT TESTED-register was unreadable. Metering Chamber- lots of scaling in it, the metering devies ran rufly. Lower bearing- Didn't spin easily
5	Strainer- plastic and small rocks, Bottom plate- 3 of the holes that hold the bottom plate was rusted away and meter leaked out of the bottom.
6	WAS NOT TESTED-dial didn't move when put in test bench. Lower bearing was gone,
7	Lower bearing was very loose.
8	gasket debis inside. There was one rock in the strainer that was bigger than the others. It was 15 x 20 mm big.
9	Debris was rusted pipe.
10	Scale was a silty substance.
11	Lower bearing was rough on spinning
12	The lower bearing was broken, looks just like DP-10-SE-P-05, So there was no picture taken. There was some debris in metering chamber. There could have been some debris in the interior body, but it was assumed that it all fell from the strainer debris.
13	Lower bearing was broken off
14	Lower bearing is rough when turned
15	Small rocks in the meter
16	Disc Guide Bearing- Very loose
17	Looks new
18	Magnet- everything was attached. No magnet to evaluate. Strainer has a big whole in it. No gaskets.
19	Small rocks in interior body. Chamber- was broken where the water enters in the meter. Chamber was broken. Picture was taken.
20	Magnet - The edges were chipped
21	Disc Guide Bearing- Was loosely fitted
22	Magnet was broken, This meter was redone since the disassemble sheet could not be found.
23	a piece of pipe in strainer
24	Guide bearing was loose, wiggled in place
25	debris is magnetic
26	Meter chamber was broken while opening.
27	Bright green/blue scale in the interior body .
28	Scale was light blue, almost white.
29	Disc guide bearing very loose.
30	One groove on upper bearing was especially deep.
31	WAS NOT TESTED. Since dial did not move. Scale was light green, almost white. Disc was broken in two.
32	Looks brand new
33	Very dirty inside.
34	Has less than 400 gal on register.
35	WAS NOT TESTED- meter did not move. There was no disc guide bearing,
36	Strainer was completely destroyed. Disc Guide bearing was very loose. Gasket broke very easily. Meter device looked like it was rebuilt.
37	Strainer was gone and what was left was brittle, a picture was taken. Gasket wsa easy to break. Disc Guide Bearing was very loose.
38	Had lot of caked on scale, that broke off easily.
39	Strainer debris was clay. Upper bearing was broken, part of it was in the metering device.
40	Strainer-couldn't get the rocks out of bottom of meter.

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PULLED METER ACCURACY AND DISASSEMBLY – 1 1/2-INCH METERS

Table B.12
Results for 1 1/2-inch DP meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index	*Comment number
3/16 gpm	3/8 gpm	3/4 gpm	1 1/2 gpm	8 gpm	50 gpm	110 gpm																
		91.51	102.13	100.09	98.42	97.94	1	3	0.23	2	1	1	1	0	1		0	3	1		10	1
		84.93	96.78	98.67	98.26	96.97	1	10	5.01	1	1	1	0	1	1		0	1	2		8	2
			86.06	96.48	98.59	97.64	0			2	1	2	1	0	1		0	2	2		11	
		160.58	169.17	175.34	174.38	172.71	3		19.8	1	1	1	0	1	1		0	2	1		8	3

*See Table B.14 for comments according to comment number.

Table B.13
Results for 1 1/2-inch ND meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index	*Comment number
3/16 gpm	3/8 gpm	3/4 gpm	1 1/2 gpm	8 gpm	50 gpm	110 gpm																
							0			0	1	0	1	1	0	2	0	0	1		6	4
	93.83	98.24	100.75	102.19	100.79	101.11	0			2	1	2	1	2	1	1	0	3	2		15	5
	93.33	97.74	100.75	101.19	100.51	100.76	0			1	1	1	1	1	1	0	0	1	2		9	
	85.11		97.51	101.57	100.78	100.31	0			0	1	0	1	1	0	2	0	0	2		7	6
	47.72	75.19	90.76	101.07	97.85	99.78	0			1	1	1	1	1	1	2	0	1	1		10	
		97.44	99.64	101.48	100.12	100.35	0			2	1	1	1	1	1	1	0	1	1		10	

*See Table B.14 for comments according to comment number.

Table B.14
Disassembly comments

Comment number	Comment
1	Lots of builid up in interior body and on metering device
2	Stainer-pieces of the pide corrosion
3	Stainer- lots of debri in strainer and also in the neck of the opening of the meter. Debri was a corrosion from the pipe
4	WAS NOT TESTED. Everything looks brand new. Register did not work when magnet was spun by hand. The leak detector would move forward to a certain spot and then bounce back, which is what it did when we put it in line to be tested.
5	A lot of scale on lid (inside of bottom of meter).
6	Disc guide bearing was loose.

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PULLED METER ACCURACY AND DISASSEMBLY – 2-INCH METERS

Table B.15
Results for 2-inch DP meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index	*Comment number
1/8 gpm	1/4 gpm	1/2 gpm	2 gpm	15 gpm	100 gpm	150 gpm																
		94.32	101.13	101.55	101.01	101.16	0			2	1	2	1	1	1		0	1	1		10	

*See Table B.17 for comments according to comment number.

Table B.16
Results for 2-inch ND meters

Registry (%)							Strainer Debris	Strainer Quantity	Strainer Debris(g)	Chamber Dep	Chamber Scar	Magnet	Up Bearing	Low Bearing	Meter Device	Disc guide bearing	Body Debris	Body Scale	Gaskets	Leaks	Problem Index	*Comment number
1/8 gpm	1/4 gpm	1/2 gpm	2 gpm	15 gpm	100 gpm	150 gpm																
		74.89	96.85	100.76	99.51	100.14	1			2	3	1	3	3	1	1	0	1	1		16	1
		83.78	98.85	100.18	99.94	100.56	0			1	2	1	3	3	1	1	0	1	2		15	
		51.83	92.95	100.19	99.06	100.07	1			2	1	1	3	3	1	2	0	1	2		16	
		80.44	98.58	100.24	99.49	100.01	0			1	3	1	3	3	1	1	0	1	2		16	
		84.7	97.93	100.54	99.94	100.24	0			1	3	1	3	3	1	1	0	1	2		16	
		80.44	98.1	100.14	100.07	100.61	0			2	1	2	3	3	1	1	1	1	2		17	

*See Table B.17 for comments according to comment number.

Table B.17
Disassembly comments

Comment number	Comment
1	Small rocks in strainer.

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APPENDIX C – PARTICULATE METER DATA

Table C.1
Meter accuracy before particulate injection

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
DP	1	99.76%	100.91%	100.99%	100.10%
DP	2	99.77%	101.18%	100.56%	99.73%
DP	3	100.16%	101.11%	100.89%	99.91%
SJ	4	100.86%	99.54%	99.15%	100.40%
SJ	5	101.25%	99.74%	99.48%	100.86%
SJ	6	100.52%	99.71%	99.34%	100.83%
ND	7	98.18%	101.02%	101.06%	100.24%
ND	8	99.19%	101.29%	100.93%	99.59%
ND	9	99.45%	100.99%	101.03%	99.65%
ND	10	99.95%	100.99%	100.62%	99.66%
ND	11	99.42%	101.27%	100.87%	99.40%
ND	12	98.48%	100.77%	100.70%	99.13%
ND	13	99.36%	100.51%	100.44%	99.20%
ND	14	98.44%	101.37%	101.35%	100.65%
ND	15	97.77%	100.49%	100.89%	99.60%
ND	16	98.08%	100.42%	100.86%	99.52%
ND	17	98.18%	100.72%	100.89%	99.62%
ND	18	99.21%	101.65%	101.62%	99.58%
ND	19	98.24%	101.91%	101.52%	99.15%
ND	20	99.67%	102.54%	102.38%	99.77%
ND	21	98.55%	101.15%	101.35%	100.43%
SJ	22	100.92%	100.35%	100.72%	100.52%
SJ	23	101.04%	100.14%	100.44%	99.83%
SJ	24	98.26%	100.75%	100.85%	101.25%
MJ	25	96.01%	100.14%	100.54%	100.53%
MJ	26	97.87%	101.04%	101.10%	101.07%
MJ	27	91.69%	99.97%	100.94%	100.32%
MJ	28	93.74%	100.08%	100.50%	99.59%
MJ	29	92.99%	99.92%	100.43%	98.50%
MJ	30	92.74%	99.85%	100.48%	98.59%
MJ	31	92.74%	102.94%	102.75%	98.98%
MJ	32	92.14%	102.58%	102.91%	99.46%
MJ	33	93.64%	102.74%	103.53%	98.97%
DP	34	95.21%	98.46%	99.20%	99.96%
DP	35	99.14%	100.33%	99.54%	99.52%
DP	36	97.53%	100.11%	98.69%	100.11%
DP	37	100.12%	100.58%	99.83%	69.06%
DP	38	101.49%	106.05%	101.12%	97.99%
DP	39	107.66%	103.60%	101.66%	101.90%
SJ	40	101.52%	101.55%	101.33%	101.46%
SJ	41	104.73%	102.37%	100.60%	99.86%
SJ	42	104.50%	102.75%	102.50%	101.08%
DP	43	98.21%	100.33%	100.59%	100.48%
DP	44	97.34%	100.26%	100.69%	100.46%
DP	45	96.84%	99.87%	100.43%	100.56%
SJ	46	100.03%	99.97%	99.50%	100.33%
SJ	47	95.80%	96.88%	96.13%	97.81%

(continued)

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Table C.1 (Continued)

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
SJ	48	98.20%	97.24%	97.76%	101.27%
MJ	49	101.16%	100.17%	100.39%	101.89%
MJ	50	102.06%	100.40%	99.82%	101.98%
MJ	51	101.70%	103.09%	99.85%	99.71%
MJ	52	100.09%	100.82%	101.12%	100.13%
MJ	53	100.03%	100.36%	100.14%	99.28%
MJ	54	97.39%	99.72%	99.85%	99.48%
MJ	55	97.92%	99.72%	99.40%	100.67%
MJ	56	98.15%	99.89%	99.03%	101.06%
MJ	57	95.57%	98.63%	98.13%	100.44%
MJ	58	102.13%	101.92%	101.37%	101.61%
MJ	59	103.06%	100.76%	100.72%	100.23%
MJ	60	102.62%	101.26%	100.49%	101.01%
DP	61	96.60%	98.50%	99.85%	100.28%
DP	62	97.03%	100.76%	100.72%	100.40%
DP	63	97.16%	99.93%	100.07%	100.30%
FO	64	97.35%	99.36%	99.97%	99.96%
FO	65	98.55%	98.93%	99.70%	100.00%
FO	66	100.19%	99.59%	100.10%	100.19%
DP	67	100.14%	101.92%	101.16%	99.50%
DP	68	99.67%	101.27%	100.73%	99.77%
DP	69	99.31%	101.26%	100.70%	99.58%
DP	70	100.50%	101.52%	100.96%	99.39%
DP	71	98.16%	101.26%	101.12%	99.83%
DP	72	98.40%	101.09%	100.89%	99.44%
DP	73	94.60%	100.16%	100.14%	99.44%
DP	74	97.56%	100.53%	100.47%	99.58%
DP	75	97.33%	100.20%	100.20%	99.38%

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Table C.2
Meter accuracy after particulate injection

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
DP	1	87.57%	99.59%	100.69%	100.17%
DP	2	80.23%	98.59%	99.94%	99.55%
DP	3	0.19%	95.60%	99.27%	99.80%
SJ	4	101.33%	99.39%	99.37%	100.65%
SJ	5	100.96%	99.59%	99.37%	100.75%
SJ	6	100.77%	99.59%	99.27%	100.84%
ND	7	98.08%	100.78%	100.88%	100.09%
ND	8	99.46%	101.31%	101.05%	99.74%
ND	9	100.23%	100.82%	100.75%	99.66%
ND	10	100.42%	100.82%	101.05%	99.64%
ND	11	99.75%	101.01%	101.05%	99.42%
ND	12	98.02%	101.31%	101.05%	99.34%
ND	13	99.46%	101.11%	100.75%	99.34%
ND	14	100.23%	101.51%	101.05%	100.39%
ND	15	97.65%	100.43%	100.79%	99.46%
ND	16	99.55%	100.72%	100.49%	99.46%
ND	17	98.12%	100.91%	100.00%	99.48%
ND	18	99.55%	101.38%	101.78%	99.40%
ND	19	99.08%	102.33%	101.78%	99.33%
ND	20	97.17%	101.48%	102.17%	99.86%
ND	21	99.65%	101.10%	101.48%	100.47%
SJ	22	100.63%	99.48%	100.42%	100.20%
SJ	23	100.86%	100.01%	100.27%	100.32%
SJ	24	99.11%	100.67%	100.90%	101.29%
MJ	25	96.71%	101.55%	100.37%	100.87%
MJ	26	95.01%	101.84%	100.75%	101.40%
MJ	27	97.01%	100.55%	100.08%	100.56%
MJ	28	95.52%	98.66%	99.58%	100.57%
MJ	29	98.96%	100.16%	99.76%	99.32%
MJ	30	97.49%	99.66%	98.41%	97.97%
MJ	31	99.65%	100.66%	100.21%	99.35%
MJ	32	100.64%	100.86%	100.39%	98.99%
MJ	33	99.75%	100.26%	100.03%	99.16%
DP	34	0.00%	88.99%	97.36%	99.76%
DP	35	91.83%	99.37%	99.93%	99.49%
DP	36	92.56%	99.57%	100.42%	99.99%
DP	37	93.20%	102.63%	103.08%	29.42%
DP	38	93.48%	102.54%	103.08%	96.77%
DP	39	94.85%	103.03%	103.38%	27.72%
SJ	40	102.87%	101.49%	101.31%	100.94%
SJ	41	103.49%	103.83%	103.10%	101.21%
SJ	42	104.06%	103.36%	103.15%	101.25%
DP	43	98.18%	100.22%	100.99%	100.44%
DP	44	97.42%	100.32%	100.99%	100.42%
DP	45	96.74%	99.73%	100.79%	100.55%
SJ	46	100.16%	99.34%	100.12%	102.04%
SJ	47	94.89%	97.05%	96.90%	97.44%
SJ	48	97.95%	96.66%	97.28%	100.74%
MJ	49	101.12%	100.23%	100.50%	101.32%

(continued)

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Table C.2 (Continued)

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
MJ	50	101.02%	99.93%	99.46%	101.77%
MJ	51	99.30%	99.44%	99.27%	99.67%
MJ	52	96.61%	101.14%	101.25%	100.47%
MJ	53	100.91%	100.75%	100.36%	99.26%
MJ	54	99.11%	99.86%	99.86%	99.36%
MJ	55	97.81%	99.96%	99.36%	100.39%
MJ	56	99.51%	100.25%	99.46%	100.81%
MJ	57	96.51%	99.07%	98.57%	99.51%
MJ	58	103.35%	102.04%	101.42%	101.75%
MJ	59	102.87%	101.25%	100.72%	100.51%
MJ	60	102.67%	101.45%	100.72%	100.59%
DP	61	44.29%	96.65%	99.62%	100.27%
DP	62	81.94%	99.00%	100.42%	100.40%
DP	63	97.78%	99.98%	100.22%	100.29%
FO	64	97.94%	99.35%	100.24%	99.98%
FO	65	98.50%	99.25%	99.95%	100.04%
FO	66	99.43%	99.85%	100.14%	100.31%
DP	67	99.24%	101.74%	101.14%	99.67%
DP	68	100.36%	101.34%	100.54%	99.57%
DP	69	100.08%	101.64%	100.84%	99.59%
DP	70	100.33%	100.76%	101.32%	99.44%
DP	71	98.75%	101.56%	100.09%	99.64%
DP	72	97.82%	100.76%	101.80%	99.37%
DP	73	86.21%	98.57%	99.61%	99.29%
DP	74	86.40%	98.07%	99.61%	99.54%
DP	75	97.73%	100.56%	100.37%	99.42%

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Table C.3
Meter accuracy after particulate injection 0.25 life

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
DP	1	98.77%	101.11%	100.89%	99.83%
DP	2	88.48%	99.42%	100.30%	99.33%
DP	3	94.97%	100.41%	100.89%	99.48%
SJ	4	101.17%	99.52%	98.90%	100.17%
SJ	5	100.97%	99.62%	99.20%	100.51%
SJ	6	100.97%	97.73%	99.10%	100.12%
ND	7	98.47%	101.11%	101.39%	100.11%
ND	8	98.64%	101.01%	100.23%	99.37%
ND	9	99.35%	100.91%	100.32%	99.49%
ND	10	99.26%	100.71%	100.32%	99.15%
ND	11	99.96%	101.01%	100.52%	99.43%
ND	12	98.64%	101.01%	99.55%	99.03%
ND	13	100.14%	101.20%	100.52%	99.25%
ND	14	0.00%	98.91%	101.00%	100.16%
ND	15	94.82%	99.62%	101.42%	99.39%
ND	16	95.82%	99.62%	99.73%	99.14%
ND	17	96.52%	100.62%	100.22%	99.66%
ND	18	97.02%	101.41%	99.63%	98.39%
ND	19	96.22%	101.22%	100.12%	98.76%
ND	20	98.22%	102.91%	100.42%	99.46%
ND	21	97.72%	100.72%	100.92%	100.23%
SJ	22	100.21%	98.24%	100.51%	100.30%
SJ	23	100.41%	98.41%	100.87%	100.17%
SJ	24	99.01%	98.66%	100.54%	101.28%
MJ	25	97.01%	100.69%	101.50%	101.66%
MJ	26	98.51%	101.59%	102.25%	102.28%
MJ	27	94.81%	100.59%	101.03%	101.48%
MJ	28	92.36%	98.42%	99.44%	101.04%
MJ	29	97.57%	100.71%	99.93%	100.29%
MJ	30	97.07%	99.91%	98.25%	98.20%
MJ	31	99.17%	100.61%	100.03%	99.45%
MJ	32	99.97%	100.71%	100.33%	99.78%
MJ	33	99.17%	100.11%	99.93%	99.45%
DP	34	94.00%	99.25%	101.08%	99.71%
DP	35	94.49%	99.74%	100.10%	99.40%
DP	36	93.31%	100.04%	100.59%	99.97%
DP	37	0.00%	101.02%	102.26%	67.77%
DP	38	93.21%	102.78%	103.04%	70.52%
DP	39	97.26%	103.18%	103.04%	57.70%
SJ	40	96.87%	101.66%	100.49%	98.73%
SJ	41	99.07%	102.17%	101.69%	99.89%
SJ	42	95.83%	99.56%	99.77%	102.15%
DP	43	94.66%	99.41%	100.34%	99.51%
DP	44	96.25%	99.90%	100.84%	100.03%
DP	45	93.83%	100.59%	101.04%	100.00%
SJ	46	91.26%	98.37%	99.02%	97.63%
SJ	47	95.22%	97.67%	97.73%	99.09%
SJ	48	96.51%	97.17%	97.93%	101.02%
MJ	49	99.36%	100.16%	100.72%	101.16%
MJ	50	101.00%	100.46%	100.52%	101.55%

(continued)

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Table C.3 (Continued)

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
MJ	51	97.38%	99.56%	100.22%	100.01%
MJ	52	96.81%	100.52%	100.60%	99.97%
MJ	53	97.71%	99.92%	99.40%	99.22%
MJ	54	95.91%	99.43%	99.74%	99.27%
MJ	55	98.40%	100.02%	99.49%	100.33%
MJ	56	99.60%	99.72%	99.15%	101.25%
MJ	57	99.20%	99.23%	98.64%	100.30%
MJ	58	100.21%	102.65%	101.79%	101.93%
MJ	59	99.10%	101.06%	100.60%	100.80%
MJ	60	96.78%	100.56%	100.30%	100.90%
DP	61	95.30%	100.36%	100.80%	100.35%
DP	62	73.58%	97.58%	100.10%	100.22%
DP	63	95.11%	100.36%	100.60%	100.14%
FO	64	95.42%	99.46%	99.86%	99.92%
FO	65	98.32%	99.26%	99.86%	100.03%
FO	66	98.82%	99.46%	99.96%	100.27%
DP	67	100.72%	101.75%	101.15%	99.45%
DP	68	100.22%	101.26%	100.45%	99.34%
DP	69	101.02%	101.56%	100.85%	99.30%
DP	70	100.12%	101.90%	100.69%	99.46%
DP	71	100.12%	102.10%	99.99%	99.56%
DP	72	96.86%	100.31%	101.98%	99.31%
DP	73	97.01%	100.41%	100.49%	99.01%
DP	74	98.89%	100.90%	100.49%	99.23%
DP	75	97.59%	100.31%	100.49%	98.96%

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Table C.4
Meter accuracy after particulate injection 0.5 life

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
DP	1	0.9117945	1.0044482	1.0119882	0.9972915
DP	2	0.7928647	0.9825691	0.997106	0.9952989
DP	3	0.8962819	0.9994757	1.0070275	0.9967933
SJ	4	1.0186588	0.9915196	0.9871846	0.9992841
SJ	5	1.0203824	0.9964922	0.9961139	1.0079518
SJ	6	1.0203824	0.9935087	0.9891689	1.0020737
ND	7	0.9626412	1.0044482	1.0100039	1.0017748
ND	8	0.992083	1.0100153	1.0064291	0.9952917
ND	9	0.9940612	1.0080251	1.0064291	0.9997804
ND	10	0.992083	1.0050399	1.004446	0.993995
ND	11	0.9990068	1.0149908	1.0064291	0.991202
ND	12	0.9910939	1.0080251	1.0034545	0.9890076
ND	13	0.9910939	1.0100153	1.004446	0.9905038
ND	14	0.9891157	0.9881234	0.9717247	1.0036706
ND	15	0.9507869	1.0020655	1.0090144	0.9964348
ND	16	0.0194038	0.9921145	0.9991221	0.9936093
ND	17	0.9672801	1.0000753	1.0040683	0.9975827
ND	18	0.9575782	1.0179871	1.0040683	0.9853976
ND	19	0.9507869	1.0150018	0.9991221	0.9915785
ND	20	0.9847435	1.0199773	1.0139605	0.9986422
ND	21	0.2202333	0.9980851	1.0139605	1.0118868
SJ	22	1.0076969	0.9854853	1.0043054	1.0087752
SJ	23	1.0062811	0.9857844	1.0052958	1.0069254
SJ	24	0.9875217	0.9926633	1.0050977	1.0175646
MJ	25	0.9530116	1.0148953	1.0122289	1.0179246
MJ	26	0.9822125	1.021874	1.0251046	1.0227242
MJ	27	0.9627452	1.0138984	1.0231237	1.0164247
MJ	28	0.917957	0.978997	0.9965798	1.0176749
MJ	29	0.9852738	1.0069114	1.0015379	1.0013368
MJ	30	0.9681386	0.996942	0.9866635	0.9809893
MJ	31	0.9962893	1.0069114	1.0045127	0.9991316
MJ	32	1.0066928	1.0099022	1.0074876	1.0015373
MJ	33	1.0085287	1.0019267	1.0005462	0.997127
DP	34	0.9325063	0.9995493	1.0118674	0.9976353
DP	35	0.9425117	0.9965656	1.0019277	0.9956331
DP	36	0.9435123	0.9995493	1.0088855	1.0019402
DP	37	0.0070038	0.9796578	1.0168373	1.0093487
DP	38	0.2001086	1.0164571	1.0188253	1.0091484
DP	39	0.1400761	1.0224246	1.030753	1.0188595
SJ	40	0.9997115	0.9918786	0.9936822	0.9810183
SJ	41	0.9225192	1.0157064	1.0150785	1.0008454
SJ	42	0.94383	0.9838414	0.986915	1.0236005
DP	43	0.947145	0.9975519	1.0071171	0.99385
DP	44	0.9632464	1.0022796	1.0101026	1.0036435
DP	45	0.947145	1.0070073	1.0150785	1.0063418
SJ	46	0.0077486	0.9838531	0.9896542	1.0289322
SJ	47	0.9724525	0.9735165	0.9771997	0.9894348
SJ	48	0.9521124	0.9735165	0.9781578	1.0180329
MJ	49	0.9995727	1.0026469	1.0068989	1.0142332
MJ	50	1.01507	1.011104	1.0068989	1.0251325

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Table C.4 (Continued)

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
MJ	51	0.9802012	0.9979484	1.0030668	1.0041339
MJ	52	0.9815113	1.0089104	1.0110604	1.0022324
MJ	53	0.9605004	0.998091	1.0001461	0.9947463
MJ	54	0.9685046	0.9971894	0.9991539	0.9957445
MJ	55	0.990516	1.0007958	0.9991539	1.0004357
MJ	56	0.988515	0.998091	0.9951851	1.009419
MJ	57	0.9855134	0.9872716	0.9951851	0.9966428
MJ	58	0.9917301	1.0249353	1.0168437	1.0224102
MJ	59	0.9858226	1.0129361	1.0069232	1.0094266
MJ	60	0.9858226	1.0279351	1.0039471	1.0097262
DP	61	0.9614539	1.0079364	1.0069232	1.0057313
DP	62	0.8366569	0.9849378	0.9970028	1.0042331
DP	63	0.9525926	0.9999369	1.001963	1.0042331
FO	64	0.9544946	0.9916791	0.9995397	0.9971444
FO	65	0.9835097	0.9887218	0.9995397	0.9986407
FO	66	0.9825092	0.9906933	1.0005027	0.9999375
DP	67	1.0105237	1.0222378	1.0159098	0.9992392
DP	68	1.0065216	1.0153374	1.0091692	0.9964461
DP	69	1.0125247	1.0182947	1.0101321	0.9973439
DP	70	1.0095487	1.0120383	1.0144763	0.9942905
DP	71	0.9992472	1.0217694	1.0075142	0.9949862
DP	72	1.0067392	1.0120383	1.0025413	0.9925013
DP	73	0.9814536	1.009119	1.0025413	0.9898175
DP	74	0.9955012	1.0071727	1.0015467	0.9923025
DP	75	0.9786441	1.0071727	1.0015467	0.9888235

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Table C.5
Meter accuracy after particulate injection 0.75 life

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
DP	1	95.93%	101.13%	100.83%	99.87%
DP	2	81.44%	98.14%	100.63%	99.51%
DP	3	85.44%	99.14%	100.63%	99.78%
SJ	4	101.03%	99.74%	98.84%	99.85%
SJ	5	101.53%	99.94%	99.64%	100.70%
SJ	6	100.93%	99.34%	99.34%	99.99%
ND	7	94.44%	100.14%	101.13%	100.20%
ND	8	99.33%	100.81%	100.39%	99.57%
ND	9	99.76%	101.11%	100.59%	99.62%
ND	10	99.42%	100.81%	100.39%	99.20%
ND	11	100.61%	101.61%	100.39%	99.53%
ND	12	98.32%	100.81%	100.39%	99.25%
ND	13	99.59%	100.81%	99.90%	99.47%
ND	14	0.00%	97.62%	99.90%	100.34%
ND	15	94.05%	99.69%	100.57%	99.56%
ND	16	93.05%	99.69%	100.27%	99.44%
ND	17	96.05%	100.39%	100.87%	99.76%
ND	18	96.05%	101.69%	100.57%	98.86%
ND	19	96.25%	100.99%	100.27%	99.24%
ND	20	98.05%	101.89%	101.07%	99.84%
ND	21	95.05%	100.39%	100.87%	100.23%
SJ	22	100.84%	98.76%	100.42%	100.84%
SJ	23	100.68%	99.88%	100.62%	100.56%
SJ	24	98.39%	99.51%	100.77%	101.51%
MJ	25	95.97%	101.57%	102.85%	101.61%
MJ	26	97.75%	102.56%	101.76%	102.01%
MJ	27	95.26%	101.57%	102.06%	101.51%
MJ	28	92.99%	98.40%	99.64%	101.49%
MJ	29	98.43%	100.39%	100.44%	100.21%
MJ	30	96.45%	99.70%	99.64%	98.11%
MJ	31	100.31%	100.89%	100.44%	99.91%
MJ	32	100.71%	100.89%	100.63%	100.14%
MJ	33	99.52%	100.10%	100.24%	99.86%
DP	34	93.01%	100.25%	100.19%	99.75%
DP	35	93.70%	99.46%	100.49%	99.53%
DP	36	94.50%	100.25%	100.89%	100.05%
DP	37	4.49%	100.95%	102.19%	44.46%
DP	38	0.00%	44.39%	97.90%	100.89%
DP	39	16.95%	101.75%	102.69%	51.84%
SJ	40	97.43%	99.34%	99.83%	97.94%
SJ	41	92.42%	101.46%	101.34%	100.58%
SJ	42	92.69%	97.60%	98.61%	102.43%
DP	43	92.44%	99.56%	100.27%	100.03%
DP	44	95.93%	100.05%	101.07%	100.50%
DP	45	94.24%	100.55%	101.56%	100.63%
SJ	46	0.30%	93.91%	98.23%	3.44%
SJ	47	87.10%	97.00%	97.49%	17.80%
SJ	48	92.40%	97.20%	97.70%	101.69%
MJ	49	97.81%	99.20%	100.19%	100.82%
MJ	50	100.91%	100.59%	100.39%	101.91%

(continued)

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Table C.5 (Continued)

		Flow rate			
Meter type	Meter number	1/4 gpm	1 gpm	2 gpm	15 gpm
MJ	51	99.21%	99.50%	100.53%	100.51%
MJ	52	95.65%	100.42%	100.71%	100.23%
MJ	53	94.35%	99.64%	100.12%	99.50%
MJ	54	89.75%	99.25%	99.52%	99.56%
MJ	55	98.85%	100.18%	99.82%	100.15%
MJ	56	98.35%	99.40%	99.32%	101.27%
MJ	57	99.05%	98.86%	99.52%	99.67%
MJ	58	98.75%	102.25%	101.95%	102.04%
MJ	59	99.55%	101.45%	100.75%	100.93%
MJ	60	97.35%	100.95%	100.45%	100.79%
DP	61	96.05%	100.75%	100.65%	100.42%
DP	62	94.75%	97.26%	100.75%	100.24%
DP	63	95.05%	100.25%	100.45%	100.24%
FO	64	95.52%	99.20%	99.98%	99.68%
FO	65	98.31%	98.80%	99.78%	99.84%
FO	66	98.17%	99.30%	99.98%	99.99%
DP	67	101.30%	102.39%	101.87%	100.13%
DP	68	100.60%	101.89%	101.27%	99.94%
DP	69	100.67%	101.89%	101.57%	100.01%
DP	70	101.05%	101.19%	100.27%	99.50%
DP	71	100.35%	101.69%	100.27%	99.65%
DP	72	99.55%	101.69%	101.07%	99.33%
DP	73	97.25%	100.69%	100.37%	98.95%
DP	74	96.75%	100.69%	100.57%	99.30%
DP	75	97.55%	100.69%	100.07%	98.87%

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Table C.6
Meter accuracy after particulate injection 1.0 life

Meter type	Meter number	Flow rate 1/4 gpm	1 gpm	2 gpm	15 gpm
DP	1	97.06%	101.25%	99.46%	100.02%
DP	2	92.09%	100.55%	98.96%	99.58%
DP	3	91.53%	100.25%	99.46%	99.68%
SJ	4	101.71%	99.46%	98.07%	99.86%
SJ	5	101.71%	99.85%	98.46%	100.97%
SJ	6	100.84%	99.26%	97.97%	99.79%
ND	7	96.50%	100.75%	98.96%	100.20%
ND	8	99.25%	101.37%	98.03%	99.47%
ND	9	99.35%	101.07%	98.51%	99.77%
ND	10	99.55%	100.57%	98.51%	99.22%
ND	11	100.05%	101.37%	98.03%	99.42%
ND	12	98.75%	101.07%	98.03%	99.15%
ND	13	99.25%	100.87%	97.05%	99.40%
ND	14	0.00%	100.57%	98.22%	100.37%
ND	15	93.91%	99.70%	100.25%	99.64%
ND	16	94.52%	99.97%	100.25%	99.39%
ND	17	96.68%	100.42%	100.75%	99.87%
ND	18	98.85%	102.24%	100.25%	98.97%
ND	19	96.08%	101.06%	100.05%	99.27%
ND	20	98.67%	102.43%	101.25%	100.02%
ND	21	82.58%	99.51%	101.75%	100.39%
SJ	22	101.00%	98.60%	100.45%	100.75%
SJ	23	100.90%	98.60%	100.45%	100.63%
SJ	24	99.53%	99.10%	100.45%	101.58%
MJ	25	95.38%	101.19%	101.64%	101.66%
MJ	26	98.31%	102.68%	101.64%	102.20%
MJ	27	97.82%	101.19%	101.64%	101.61%
MJ	28	91.71%	98.44%	99.91%	101.55%
MJ	29	96.66%	100.63%	100.41%	99.96%
MJ	30	96.19%	99.63%	98.23%	97.86%
MJ	31	99.74%	100.83%	100.01%	99.90%
MJ	32	100.86%	100.83%	100.61%	100.29%
MJ	33	99.55%	101.83%	102.40%	99.60%
DP	34	93.88%	99.34%	101.38%	99.73%
DP	35	94.58%	99.63%	100.39%	99.47%
DP	36	95.08%	99.83%	100.69%	100.08%
DP	37	0.00%	100.93%	101.88%	41.10%
DP	38	0.00%	97.64%	101.38%	70.92%
DP	39	81.20%	101.13%	102.88%	51.81%
SJ	40	93.52%	99.98%	99.84%	97.88%
SJ	41	91.91%	101.28%	101.22%	100.63%
SJ	42	93.31%	97.53%	97.73%	102.16%
DP	43	94.28%	98.69%	100.87%	100.09%
DP	44	94.57%	100.35%	101.27%	100.44%
DP	45	95.05%	101.00%	101.57%	100.72%
SJ	46	0.20%	93.51%	97.91%	4.14%
SJ	47	79.09%	96.70%	97.51%	24.80%
SJ	48	93.92%	97.50%	97.91%	101.63%
MJ	49	98.56%	99.39%	100.21%	100.73%
MJ	50	101.13%	100.39%	100.61%	101.96%

(continued)

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Table C.6 (Continued)

Meter type	Meter number	Flow rate			
		1/4 gpm	1 gpm	2 gpm	15 gpm
MJ	51	99.16%	99.59%	100.85%	100.49%
MJ	52	97.64%	100.45%	101.03%	100.31%
MJ	53	96.84%	99.96%	99.84%	99.61%
MJ	54	0.10%	96.72%	98.15%	99.66%
MJ	55	99.93%	99.47%	99.84%	100.05%
MJ	56	98.64%	99.47%	99.04%	101.15%
MJ	57	98.14%	98.68%	98.84%	99.61%
MJ	58	97.19%	102.22%	102.20%	102.18%
MJ	59	98.69%	101.73%	100.29%	100.93%
MJ	60	98.69%	101.04%	100.67%	100.92%
DP	61	96.31%	100.55%	100.67%	100.42%
DP	62	94.90%	95.91%	99.23%	100.25%
DP	63	94.90%	99.86%	100.67%	100.22%
FO	64	95.39%	99.18%	100.03%	99.70%
FO	65	98.18%	98.90%	99.93%	99.80%
FO	66	98.36%	99.27%	100.03%	100.08%
DP	67	100.97%	102.56%	101.92%	100.19%
DP	68	100.25%	102.01%	101.32%	100.06%
DP	69	101.33%	102.20%	101.62%	100.04%
DP	70	100.26%	101.99%	100.43%	99.55%
DP	71	99.37%	101.79%	101.23%	99.80%
DP	72	100.86%	99.99%	101.94%	99.42%
DP	73	97.29%	100.79%	100.23%	99.05%
DP	74	93.79%	99.69%	100.53%	99.37%
DP	75	95.13%	100.19%	100.23%	98.93%

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ABBREVIATIONS

AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
CCR	Consumer Confidence Report
DP	displacement piston type water meter
°F	degrees Fahrenheit
FO	fluidic oscillator type water meter
g	grams
gpm	gallons per minute
ID	identification
in	inch
Int1	intermediate flow 1
Int2	intermediate flow 2
Max	maximum
MG	million gallons
Min	minimum
MJ	multi-jet type water meter
mm	millimeter
ND	nutating disc type water meter
NEWWA	New England Water Works Association
NHDES	New Hampshire Department of Environmental Services
NIST	National Institute of Standards and Technology
No.	number
PR	propeller type water meter
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
SJ	single-jet type water meter
TU	turbine type water meter
USU	Utah State University
UWRL	Utah Water Research Laboratory
yr	year

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