

U.S. Water Meter Testing Equipment Compliance with AWWA C715 Paper

Purpose

This paper's purpose is to independently assess the requirements for accuracy testing compliance of water meter test bench systems used to provide modern utility testing solutions for ANSI / AWWA C715 Electromagnetic and Ultrasonic Meters. It is not intended to compare different water meters or their manufacturers.

This evaluation focuses on the requirements of water meter testing equipment necessary to comply with the ANSI / AWWA C715 standard¹. The analysis draws on publicly available information, physical inspections of the test bench systems, written input from vendors, and direct confirmations from the manufacturers regarding C715 compliance. Furthermore, this paper is not meant to endorse any specific manufacturer. Instead, it provides a detailed technical examination of the requirements for meter test bench systems necessary to comply with the ANSI/AWWA C715 standard.

Significance of Compliance

Compliance with ANSI / AWWA C715 is crucial for ensuring the accuracy and reliability of water meter test bench systems. For utilities, adherence to these standards means that their water meters are tested under conditions that closely mimic real-world usage, thereby guaranteeing precise measurement and billing. This compliance also enhances consumer confidence in the utility's metering and billing processes, minimizes revenue loss due to inaccurate meters, and supports regulatory adherence. Moreover, it helps utilities avoid potential legal issues and ensures the efficient allocation of resources by reducing the need for frequent retesting and meter replacement.

Compliance Criteria

The requirements, as outlined in the American Water Works Association ("AWWA") documents, *ANSI / AWWA C715 on Cold-Water Meters—Electromagnetic and Ultrasonic Type, for Revenue Applications* and the *M6 Manual Water Meters – Selection, Installation, Testing and Maintenance* ("M6 Manual") provide the foundation for the primary requirements.

- Straight Pipe / Full Bore throughout test system, including no cavities that could cause flow disturbance (i.e., no bleeder valves)
- No constraints or "pinch points" to restrict flow
- Evidence that the test bench system undergoes annual maintenance and system calibration

The AWWA C715 Standard, Section A.3.3, specifies adherence to the quality of the Meter Testing Device (also known as a Test Bench or Test Stand).

Test quantities shall match manufacturer recommendations to ensure that adequate sample intervals are included in the test process³. Test equipment should provide full-bore diameter fittings for the meter size being tested and a constant flow stream that is free from disturbances. When two or more meters are being tested simultaneously in a single line, some meter designs will require at least five diameters of straight pipe between the outlet of one meter and the inlet of the next meter in line. This straight pipe will minimize the errors associated with flow profile disturbances created by meter internal flow geometries.³ If the purchaser does not have suitable means for testing, the manufacturer should be requested to provide a certificate showing that each meter has been tested for accuracy of registration and that it complies with the accuracy and capacity requirements of ANSI / AWWA C715 standards³.

The “full-bore” criteria are a key measure in determining the accuracy of the C715 meter. Full-bore means to operate at the fullest extent with minimal intrusion. The “full bore”, or “straight pipe methodology”, ensures that the Test Bench does not introduce disturbance (formerly known as turbulence) into the testing system. This disturbance can potentially affect the meter performance and may result in inaccurate test results. These disturbances may cause the meter (or meters) to fail the accuracy test, producing concerns related to, but not limited to, vendor selection, revenue loss from under-performing meters, workforce loss due to re-testing of the failed meters, and unnecessary replacement of accurate meters.

The straight pipe methodology is achieved by providing meter settings or adapters that do not leave any gaps, spaces, or areas that would allow water to sit, swirl, or form air pockets.

Previous meter technologies allowed for the bleeder valve to be opened at each test bench position, enabling the operator to set the dial on the register to an 'acceptable' starting point, ensuring an accurate starting point in the meter read and subsequent test. However, current technologies with digital displays on meter registers render this function obsolete. Water may collect, sit, or swirl at the point of entry to the valve, causing disturbances that do not meet the requirements of straight pipe or full-bore compliance. Additionally, bleeder valves are used to release pressure at each station, minimizing water jetting from the meter positions on the test bench. The bleeder valve can be placed at the end of the row on the test bench, but water may still collect, sit, or swirl, leading to non-compliance. Similarly, the placement of saddles and adapters to fit various meter sizes often requires an adapter on both sides of the saddle, creating a gap that causes disturbances and fails to meet straight pipe or full-bore compliance.

ANSI / AWWA Background

The American Water Works Association (“AWWA”) is a non-profit organization that provides education, advocacy, and research for the water industry. AWWA provides manuals and research information on various water-related subjects related to water meters and associated technologies. The AWWA is one of seven (7) organizations that have been accorded “ANSI Audited Designator Status”, an essential criterion for ANSI accreditation.

With the advent and migration of meter technologies from mechanical-based meters to the more recent innovations in electromagnetic and ultrasonic meters, the methodology for accurately testing ultrasonic meters has changed the way this class of meters is tested. Often, these meters are tested under different criteria specified in the AWWA M6 Manual Water Meters – Selection, Installation, Testing, and Maintenance (“M6 Manual”). The M6 Manual has served as a guide to best practices for water meters, complementing the AWWA water meter standards. From a practical standpoint, the manual is often used as a reference tool by utilities in their meter testing facilities to determine and execute the proper testing procedures for various meter types and sizes.

In November 2018, the AWWA released an Addendum to the M6 Manual to provide updates to meter testing practices, specifically introducing the latest category of meter technology, the C715. The purpose of the Addendum is to guide users on testing procedures and related topics for meters conforming to standard *ANSI / AWWA C715 on Cold-Water Meters—Electromagnetic and Ultrasonic Type, for Revenue Applications*. In October 2022, the AWWA released an additional C715 Addendum to provide updates to meter testing practices, effective May 2023.

The AWWA Water Meter Standards Committee #380 and the Manual M6 Subcommittee are actively preparing further updates to the M6 Manual. The AWWA Standards Council has approved the Sixth Edition of the Manual M6 and is currently awaiting the official publication date.

The following is an excerpt from the AWWA C715 Addendum.

Table 5-3 of the M6 Manual provides recommended data for testing cold-water meters using the volumetric method with volumetric tanks or the gravimetric method with weight scales. This data may also be of use in testing cold-water meters against a master or reference meter that has a known calibration curve. Accuracy standards for new meters are outlined in the latest editions of the following standards: ANSI/AWWA C700, C701, C702, C703, C704, C708, C710, C712, C713, C714, and C715. The modified Table 5-3 issued in this addendum reflects the latest accuracy standards from these AWWA standards.⁴

The following listing provides additional guidance on meter testing beyond the modifications made in Table 5-3.

1. When testing meters to validate their accuracy (either before deployment or after some time in service), note that the testing procedures for electronic meters may differ from those of meters previously placed in service. The manufacturer’s recommended testing procedures should be followed. Failing to follow these recommendations can compromise or invalidate the accuracy of the results.
2. Electronic meters do not have moving parts and are not subject to the same wear and tear as mechanical meters. Although AWWA standards for mechanical water meters provide recommended testing frequencies in the appendices of each standard, recommended testing frequencies are not provided in the appendix of ANSI/AWWA C715. Water quality and other local conditions may affect the performance of electronic meters over time. To assess these site-specific effects, the utility may choose to verify the accuracy of electronic meters at the recommended test frequencies specified in AWWA standards for

mechanical meters, until the utility establishes its own criteria based on data collected from its operational experience and local conditions.

3. Some smaller electronic meters have minimum rate accuracy requirements at flow rates lower than those specified in other AWWA meter standards (i.e., rates below 0.25 gpm). In some other cases, the minimum flow rate of electronic meters may be lower than that of the mechanical meters previously deployed by the utility for any given line size. Accuracy at these lower flow rates, therefore, might be more challenging to test and verify on the existing utility's meter test bench equipment. Gravimetric systems offer greater sensitivity than volumetric systems. In all cases, the testing equipment must be maintained appropriately, periodically calibrated, and certified to ensure it is functioning correctly.
4. As discussed in item #3, a utility's testing equipment may not be capable of testing electronic meters reliably at the lower flow rates (particularly for flow rates even lower than the minimums given in ANSI / AWWA C715, if part of the manufacturer's warranted accuracy claims). If this is the case, an independent third-party service company with certified and calibrated equipment and sound testing protocols may need to be engaged to verify accuracy. As provided in one of the footnotes for the modified Table 5-3 in this addendum, a utility may alternatively increase the minimum test rate flow to stay within the capability of their equipment while holding the electronic meters to their tighter accuracy requirement at these somewhat higher flow rates. Utilities may also wish to use these slightly higher flow rates when time constraints are present during testing.
5. Historically, Table 5-3 has included caveats in test quantity recommendations, as noted in the footnote "not less than 3 min running." This has been most notable for some of the maximum rate test quantities, which result in test run times of well under 3 minutes. This ambiguity acknowledges the limitations in the number and size of test tanks that the utility may be equipped with. The footnote further provides that, for reduced test quantities, "the resultant increase in total test uncertainties and errors need to be recognized." While mechanical water meters may be able to accommodate the test quantities in Table 5-3 that result in test times of less than 3 minutes, this may not be the case for some electronic meters. A special test mode—temporarily increasing the sampling rate for the Meter—may be available for some electronic meter designs to mitigate test uncertainties associated with test times shorter than 3 minutes.
6. Table 5-3 provides recommended test flow rates. These recommendations are based, in part, on the observation that all meters of the same type (all positive displacement meters, all turbine meters, and so on) will exhibit the same or similar characteristic accuracy curves. This may not be a valid observation for electronic meters, for which distinct calibration algorithms may be used. As a result, alternate or additional flow test rates may be considered. These would be especially relevant for flow rates given in the manufacturer's performance claims that significantly exceed the ranges established in AWWA water meter standards.
7. Electromagnetic and ultrasonic type electronic meters are inferential, measuring water velocities and inferring volumetric flows based on these velocities. (Many mechanical flow meters are also inferential.) Inferential meters can be susceptible to flow profile disturbances and to "noisy" flow delivery systems (e.g., pressure pulsations). Care should be taken to ensure that utility test stands do not introduce disturbances or noise at levels that are not representative of those that occur in actual field installations.

Testing Requirements for the AWWA C715

The C715 Manual Cold-Water Meters – Electromagnetic and Ultrasonic Type, for Revenue Applications, provides guidance on this particular class of water meter, covering manufacture, use, and implementation. Additionally, guidelines are provided to ensure the best possible testing methods for the meters, in accordance with the recommendations outlined in the M6 Manual.

As stated above, as referenced in the Addendum to Manual M6, several items should be considered when testing a C715 class water meter.

The manufacturer's recommended testing procedures should be followed. Failing to follow these recommendations can invalidate the accuracy of the results. Accuracy at the lower flow rates, therefore, might be more challenging to test and verify on the existing utility's meter test bench equipment. Gravimetric systems might provide more sensitivity than volumetric systems⁶. In all cases, the testing equipment must be maintained appropriately, periodically calibrated, and certified to ensure it is functioning correctly.⁶ Care should be taken to ensure that utility test stands do not introduce disturbances or noise at levels that are not representative of those that occur in actual field installations.⁶

The AWWA Manual C715, Section A.3.3, provides specific guidelines for adhering to the quality of the Meter Testing Device (also known as a Test Bench or Test Stand).

Test quantities shall match manufacturer recommendations to ensure that adequate sample intervals are included in the test process. Test equipment should provide full-bore diameter fittings for the meter size under test and a constant flow stream that is free of disturbances. When two or more meters are being tested simultaneously in a single line, some meter designs will require at least five diameters of straight pipe between the outlet of one meter and the inlet of the next meter in line. This straight pipe will minimize the errors associated with flow profile disturbances created by meter internal flow geometries. Suppose the purchaser does not have suitable means for testing. In that case, the manufacturer should be requested to provide a certificate showing that each meter has been tested for accuracy of registration and that it complies with the accuracy and capacity requirements of ANSI / AWWA C715.⁷

The AWWA Manual C715, Section A.4, Testing Equipment, states:

The measuring device used to determine the amount of water discharged during testing should be designed to provide measuring accuracy within 0.25 percent of the actual quantity. Tanks and scales should be tested and calibrated at least once a year, and records kept of such tests and calibrations.⁸

In addition, it is recommended that the meter testing apparatus be maintained by trained personnel. The rationale is straightforward – this ensures that the meter testing apparatus is fully functional, with no leaks due to faulty gaskets, valves, pipes, or other components involved in meter testing. All other devices in today's

modern meter shop undergo periodic maintenance or preventive maintenance, and the meter testing components need to receive the same level of coverage.

With the advent of the C715 technology, focus on the meters, the accuracy of the meters, and overall performance, many points support periodic maintenance and calibration:

- Significant investments are made in meter acquisition by the modern Utility. Periodic checking of newly received meters verifies the accuracy of the meters as provided by the meter supplier or manufacturer. If the received meters do not meet a specified testing criterion, the Utility may opt to return the meters to the respective meter supplier or manufacturer.
- When a meter changeout program is implemented, the meters removed from the field tend to be less accurate than the replacement (“new”) meters. A rise in water usage is then recovered and billed. Disputes in billing and questions related to meter accuracy tend to increase during these programs and are oftentimes subject to litigation.

A well-documented defense includes:

- Demonstration of ongoing calibration of the scales and tanks
- Evidence of a regular maintenance program, preferably with an authorized and experienced organization. Demonstration of a meter test results database that the Utility cannot edit.
- Evidence of operator training, preferably with an authorized and experienced organization.

About the Author:



Michael Mastic

Michael Mastic is a seasoned executive with over three decades of experience spanning high-tech industries and the water utility sector. He has played a pivotal role in the development and implementation of over 400 meter-shop facilities across the United States. His expertise lies in strategic planning, logistics, and the advancement of meter testing methodologies for utilities, municipalities, and private organizations.

Mr. Mastic began his career in mainframe computing, data center operations, and telecommunications, where he honed his skills in technical sales, management, training, and financial oversight. Leveraging this diverse background, he brought a systems-oriented approach to the water industry, emphasizing efficiency, standardization, and modern operational planning.

An active member of the American Water Works Association (AWWA), Mr. Mastic has been a contributing member of the Water Meter Standards Committee since 2011. He currently serves as Vice Chair and has held several leadership roles, including Chair of the M6 Subcommittee, former Chair of the C714 Subcommittee, and Recording Secretary for the committee from 2014 to 2023.

Mr. Mastic holds a Bachelor of Arts in Economics from Washington and Jefferson College in Washington, Pennsylvania.

¹ American Water Works Association Standard – *Cold-Water Meters – Electromagnetic and Ultrasonic Type, for Revenue Applications*; First Edition; Reaffirmed without revision 2022, page 14

² 2018 Addendum/Supplement to AWWA Manual M6, *Water Meters—Selection, Installation, Testing, and Maintenance*, Fifth Edition (2012), page 1 of 3

³ 2018 Addendum/Supplement to AWWA Manual M6, *Water Meters—Selection, Installation, Testing, and Maintenance*, Fifth Edition (2012), pages 1 of 3, 2 of 3, 3 of 3

⁴ 2018 Addendum/Supplement to AWWA Manual M6, *Water Meters—Selection, Installation, Testing, and Maintenance*, Fifth Edition (2012), page 2 of 3

⁵ American Water Works Association Standard – *Cold-Water Meters – Electromagnetic and Ultrasonic Type, for Revenue Applications*; First Edition; Reaffirmed without revision 2022, page 14

⁶ American Water Works Association Standard – *Cold-Water Meters – Electromagnetic and Ultrasonic Type, for Revenue Applications*; First Edition; Reaffirmed without revision 2022, page 15