AQUAFLOW TECHNICAL WHITEPAPER

Water Meter Accuracy Acceptance Windows and Municipal Billing

An engineering reference for property owners, asset managers, consulting engineers, and finance teams

±1.5% Accepted accuracy limit at high and intermediate flow for new, rebuilt, or repaired meters under the ANSI/AWWA C-Series.

10% Permitted under-registration at low flow for the same meters, reflecting the physical limits of mechanical sensing at slow rates.

Field Installation geometry, pressure transients, and entrained air can shift actual registration within or beyond these windows.

SECTION 00

Contents

SECTION 01

Scope of This Document and How to Read It

This document summarizes the engineering standards, municipal and state code provisions, and operational factors that govern how billed water consumption relates to actual water delivered to a property. It is intended as an engineering reference for commercial, multifamily, industrial, and institutional property owners and the professionals advising them.

What this document is

A technically sourced summary of (a) the accepted accuracy windows defined in the ANSI/AWWA C-Series meter standards and the AWWA Manual of Water Supply Practices M6, (b) how selected U.S. jurisdictions codify those standards in utility policy and state code, and (c) the physical and installation factors that can cause field meter registration to diverge from true flow.

What this document is not

It is not a legal opinion. It does not assert that any utility has overbilled any specific customer, that any meter is individually inaccurate, or that any specific billing dispute will succeed. Specific billing conclusions for a given property require a meter test and a site investigation conducted under the applicable utility and regulatory process.

How claims in this document are sourced

Every substantive claim falls into one of five categories, identified inline or in the References section:

- **Standards-based** — drawn from the ANSI/AWWA C-Series or the AWWA Manual M6.
- **Municipal or state code-based** — drawn from a specific utility policy, municipal ordinance, or state administrative code provision cited by reference number.
- **Manufacturer or technical literature-based** — drawn from published meter manufacturer documentation or peer-reviewed engineering literature.
- **AquaFlow engineering interpretation** — an engineering inference drawn by AquaFlow from the sources above. Labeled as such.
- **AquaFlow product claim** — a performance, certification, or warranty claim specific to the AquaFlow Valve product line. Labeled as such.

SECTION 02

Executive Summary

Water utility billing in the United States is based on metered measurements produced by devices manufactured, tested, and maintained under the ANSI/AWWA C-Series meter standards[1] and the AWWA Manual M6 field reference[2]. Those standards define the accuracy windows within which a meter is considered accurate for acceptance purposes — not an absolute zero-error benchmark.

Three facts follow directly from those standards:

- At high and intermediate flow, the accepted accuracy window is 98.5 to 101.5 percent of true flow (±1.5%)[3].
- At low flow, the accepted window is wider and asymmetric: 90.0 to 101.5 percent of true flow. A meter may therefore be accepted as compliant while under-registering slow flow by up to 10 percent [3]. At high flow the same standard caps over-registration at +1.5 percent[3].
- Field performance over time depends on installation geometry, pressure variability, entrained air, meter age and class, and water quality. These factors are recognized in the governing standards themselves[1] and can shift actual registration within or beyond the acceptance window.

> **The short, accurate version**
>
> Your water bill reflects a metered measurement produced by a device operating within a defined accuracy window and subject to field conditions. The window is wider at low flow than at high flow. Under-registration at low flow generally reduces billed consumption relative to true flow; turbulence, pressure transients, and entrained air at the meter inlet are documented causes of transient over-registration. Neither effect is a defect in the meter. Both are consequences of the engineering compromise that the standards codify.

This document explains how the standards work, cites the specific provisions, and introduces the AquaFlow Valve as an engineering response — an inline, calibrated, third-party-certified water control device installed post-meter to stabilize pressure and flow to the building. AquaFlow product performance is quantified under the International Performance Measurement and Verification Protocol[13] and is supported by third-party testing and certification cited in Section 10.

SECTION 03

The Governing Standards

AWWA M6 and the ANSI/AWWA C-Series

Water meter design, performance, testing, and field maintenance in the United States are governed primarily by two bodies of reference material: the AWWA Manual of Water Supply Practices M6, *Water Meters — Selection, Installation, Testing, and Maintenance*[2], and the ANSI/AWWA C-Series of meter product standards[1]. These documents, developed and maintained by the American Water Works Association and accredited by ANSI, are widely referenced by U.S. water utilities — either by direct adoption, by incorporation into local tariffs, or by cross-reference in state administrative code.

The ANSI/AWWA meter standards in force

Standard	Meter type covered	Typical size range
ANSI/AWWA C700	Cold-water displacement type, bronze main case	5/8 in. through 2 in.
ANSI/AWWA C701	Cold-water turbine type, Class I and Class II	1-1/2 in. through 20 in.
ANSI/AWWA C702	Cold-water compound type (turbine + displacement bypass)	2 in. through 6 in.
ANSI/AWWA C703	Cold-water fire-service type	3 in. through 10 in.
ANSI/AWWA C704	Propeller type, for mainline applications	2 in. through 72 in.
ANSI/AWWA C708	Cold-water multi-jet type	5/8 in. through 2 in.
ANSI/AWWA C710	Cold-water displacement type, plastic main case	5/8 in. through 1 in.
ANSI/AWWA C712	Cold-water single-jet type	5/8 in. through 2 in.
ANSI/AWWA C713	Cold-water fluidic-oscillator type	5/8 in. through 1 in.
ANSI/AWWA C715	Cold-water electromagnetic and ultrasonic type	5/8 in. through 16 in. and above

Source: ANSI/AWWA C-Series, current editions. Size ranges represent the scope of each standard, not the full set of sizes any individual manufacturer produces.

AWWA Manual M6 — the master field reference

AWWA Manual M6 (currently in its Fifth Edition, with a 2018 addendum updating Table 5-3) is the authoritative field document that tells utilities how to select, install, test, repair, and replace meters. It specifies separate accuracy windows at three test-flow regimes — low, intermediate, and high — rather than a single accuracy number, because a meter's accuracy depends on the flow rate through it. M6 also recommends testing intervals for meters in service, scaled to meter size[2].

- 5/8-inch to 1-inch meters — every 10 years on average
- 1-inch to 4-inch meters — every 5 years on average
- 4-inch and larger meters — annually

Under M6, at least 95 percent of meters scheduled for periodic testing should be tested, and at least 95 percent of those tested should register within the specified accuracy limits. The corollary: up to 5 percent of tested meters may fall outside the accuracy window and the utility's testing program can still be in compliance, and the testing interval for small meters can reach a decade[2].

> **Engineering implication**
>
> In practice, a 3/4-inch or 1-inch mechanical service meter can operate for years between formal accuracy tests. The operating accuracy of any individual meter in a given period is not directly measured — it is inferred from the acceptance tests conducted on new, rebuilt, or periodically pulled meters.

SECTION 04

Accepted Accuracy Windows

The accuracy windows defined in the ANSI/AWWA C-Series meter standards apply to acceptance testing of new, rebuilt, or repaired meters under controlled bench conditions. A meter is *considered accurate* for acceptance purposes if its registered flow falls within the limits below at each of three defined test-flow regimes[3]:

Test flow regime	Lower limit	Upper limit	Permitted error band
High flow rate	98.5%	101.5%	**±1.5%**
Intermediate flow rate	98.5%	101.5%	**±1.5%**
Low flow rate	90.0%	101.5%	**-10.0% / +1.5%**

Source: ANSI/AWWA C700, C701, C702, C708, C710, C712, C713, and C715 product standards; AWWA Manual M6 Table 5-3 (2018 addendum).

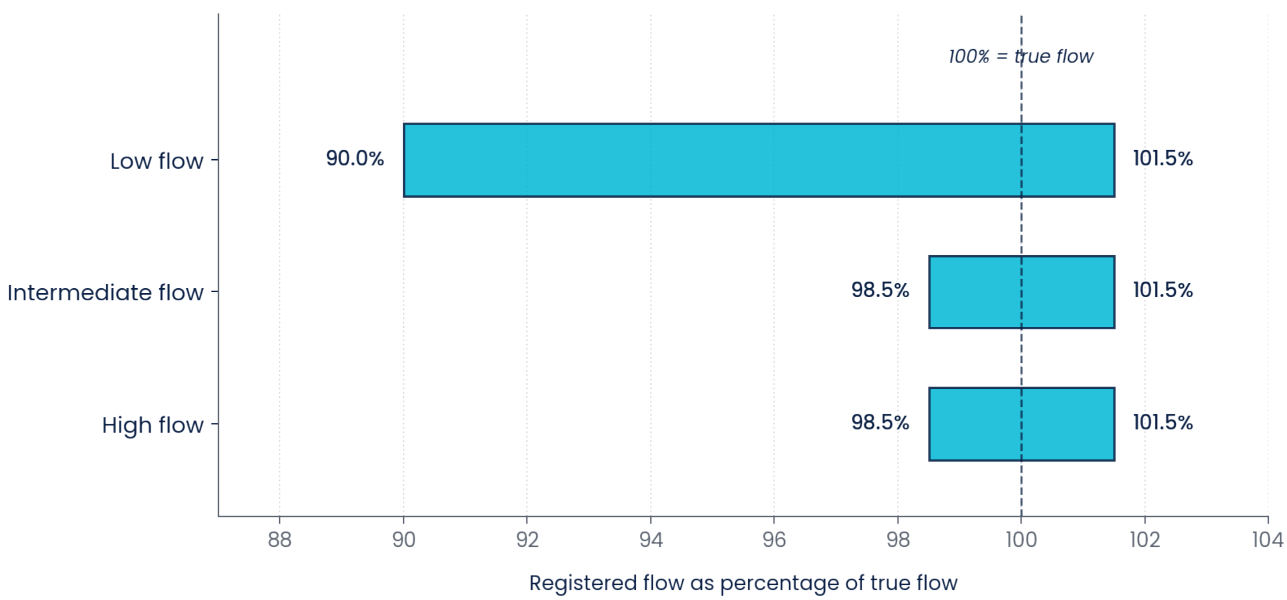


Figure 1. Accepted accuracy windows at each test-flow regime, as defined in the ANSI/AWWA C-Series. The low-flow band is wider and asymmetric (permits up to 10% under-registration); the high and intermediate-flow bands are symmetric (±1.5%).

SECTION 04

Accepted Accuracy Windows

Reading the windows correctly — directional implications

The asymmetry at low flow has a directional consequence that is important to state precisely:

- Over-registration at any flow regime is capped at +1.5 percent of true flow[3]. A meter that passes acceptance testing does not register materially more water than flowed through it under the test-flow conditions.
- Under-registration is capped at -1.5 percent at high and intermediate flow, but at -10 percent at low flow. The standard therefore permits substantially more under-registration at low flow than over-registration at any flow regime.

Engineering consequence. Where low-flow under-registration occurs in field service, billed consumption is lower than true flow at the affected flow regime — a direction that generally favors the customer for that portion of flow. This is not a claim of utility mispractice; it is the engineering compromise encoded in the standard itself. The standard recognizes that mechanical sensing of very slow flow is physically difficult and accepts a wider registration window in that regime in exchange for practical, cost-effective meter design.

Where field-condition effects can shift registration the other way. Separate from the acceptance-window asymmetry, operating conditions at the meter can produce transient shifts in registration relative to true flow. Entrained air, pressure transients, and turbulent upstream flow are recognized in AWWA M6 and in meter-manufacturer literature as causes of momentary over-registration in mechanical meters[2][4]. In any individual service, the net direction and magnitude of any deviation depend on the flow profile, installation geometry, meter type, and meter age, and can only be established by a meter test combined with a site investigation.

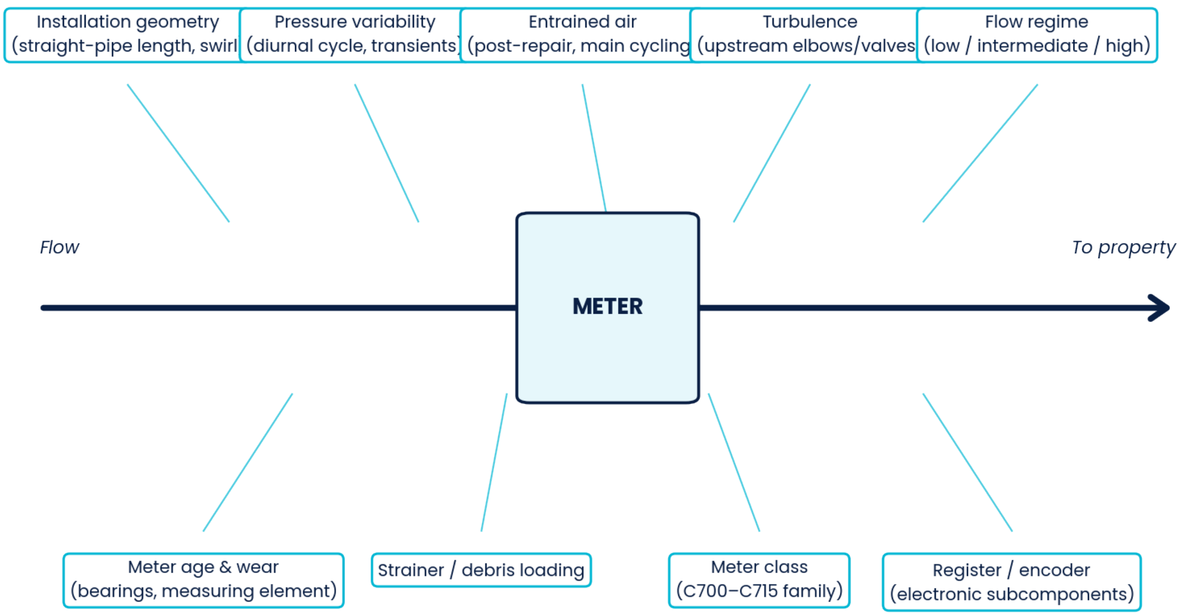
How municipalities and states codify these windows

Utility policy in the United States typically adopts or references the AWWA accuracy windows. Examples reviewed for this document include Miami-Dade Water and Sewer Department's published meter accuracy policy[7], New Jersey Administrative Code N.J.A.C. 14:3-4.5 and 14:3-4.6[8][9], the City of West Palm Beach Public Utilities customer re-read and leak-credit policy[10], DC Water's customer dispute process[11], and NYC DEP's customer complaint process[12]. Specific provisions and deadlines vary; customers should verify the framework applicable to their service.

SECTION 05

Why Measured Consumption Can Diverge From True Flow

Acceptance testing under the ANSI/AWWA C-Series is conducted on new, rebuilt, or repaired meters under controlled laboratory conditions. Field service introduces variables that do not exist on a test bench and that the governing standards and AWWA manuals explicitly recognize. These variables can shift actual field registration within or beyond the acceptance windows shown in Section 04[1][2].



Factors that can shift field registration relative to true flow

Figure 2. Factors that can shift field meter registration relative to true flow. Upstream factors affect the flow profile presented to the measuring element; operating and meter-internal factors affect how that flow is counted and transmitted to the register. Source: synthesized from AWWA Manual M6 (Reference 2), ANSI/AWWA C-Series product standards (Reference 1), and peer-reviewed engineering literature on field meter accuracy (References 4 and 6).

SECTION 05

Field Divergence Factors

The factors below are drawn from AWWA Manual M6, the ANSI/AWWA C-Series, and published meter-manufacturer technical literature. Their magnitude in any individual installation is site-specific and can only be established by a meter test and site survey.

Installation geometry and upstream flow profile

AWWA M6 specifies minimum upstream and downstream straight-pipe lengths for each meter type to allow the velocity profile entering the meter to normalize. Retrofitted and space-constrained installations may not fully meet these requirements. A turbulent or swirl-laden flow profile can, for turbine and propeller meters, cause the rotor to rotate faster or slower than steady axial flow would dictate, shifting registration in either direction[2].

Pressure variability and transients

Municipal supply pressure can vary with time of day, season, demand, and distance from the supplying pumping station or tank. Transient events — valve closures, pump cycles, hydrant operations — can momentarily spike pressure and velocity. Mechanical meters are recognized in AWWA M6 and in manufacturer technical literature as potentially subject to transient over-registration under high-velocity excursions[2][4].

Entrained air

When a mechanical meter ingests air along with water, the measuring element displaces the combined volume; the register does not distinguish between air and water. Entrained air has been documented in meter-manufacturer technical literature as a cause of transient over-registration[4]. Air can enter a service line after main repair work, hydrant flushing, intermittent supply conditions, or the re-pressurization of an internally drained plumbing system. Electronic meter classes (AWWA C715) can be less susceptible to this effect depending on their sensing method[5].

Meter age, wear, and maintenance condition

Displacement meters can lose accuracy as internal clearances open with wear; turbine meters can lose accuracy as rotor bearings degrade; compound meters can additionally experience registration error in the crossover region between their turbine and displacement elements. Peer-reviewed and utility-based research has documented measurable in-service accuracy shifts in small residential-class mechanical meters, with the direction of long-term drift typically toward slower registration at low flow[4][6]. The magnitude of drift in any individual installation depends on duty cycle, water quality, meter class, and maintenance history, and can only be established by a meter test.

Strainer and debris loading

Most AWWA-compliant meters incorporate an inlet strainer. A partially fouled strainer restricts flow and alters the velocity profile entering the measuring chamber, potentially causing under-registration in turbine and propeller designs[2][4].

Electronic meter subcomponents

AWWA C715 addresses electromagnetic and ultrasonic meters, which use electronic sensing rather than moving measuring elements. These meters have different failure modes — battery depletion, transmitter drift, encoder faults — that can independently affect billing without the primary sensing element being out of specification. The standard defines acceptance criteria covering these subcomponents[5].

SECTION 06

Meter Classes and Operational Differences

Different meter classes respond differently to the same field conditions. The class installed at a given service is a factor the property owner typically does not control, but it is a factor worth understanding when interpreting billing behavior.

Displacement meters (ANSI/AWWA C700, C710)

Most common type for residential and small commercial services. A nutating disc or oscillating piston displaces a known volume of water per cycle. Good low-flow response when new; accuracy drifts with wear of the measuring element.

Turbine meters (ANSI/AWWA C701)

Used for larger services where sustained high flow dominates. A rotor rotates in proportion to axial flow velocity. Low head loss and good high-flow accuracy; limited low-flow sensitivity; can register incorrectly under swirl-laden upstream flow.

Compound meters (ANSI/AWWA C702)

Two measuring elements — a small displacement element for low flows and a larger turbine element for high flows — selected by an internal changeover valve. Wider effective accuracy range than either element alone; introduces an additional source of error in the crossover region between the two elements.

Propeller, jet, and fluidic-oscillator meters (C704, C708, C712, C713)

Each with different measuring principles and different sensitivities to installation, water quality, and flow profile. Fluidic-oscillator meters (C713) have no moving measuring elements in the main flow path.

Electromagnetic and ultrasonic meters (ANSI/AWWA C715)

The current generation of electronic meters used in many AMI (advanced metering infrastructure) deployments. No moving measuring elements; long-term measurement stability under clean conditions; electronic subcomponent reliability becomes a separate factor. These meters are typically less susceptible to entrained air and mechanical wear, but remain sensitive to installation geometry and to the condition of their electronic subcomponents.

Regardless of meter class, the ANSI/AWWA acceptance framework applies, and field conditions at the service entrance affect the outcome. Stabilizing pressure and flow delivered to the building — the engineering premise behind the AquaFlow Valve, in Section 09 — reduces the transient excursions that most strongly affect mechanical meter registration.

SECTION 07

Customer Rights and Dispute Pathways

Regulated U.S. water utilities typically operate under a customer dispute framework — established through a state public utility commission, a municipal ordinance, or a published utility tariff. Specific provisions vary. The jurisdictions reviewed for this document share four broad customer entitlements in some form, although the details, deadlines, and remedies differ by jurisdiction.

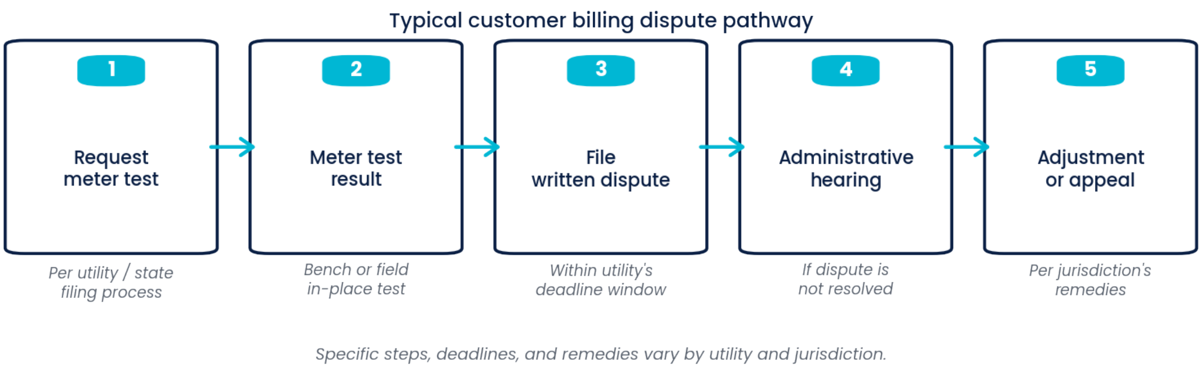


Figure 3. Typical customer billing dispute pathway, generalized from the jurisdictions cited in this document (References 7 through 12). Specific steps, deadlines, evidentiary requirements, and remedies are defined by the applicable utility tariff, municipal ordinance, or state administrative code, and may change over time.

1. Meter accuracy test on customer request

Customers can typically request that the utility test the meter serving their account. In New Jersey, this right is codified at N.J.A.C. 14:3-4.5 and includes one free test per 12-month period[8]. In Miami-Dade County, customers may request a certified meter test through the Water and Sewer Department[7]. Fees, test methods (bench vs. in-place), and witnessing rights vary by jurisdiction.

2. Adjustment when a meter registers outside tolerance

Where a meter is found to be outside the accepted accuracy window in a direction unfavorable to the customer, most regulated jurisdictions provide a mechanism for bill adjustment. New Jersey codifies this explicitly: N.J.A.C. 14:3-4.6 requires adjustment when a meter is found to register fast by more than 1.5 percent[9]. Other jurisdictions apply similar thresholds by tariff or ordinance.

3. Formal billing dispute with defined deadlines

Regulated utilities publish written dispute processes with filing deadlines. Examples reviewed:

- DC Water — written challenge within 20 calendar days of the bill date (21 DCMR § 402.1)[11].

- Miami-Dade Water and Sewer Department — administrative hearing request within 60 days for monthly accounts and 90 days for quarterly accounts[7].
- New York City Department of Environmental Protection — published customer billing dispute process, with limitation periods for billing claims governed in part by applicable New York civil practice statutes[12].

Deadlines and eligible grounds differ by jurisdiction and can change. Customers should verify the applicable deadline directly with their utility before relying on any figure in this document.

4. Administrative hearing and appeal

If the utility's initial disposition of a dispute is unsatisfactory, most regulated jurisdictions provide a formal administrative hearing before an independent officer, followed by further appeal to the utility's governing board and ultimately to a court of competent jurisdiction. Protections against service disconnection during disputes generally apply to the disputed portion of the bill only, and customers are generally expected to remain current on all undisputed charges during the dispute process. Specific provisions vary by jurisdiction.

Practical application

These rights are real, they are enforceable, and they are routinely underused. Most property owners pay a high or anomalous water bill without challenging it, in part because the dispute window is shorter than the time it takes to investigate internally. Properties managed with structured monthly bill review — and with documented baseline consumption data — are in a materially stronger position to identify and dispute billing errors within the applicable deadlines.

SECTION 08

What This Means for Property Owners

The engineering and regulatory facts above have three direct, defensible implications for commercial, multifamily, industrial, and institutional property owners.

Your water bill is an accepted metered measurement, not an absolute measurement

The bill reflects the output of a device that is considered accurate within defined acceptance windows[3] and subject to the field factors identified in Section 05[1][2]. Field-condition effects on mechanical meter registration are documented in the governing standards and in the peer-reviewed engineering literature[2][4]. A property owner who treats the bill as exact forgoes the opportunity to evaluate whether the underlying measurement reflects efficient building operation.

Mechanical meters can drift with age — and replacement can surface a step-change

Peer-reviewed and utility-based research has documented that mechanical meters in field service can drift toward slower registration at low flow over their service life[4][6]. When a utility tests and replaces an older meter with a new, in-specification unit, the subsequent bill can show what appears to be a consumption increase. That increase can reflect recovery of low-flow water the prior meter was not capturing, rather than a change in building consumption. This phenomenon is engineering-based, not a utility defect. Properties with an established, documented consumption baseline are better positioned to distinguish the two.

Pressure and flow stabilization at the service entrance is within property-side control

Among the field factors that can affect mechanical meter registration, the ones most accessible to property-side engineering control are pressure variability and the internal flow profile downstream of the meter. Stabilizing the pressure delivered to the building can reduce internal plumbing stress, can reduce per-use flow at fixtures, and can reduce the frequency and magnitude of transient high-velocity events associated with the field conditions identified in Section 05. The AquaFlow Valve is AquaFlow Technologies' engineered response to this opportunity; its performance, claim boundaries, and certifications are described in Sections 09 and 10.

SECTION 09

The AquaFlow Engineering Response

[AquaFlow product claim — performance backed by third-party testing cited in Section 10]

The AquaFlow Valve is a calibrated, inline potable-water control device installed post-meter at the building service entrance. It is AquaFlow Technologies' core product line and the engineering solution to the pressure, flow, and air-related effects described in Section 05.

What the AquaFlow Valve does

Operating downstream of the utility meter, the AquaFlow Valve is designed to stabilize the pressure and flow profile delivered to the building's internal plumbing system. Under the conditions for which a given valve is sized and specified, this is intended to produce three operational effects, the magnitude of each depending on the specific installation:

- **Reduced pressure volatility** delivered to the building, which can reduce the high-velocity transients associated with plumbing stress and with the field conditions identified in Section 05 as causes of transient meter over-registration.
- **More consistent flow velocity** at fixtures, which can reduce the volume of water consumed per use event while maintaining functional fixture performance; the degree of reduction is site-specific.
- **Reduced frequency and magnitude** of the transient conditions documented in AWWA and manufacturer literature as causes of over-registration in mechanical meters[2][4].

The product range

The AquaFlow Valve is manufactured in a size range covering 3/4-inch through 32-inch services, with IAPMO R&T Listing K-17679 covering the AF-050 through AF-1200 model range[14]. Every installation is preceded by a site survey; the specific model specified for a given building is matched to the service line size, the measured and expected flow and pressure profile, and the property's fixture and use pattern. No two installations are identical.

Installation and operational profile

The AquaFlow Valve is installed at the post-meter service entrance. Typical installation time averages approximately 32 minutes per valve, measured across AquaFlow's commercial installation base; site-specific time depends on pipe access, isolation-valve configuration, and service size. In most configurations, installation does not require service interruption for connected tenants. Once installed, the valve operates passively — no electrical connection, no software, no monitoring subscription — and is designed for the service life of the building's plumbing system.

SECTION 09

The AquaFlow Engineering Response

Savings quantification — IPMVP Option B

AquaFlow quantifies customer water and sewer savings using the International Performance Measurement and Verification Protocol (IPMVP), Option B[13]. IPMVP is the internationally recognized protocol for energy and water savings measurement and verification, maintained by the Efficiency Valuation Organization. Option B isolates the retrofit measure — the AquaFlow Valve — and quantifies savings by comparing measured post-installation consumption against a documented, normalized pre-installation baseline. The result is independently-reviewable savings documentation suitable for internal audit, CFO review, and third-party engineering review.

Customer guarantees

Every AquaFlow installation is accompanied by three customer guarantees, printed on every customer agreement:

- Save **up to 30 percent** on monthly water and sewer bills (savings are site-specific and quantified under IPMVP Option B).
- Six-month money-back guarantee.
- Lifetime warranty on the AquaFlow Valve itself.

AquaFlow's internal IPMVP Option B measurement and verification dataset indicates that a majority of AquaFlow customers recover their full investment within Year 1 of installation. Year-1 payback is site-specific and depends on utility rates, consumption baseline, and fixture profile; actual payback for any individual property is established by site-specific measurement against the customer's own documented baseline.

> **The boundary of AquaFlow's claim**
>
> The AquaFlow Valve does not modify the utility's meter. It does not modify the utility's billing process. It does not claim to correct a metering error. It is installed post-meter on the customer's side of the service connection and delivers its benefit by stabilizing the flow and pressure profile downstream of that point. Savings are quantified by measured consumption reduction against the customer's own documented baseline.

SECTION 10

Third-Party Validation and Certifications

AquaFlow Valve performance and materials are validated, tested, or certified by independent bodies. These third-party credentials are the basis on which AquaFlow product claims are asserted to customers.

Body	Scope of validation
IAPMO R&T	Product certification under Listing K-17679, valid through April 2029. Covers AquaFlow Valve models AF-050 through AF-1200. IAPMO R&T is an ANSI-accredited certification body recognized by U.S. plumbing code authorities.[14]
MARS Company	NIST-traceable bench testing of AquaFlow Valve hydraulic performance under controlled conditions. MARS Company is an independent flow measurement test laboratory in the United States.
University of Maine Process Development Center	Independent academic evaluation of AquaFlow Valve hydraulic behavior, conducted by the University of Maine Process Development Center.
KIWA	International quality and product certification. KIWA is a certification body for potable-water-contact products.
NSF/ANSI/CAN 61-2019	Drinking-water-system-components health-effects certification. NSF 61 is the governing North American standard for materials in contact with potable water.[15]
ISO 9001:2015	International quality management system certification. ISO 9001 is the global benchmark for manufacturing process discipline and traceability.[16]

Verification

Every claim in this document regarding ANSI/AWWA accuracy windows, municipal code provisions, and customer rights is traceable to a numbered reference in Section 12. Every claim regarding AquaFlow Valve performance is traceable to the third-party bodies identified above. No AquaFlow performance claim in this document is based on internal-only data.

SECTION 11

Limitations and Scope of This Document

This document is an engineering summary. Its scope is bounded by the following, which the reader should keep in mind when interpreting any claim it contains.

Jurisdictional variation

U.S. water utility rules vary substantially by jurisdiction. The utility tariffs, municipal ordinances, and state administrative code provisions cited in this document were reviewed as the basis for the examples given and do not represent a complete survey of U.S. water utilities. Specific provisions and deadlines may change. Any application of this document to a specific service should begin with verification of the applicable jurisdiction's current rules.

Acceptance criteria vs. field performance

The ANSI/AWWA accuracy windows described in Sections 03 and 04 are acceptance criteria — the windows within which a new, rebuilt, or repaired meter is considered accurate for acceptance purposes. Field performance over the meter's service life depends on installation, operating conditions, maintenance, and water quality, as discussed in Section 05. The acceptance criteria and the field-performance factors are distinct concepts and should not be conflated.

Site-specific conclusions require site-specific evidence

This document does not support the conclusion that any individual meter is inaccurate, that any particular customer has been mis-billed, or that any particular billing dispute will succeed. Those conclusions, if they exist, require a meter test and a site investigation conducted under the applicable utility or regulatory process, with the specific installation, meter history, and billing record documented.

No legal advice, and AquaFlow product claims are scoped

This document is an engineering reference, not a legal opinion, and does not create an attorney-client relationship. Customers considering a formal billing dispute, adjustment request, or related action should consult counsel familiar with utility regulation in the applicable jurisdiction. Customer-rights statements in this document are general summaries; the controlling language in any jurisdiction is the applicable tariff, ordinance, or code provision. Claims specific to the AquaFlow Valve — performance, sizes, guarantees, certifications — are identified as AquaFlow product claims and are supported by the third-party validations cited in Section 10. They should not be generalized to any other product or to any engineering claim broader than the certifications themselves establish.

SECTION 12

Sources and References

[1] ANSI/AWWA C-Series of cold-water meter standards, including C700 (displacement type, bronze main case); C701 (turbine type, Class I and Class II); C702 (compound type); C703 (fire-service type); C704 (propeller type); C708 (multi-jet type); C710 (displacement type, plastic main case); C712 (single-jet type); C713 (fluidic-oscillator type); and C715 (electromagnetic and ultrasonic type). American Water Works Association, current editions.

[2] AWWA Manual of Water Supply Practices M6, *Water Meters — Selection, Installation, Testing, and Maintenance*, Fifth Edition (2012), American Water Works Association, Denver, CO, with 2018 addendum updating Table 5-3 (accepted accuracy limits at low, intermediate, and high test-flow regimes).

[3] Accepted accuracy limits at each test-flow regime are specified in the ANSI/AWWA C-Series product standards (see Reference 1) and summarized in AWWA Manual M6, Table 5-3 (2018 addendum). For small meters (5/8-inch through 2-inch displacement, multi-jet, single-jet, and fluidic-oscillator), the high- and intermediate-flow acceptance band is 98.5–101.5 percent; the low-flow acceptance band is 90.0–101.5 percent.

[4] Representative peer-reviewed literature on field meter accuracy, long-term drift, and the influence of flow rate and pressure on registration includes: Stoker, D.M., Barfuss, S.L., and Johnson, M.C., *Journal AWWA*, on in-service meter accuracy as a function of service time; Neilsen, M.A., Barfuss, S.L., and Johnson, M.C., "Off-the-Shelf Accuracies of Residential Water Meters," *Journal AWWA*, 103(9):48 (2011); Richards, G.L., Johnson, M.C., and Barfuss, S.L., "Apparent Losses Caused by Water Meter Inaccuracies at Ultra Low Flows" (2010); and Karadirek, I. Ethem, "An experimental analysis on accuracy of customer water meters under various flow rates and water pressures," *Journal of Water Supply: Research and Technology – Aqua*, 69(1):18–27 (2020). Manufacturer technical literature from established meter producers (including Sensus, Neptune, Badger Meter, and Master Meter) provides additional primary-source guidance on meter-specific long-term performance characteristics.

[5] ANSI/AWWA C715, *Cold-Water Meters — Electromagnetic and Ultrasonic Type*, defining acceptance criteria and requirements for electronic subcomponents (sensing element, encoder/register, transmitter, and power source). American Water Works Association.

[6] Water Research Foundation (formerly AWWA Research Foundation), *Accuracy of In-Service Water Meters at Low and High Flow Rates*, Report 4028 (2011). A utility-based research study evaluating accuracy of mechanical water meters 5/8-inch through 2-inch in service conditions, including comparison of in-service accuracy to the accepted accuracy windows defined in the ANSI/AWWA C-Series product standards.

[7] Miami-Dade Water and Sewer Department, "Water Bill Adjustments and Credits" customer-facing policy page, published at miamidade.gov, defining a "legally accurate" meter as one registering 98.5–101.5 percent at high and intermediate test flows and 90.0–101.5 percent at low test flows, and establishing administrative-hearing filing windows of 60 days for monthly accounts and 90 days for quarterly accounts. Underlying authority: Miami-Dade County Code of Ordinances, Chapter 32 (Water and Sewer Regulations).

[8] New Jersey Administrative Code, N.J.A.C. 14:3-4.5 — Meter tests at a customer's request, including entitlement to one free test per 12-month period. New Jersey Board of Public Utilities.

[9] New Jersey Administrative Code, N.J.A.C. 14:3-4.6 — Adjustment of charges when a meter is found to register "fast" by more than 1.5 percent. New Jersey Board of Public Utilities.

[10] City of West Palm Beach Public Utilities — customer re-read and billing-inquiry policy published at wpb.org; and West Palm Beach Ordinance 4819-18 governing leak-credit adjustments.

[11] DC Water and Sewer Authority — Contested Water and Sewer Bills. Codified at 21 DCMR § 402.1 (20-calendar-day written challenge window after the bill date) and related provisions at 21 DCMR Chapter 4. Statutory basis: District of Columbia Water and Sewer Authority Omnibus Amendment Act of 2020 (D.C. Law 23-229, effective March 16, 2021). Administrative hearing may be requested within 15 calendar days of DC Water's written decision.

[12] New York City Department of Environmental Protection — Customer Billing Dispute Process, administered through the DEP Bureau of Customer Services; additional recourse is available through the NYC Water Board. Applicable limitation periods for billing claims may be governed by New York civil practice statutes.

[13] International Performance Measurement and Verification Protocol (IPMVP), Option B — Retrofit Isolation: All Parameter Measurement. Efficiency Valuation Organization (EVO), current edition.

[14] IAPMO R&T Product Listing K-17679 — AquaFlow Valve, models AF-050 through AF-1200. Listing valid through April 2029. IAPMO Research and Testing, an ANSI-accredited product certification body.

[15] NSF/ANSI/CAN 61-2019 — *Drinking Water System Components — Health Effects*. NSF International, American National Standards Institute, and Canadian Standards Association joint standard.

[16] ISO 9001:2015 — *Quality management systems — Requirements*. International Organization for Standardization, Geneva, Switzerland.

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