Built to Stay Accurate

How Even Compression, Chloramine-Resistant Silicone, and an Oversized Outlet Gasket Protect Revenue Over the Service Life of the RG3 Perpetual® PD Meter

RG3 Meter Company • Longview, Texas

A technical discussion for utilities, engineers, and meter buyers

Executive Summary

A water meter earns its keep not on the day it is installed but across the decades it spends in the ground. A well-built positive displacement meter has a mechanical service life that reaches well beyond 25 years — field regressions extend toward 30 — yet most units are pulled at 15 to 20 years, not because the mechanism failed but because accuracy economics said it was time. The figure that matters to a utility, then, is not as-new accuracy — nearly every approved displacement meter passes that test — but how long the meter stays accurate enough to keep earning: how slowly it gives up low-flow accuracy and how well it resists the internal leakage paths that let water slip through unmetered as it ages. Water that passes unmetered is apparent loss, and apparent loss is one of the largest controllable components of non-revenue water (NRW).

The RG3 Perpetual® positive displacement meter is engineered around that reality. Three design decisions work together to attack the mechanisms that degrade a displacement meter over time: uneven clamping that distorts the measuring chamber, chemical attack on the meter's sealing elements, and the gradual loss of seal force that opens a bypass path at the chamber outlet. A fourth feature — vibration and acoustic isolation of the measurement mechanism — protects the meter from its own running wear. The design is protected by a layered patent portfolio: two utility patents and one design patent.

In short: **a patented boltless brass main case applies a full 360° of uniform compression so the chamber never deforms; every sealing element is 100% silicone, the most chloramine-resistant common elastomer, so the seals do not harden, crack, or swell as disinfection chemistry changes; and an intentionally oversized silicone outlet gasket carries enough reserve sealing force to keep the chamber outlet closed for the life of the meter, even after years of stress relaxation.** This is exactly where competitive meters are most exposed: the prevailing industry outlet seal is a thin, square-section nitrile gasket that embrittles and cracks over time, opening the bypass path that quietly feeds non-revenue water. The net result is a meter that holds its low-flow accuracy and minimizes slip far longer than conventional designs — which is why RG3 backs it with a 10-year new-meter accuracy warranty and a 25-year main case warranty.

The Perpetual® at a Glance

Meter type	Oscillating-piston positive displacement (PD) cold-water meter
Representative model	Perpetual® PPD07, 5/8" x 3/4" (DN 15 mm); full size range available
Main case	Patented boltless low-lead brass body applying 360° uniform compression on the measuring chamber
Chamber mounts	100% silicone (top and bottom), isolating the measuring element from stress and vibration
Outlet seal	Oversized 100% silicone gasket sealing the chamber outlet to the machined brass body
Reading / network	All endpoints of any manufacturer that accept industry standard protocols, as well as touch coupler, and manual read registers
Patents	U.S. 9,568,351 & 10,006,794 (utility); U.S. D814,951 & D680,457 (design). Owner: RG-5 Company, LP
Warranty	10-year new-meter accuracy warranty; 25-year main case warranty

Why Displacement Meters Lose Money as They Age

Revenue is lost at the low end of the flow range. A running toilet, a dripping fixture, or a slow continuous draw produces exactly the low flow rates where meter registration is hardest to sustain. A meter that drifts even slightly low at these flows quietly under-bills every account it serves, every hour, for years.

In an oscillating-piston displacement meter, accuracy depends on a simple principle: a precisely sized chamber traps a fixed volume of water with each cycle of the piston, and every cycle is counted. Accuracy degrades when water finds a way to pass through the meter without completing a full, counted displacement — a phenomenon called slip or bypass. Importantly, this error is one-directional. A displacement meter cannot over-register, because it cannot count volume it never displaced; as it ages, it can only read correctly or read low. Every dollar of aging error therefore comes out of the utility's revenue, not the customer's pocket, and it accumulates as apparent loss in the utility's water balance.

Three mechanisms open those bypass paths over a meter's service life, and each maps directly to one of the Perpetual's design features:

- **Chamber distortion** from uneven mechanical clamping, which changes the piston-to-wall clearance.
- **Chemical degradation** of elastomer seals exposed to chloramine and oxidizers in the water.
- **Loss of seal force** at the chamber outlet as gaskets take a permanent set, embrittle, and eventually crack.

1. Even, Boltless Compression: A Chamber That Stays Round

The Perpetual builds on the oscillating-piston displacement principle that has measured residential water reliably for decades and is codified in AWWA C700. Rather than reinvent a sound measuring concept, RG3 took that proven foundation and focused its engineering on the specific mechanisms that cause even good displacement meters to lose accuracy as they age — starting with how the measuring chamber is held.

Most displacement meters clamp the measuring chamber with a bolted bottom plate — a leading competitor's own patent describes the typical arrangement exactly: a cast-iron bottom plate fastened to the meter casing with four bolts. Bolts concentrate load at discrete points. As those points are torqued — and as the assembly is later subjected to thermal cycling, water-hammer, and freeze events — the chamber is loaded unevenly. Even a few thousandths of an inch of out-of-round distortion changes the clearance between the oscillating piston and the chamber wall. Too tight, and the piston binds and the meter stalls at low flow; too loose, and water slips past the piston without being counted. Either way, low-flow accuracy suffers — a failure mode competitors acknowledge in their own patents, which note that compressing the chamber too tightly affects accuracy and can bind the piston.

The Perpetual eliminates the point-loading problem at its source by doing away with the bolt pattern entirely. Its patented boltless brass main case applies a continuous 360° of uniform compression around the full circumference of the measuring element, rather than clamping it at a handful of bolt locations. The chamber is held round and concentric, and the piston-to-wall clearance stays uniform around the entire bore. Because the closing load is distributed rather than concentrated, the design avoids the bolt-induced deformation that drives early low-flow drift — the geometry the meter leaves the factory with is the geometry it keeps. The boltless construction and its accuracy are protected under U.S. Patent 9,568,351, with the boltless meter form further protected by design patent U.S. D680,457 and the chamber geometry by design patent U.S. D814,951.

2. Chloramine-Resistant 100% Silicone Sealing Elements

Disinfection chemistry has changed under the industry's feet. To meet tighter disinfection-byproduct limits, a large and growing share of U.S. systems have switched from free chlorine to chloramine, which is more persistent in the distribution system and considerably more aggressive toward elastomers. Total residual levels under chloramination commonly run several times higher than the free-chlorine residuals meters were historically designed around.

This matters because the sealing elements inside a meter are elastomers, and not all elastomers tolerate chlorinated water. Nitrile rubber (NBR) — long the default low-cost sealing material — is a poor performer in both chlorinated and chloraminated water; both disinfectants oxidize the rubber. The result is something most operators have held in their hands: pull a meter that has been in service for years and the nitrile seal has hardened and cracked, shedding a black, sooty residue that transfers to the skin and is stubborn to wash off. That visible breakdown is the seal failing — as nitrile degrades it stops conforming to its sealing surface, and a bypass path opens. Independent elastomer testing programs consistently rank silicone (VMQ) at the top for chlorine and chloramine resistance, ahead of even EPDM, the material many utilities adopted specifically to escape nitrile's oxidation problem.

The Perpetual uses 100% silicone for every sealing element — both the top and bottom chamber mounts that isolate the measuring element from assembly stress, and the outlet gasket. Silicone's silicon-oxygen backbone is fundamentally more resistant to oxidative attack than carbon-backbone rubbers, so the seals do not harden, craze, or swell as the meter sits in chloraminated water year after year. They stay resilient, and a resilient seal keeps sealing.

How the common sealing elastomers compare

The following qualitative comparison reflects the consensus of published elastomer-compatibility and seal-testing literature for potable-water service. Ratings describe relative performance, not pass/fail; properly compounded grades of each material vary.

Property (potable-water service)	Nitrile (NBR)	EPDM	Silicone (VMQ)
Chlorine / chloramine resistance	Poor	Good*	**Excellent**
Long-term sealing-force retention	Fair	Good	**Excellent**
Compression-set recovery	Fair	Good	**Excellent**
Resistance to embrittlement / cracking	Poor	Good	**Excellent**
Ozone / UV resistance	Poor	Excellent	**Excellent**

** EPDM resists chloramine well only when correctly compounded (typically peroxide-cured); some EPDM grades swell or deteriorate in chloraminated water. Silicone's advantage is more consistent across formulations.*

One honest caveat keeps this defensible: silicone has lower tensile, tear, and abrasion strength than nitrile. That is a real tradeoff — but it is irrelevant in this application. The Perpetual's silicone elements are **static seals**, clamped in place and not subjected to sliding or abrasion. In static sealing service the properties that matter are chemical resistance and long-term recovery, and those are precisely silicone's strengths. The material is matched to the job.

3. The Oversized Outlet Gasket: Closing the Bypass Path for the Life of the Meter

The chamber outlet is the highest-stakes seal in the meter. It is the boundary the full displaced volume must cross on its way to being counted. If a leak path opens there, water bypasses the register and the utility never bills for it. This is the seal most likely to fail quietly and the one whose failure costs the most.

The aging mechanism that opens this path is well understood: compression set and stress relaxation. Every clamped gasket is installed under compression, and that compression generates the sealing force that holds the joint closed. Over time, an elastomer under sustained load slowly takes a permanent set — it stops pushing back as hard as it did when new. As sealing force decays, and as the surrounding brass expands and contracts through thermal and pressure cycles, a marginally sized gasket can relax just enough to let a thin film of water slip past the chamber outlet. The meter still runs; it simply stops counting all the water.

RG3 attacks this in two complementary ways. First, the outlet gasket is 100% silicone, the elastomer with the best long-term sealing-force retention of the common materials — its relaxation behavior is dominated by stable physical mechanisms rather than the chemical breakdown that degrades carbon-backbone rubbers, so it holds its load remarkably well over decades. Second, and just as important, the gasket is deliberately oversized relative to the joint it seals. The extra cross-section and sealing area build in a reserve of compression: even after the gasket has given up some of its original height to permanent set, there is still ample residual sealing force pressing it against the machined brass body. The seal does not depend on staying near its as-installed dimension to keep working.

The combination is what makes the claim hold up. A standard-sized gasket of an ordinary elastomer starts with limited sealing-force margin and loses it relatively quickly. An **oversized silicone** gasket starts with a large margin and gives it up slowly. The bypass path that would open in a conventional meter as it ages simply does not get the chance to open in the Perpetual.

4. The Industry's Weak Point: The Thin Square Nitrile Outlet Gasket

The sharpest contrast between the Perpetual and competitive PD meters is at this same outlet seal — because that is precisely where the rest of the industry is most exposed. The prevailing approach uses a thin sealing ring of substantially square or rectangular cross section, seated in a channel around the chamber outlet and molded from nitrile rubber (Buna-N).

This is not speculation about competitors; it is documented in their own patents. Master Meter's "Positive Displacement Meter Seal Scheme" (U.S. Patent 7,493,811 B2; inventors Ronald N. Koch and James L. Rogers) specifies exactly this design — a substantially rectangular sealing ring of square cross section, constructed of an elastomeric material such as Buna-N (NBR) or EPDM, set into a channel around the chamber outlet.

Two weaknesses compound in that design. First, the material: nitrile is a poor performer in chlorinated and chloraminated water. Over years of exposure it hardens, loses resilience, and embrittles — reaching the cracked, crumbling, black-residue state operators know from old meters — and a thin cross section gets there fastest, because there is little material to lose before the seal can no longer conform. Second, the geometry: a thin square gasket carries little reserve sealing force, so once it takes a set and starts to crack, a leak path opens quickly around the chamber outlet.

Once that path opens, water passes the chamber without being fully registered. This is precisely the kind of apparent loss that drives non-revenue water in aging PD meter populations, and it is most damaging at low flow, where the legitimately registered volume is small and any leakage is a large fraction of the reading. A utility running an aging fleet of square-nitrile-sealed meters is, in effect, slowly losing revenue through cracked gaskets it cannot see.

The Perpetual answers both weaknesses at once. Its outlet gasket is oversized, carrying a large reserve of sealing force that survives years of stress relaxation, and it is 100% silicone, which does not embrittle or crack in chlorinated or chloraminated water. The seal neither relaxes below its sealing threshold nor cracks — so the bypass path that opens in a thin-nitrile design simply does not develop, and the meter stays accurate longer.

5. Vibration and Acoustic Isolation: Protecting the Measurement From Itself

An oscillating-piston meter is a mechanical system, and mechanical systems generate vibration and structure-borne (acoustic) noise as they run. Left uncontrolled, that energy couples into the measuring element and the register train, where over years it contributes to wear, fatigue, and small measurement disturbances. The Perpetual's chamber is designed to damp and isolate this vibration and noise from the measurement mechanism, a feature protected under U.S. Patent 10,006,794.

The 100% silicone chamber mounts do double duty here: silicone is an effective vibration isolator as well as a chemically stable seal, so the same components that protect the measuring element from assembly stress also decouple it from operating vibration. The payoff is twofold — longer accurate service life and lower maintenance — and both compound with the accuracy-preservation features above.

Layered Patent Protection

The Perpetual's longevity features are not only engineering claims; they are protected intellectual property. RG3 Meter Company holds a portfolio that covers the meter from several independent angles — the boltless construction and its accuracy, anti-wear vibration damping, the boltless meter form, and the measuring-chamber geometry — pairing utility and design patents so the meter is materially harder for a competitor to design around than any single patent could make it.

Patent	What it protects, and why that matters
U.S. 9,568,351 Water Meter Technology *(utility, issued 2017)*	The boltless positive-displacement construction and its measurement accuracy. A utility patent protects function — how the meter achieves and holds accuracy — not merely appearance, which is the form of protection hardest for a competitor to design around.
U.S. 10,006,794 Perpetual Meter with Noise Damping *(utility)*	A chamber design that isolates mechanical vibration and acoustic noise from the measurement mechanism. Decoupling the measuring element from operating vibration reduces wear and measurement disturbance, extending accurate service life and lowering maintenance.
U.S. D814,951 Perpetual Meter Chamber *(design)*	The physical geometry of the measuring chamber engineered for extended service life. A design patent grants exclusive rights to that specific chamber configuration, closing the door on direct geometric copying.
U.S. D680,457 Water Meter — boltless meter *(design, acquired)*	The boltless meter configuration itself. This design patent adds a second layer of protection around the bolt-free case that makes 360° uniform compression possible.

All patents are owned by RG-5 Company, LP (dba RG3 Meter Company). Refer to the granted patents for definitive claim scope.

Why the Features Compound

Treated separately, each feature addresses one failure mode. Treated together, they close the loop on long-term accuracy. Even compression keeps the measuring chamber dimensionally stable, so the piston-to-wall clearance that defines accuracy does not drift. Silicone keeps every sealing element chemically intact in modern chloraminated water, so the seals that hold that geometry together do not degrade. The oversized silicone outlet gasket keeps adequate sealing force on the most critical joint long after a thin nitrile gasket would have relaxed and cracked. And vibration isolation protects the whole mechanism from its own running wear.

Remove any one of them and the others are undermined: a perfectly round chamber still leaks if its outlet seal relaxes; a great seal material still fails early if the gasket is undersized; and the best gasket in the world cannot rescue a chamber distorted by uneven clamping. The Perpetual is designed so that the mechanical, chemical, sealing, and anti-wear defenses all hold for the same long service life — which is the only way a meter actually stays accurate in the ground rather than just on the test bench. Just as important, the Perpetual's read architecture never traps that durability behind a failing battery. The Optical encoder register has no battery to fail at all. The Tesla 4 drive-by register does carry a battery, but it can be replaced in the field without removing the meter from service, so the mechanism keeps measuring through several endpoint cycles. Contrast that with a static meter, where the register, radio, and measuring element all draw from the same power source and reach end of life together — when the battery is done, the whole meter is done. With the Perpetual, the electronics are renewed on their own cycle while the boltless, silicone-sealed mechanism runs on toward its full 25-plus-year mechanical life. RG3's 10-year accuracy warranty and 25-year main case warranty are the company's expression of confidence in that system.

Conclusion

Long-term revenue accuracy in a displacement meter is a durability problem, not an out-of-the-box-accuracy problem. The Perpetual’s design choices — 360° uniform compression, 100% chloramine-resistant silicone sealing, an oversized outlet gasket with reserve sealing force, and vibration isolation of the measurement mechanism — are each aimed at a specific, well-documented mechanism by which meters lose accuracy as they age. Where the rest of the industry relies on a thin square nitrile gasket that embrittles and cracks, the Perpetual keeps the chamber round, the seals intact, and the bypass path closed for the service life of the meter — protecting the utility's revenue where it is most easily lost: at low flows, and over the long horizon.

Technical basis

Material-performance statements draw on published elastomer-compatibility and seal-testing literature, including chloramine-resistance evaluations of EPDM, VMQ (silicone), and NBR for potable-water service; ASTM D395 compression-set and ISO 3384 compression-stress-relaxation characterizations of these elastomers; and AWWA M75 (Elastomers for Waterworks) guidance on chloramine effects. Displacement-meter performance principles follow AWWA C700 for oscillating-piston cold-water meters. The competitor outlet-seal and bolted-bottom-plate design is documented in U.S. Patent 7,493,811 B2 / Canadian Application 2,532,876 (“Positive Displacement Meter Seal Scheme,” Koch and Rogers, assigned to Master Meter Inc.). RG3 patents — U.S. 9,568,351 (“Water Meter Technology”), U.S. 10,006,794 (“Perpetual Meter with Noise Damping”), U.S. D814,951 (“Perpetual Meter Chamber”), and U.S. D680,457 (“Water Meter,” boltless meter) — are owned by RG-5 Company, LP (dba RG3 Meter Company).