kamstrup

The Cost of Quality

Exploring Why Quality Is Kamstrup's Top Priority – And Why It Should Be Yours Too

by Jake Piccioni, Kamstrup

Part 1 Quality by Design

INTRODUCTION

A HISTORY OF COMPROMISE - AND THE NEED FOR CHANGE

Quality starts with design. For decades, water utilities have operated in a challenging reality. Where meter failures, degrading performance and costly replacements have come to be expected. From mechanical meters with worn internal parts to static meters plagued by water intrusion and fragile components, the industry has treated quality as an afterthought rather than a foundation for far too long.

Warranty replacement programs can help ease the sting of a failed meter. Still, they do not address the operational strain, including truck rolls, labor costs, lost data, and erosion of trust between utilities and vendors. Behind each failure is a design flaw—a compromise that passes unnoticed until it reaches the field.

Quality issues affect meters of all types. Mechanical meters, for instance, suffer from accuracy degradation as moving parts wear down over time, with the greatest accuracy loss occurring at low flow rates. These meter inaccuracies lead to apparent losses and an increase in non-revenue water (NRW) for the utility, which in turn results in a loss of revenue. This loss of revenue often destabilizes rates as utilities are forced to increase rates to account for that loss of revenue. The inherent accuracy issues with mechanical meters have led many utilities to begin using static meters—both electromagnetic and ultrasonic.

However, static meters are not immune from quality concerns, either. The internal electronic components of static meters often fail due to water ingress, typically due to potting that fails over time or transducers that are press-fit through the meter body, allowing a small point of entry for moisture that leads to failure over time. Additionally, these meters often rely on separate wired radio units that come with their own set of issues. Cable terminations on meters and communication devices are prone to failure over time, with penetrations in meter housings providing yet another potential point of water intrusion. These cables are also an easy target for tampering, with cables being cut or disconnected by consumers. At a cost between $20–$80 per cable, plus the aforementioned costs to the utility to replace or repair these components, the cost of these failures adds up quickly.

All of these quality issues underscore the importance of choosing a more reliable, long-term solution that utilities can trust.

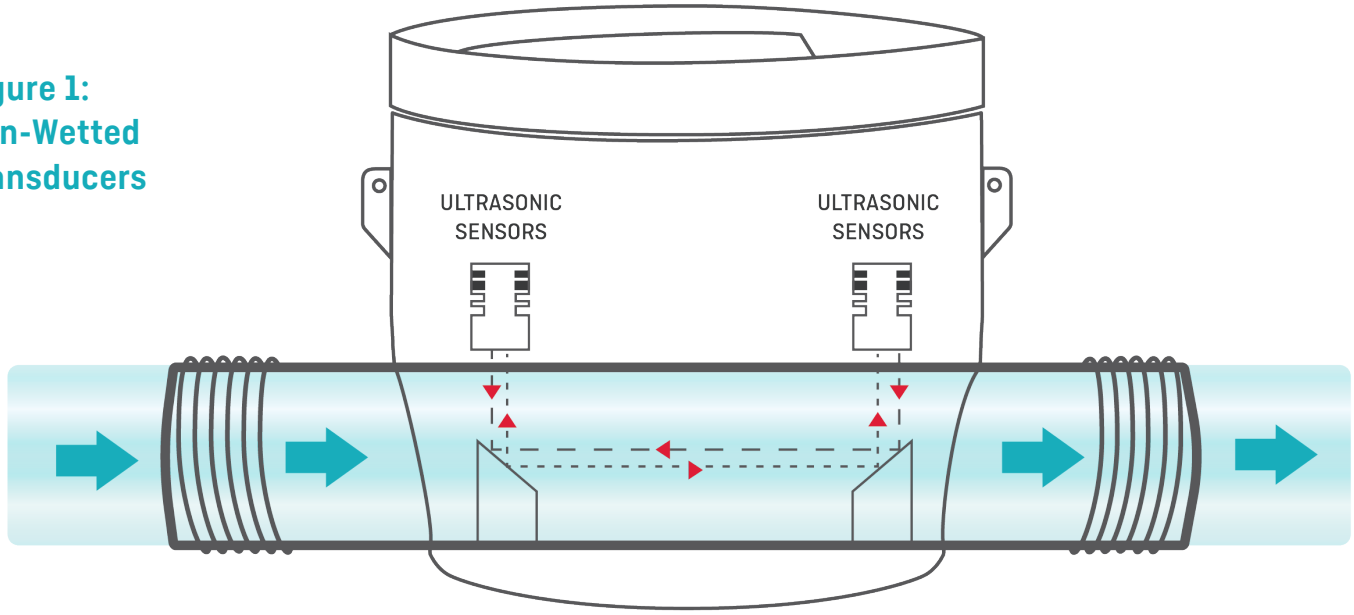
QUALITY BY DESIGN

ADDRESSING COMMON FAILURE POINTS

1. Water Intrusion

Water intrusion is the most common cause of failure in static meters. Kamstrup exclusively manufactures ultrasonic meters and has made several unique design choices to address the most common points of moisture ingress. Ultrasonic meters rely on transducers that measure the transit time between each transducer as water flows through, providing highly accurate measurements that are superior to mechanical meters and other types of static meters like electromagnetic meters. These meters are typically designed with wetted transducers that are press-fit through the meter's flow tube, providing a small but critical potential entry point for moisture that can lead to failure over time. As shown in *Figure 1: Non-Wetted Transducers*, Kamstrup's transducer design is unique as they are not press-fit into the flow tube. **This deliberate design choice prevents moisture ingress into the internal electronic components of the meter.**

Figure 1: Non-Wetted Transducers



2. Integrated Radio

In addition to the transducer design, **Kamstrup's meters utilize integrated radios and eliminate the need for multiple devices in the pit.** Most meter manufacturers rely on separate, wired radio units that attach to the meter. There may be situations where a cable makes sense, such as deep sub-basements or deep, flooded pits where radio signals are so severely impeded that an external cable is necessary to ensure reliable propagation. However, in most cases, external wiring presents more problems than solutions. Cable terminations are highly susceptible to corrosion and failure over time, and penetrations in device housings, even those that are potted, often fail. In addition, cables are prone to tampering. Cables that are cut will result in a loss of data for utilities, with costly truck rolls needed for repair. If a cable is cut—particularly one that is internally potted into a meter or endpoint—the entire device is rendered inoperable and must be discarded. These types of failures are typically not covered under warranty, leaving the utility responsible for the full cost of replacement and any associated repairs. The cost of the cables themselves, along with the cost of replacing damaged units, makes it difficult to justify choosing these units over a meter with an integrated radio.

3. Sealed Design

Static meters typically rely on potting to protect the internal electronic components of the meter from moisture ingress. While it does provide protection, potting is often just a temporary solution. All potting materials—whether hard or soft—are inherently permeable, allowing moisture to penetrate the internal components over time. **This "breathing" leads to internal condensation and eventual failure.** In addition, air pockets formed during the potting process, as well as delamination or separation between the potting material and components, create further points of vulnerability. To address these inherent flaws with potting, Kamstrup employs a fully hermetically-sealed design that eliminates the need for potting entirely. This provides an IP68 rating that allows the meter to remain fully operational underwater for the full duration of its lifespan.

SUPERIOR MATERIALS AND CONSTRUCTION

Historically, water meters have been constructed with metal bodies—often composed of brass or bronze—materials chosen for their strength and durability. But even as the industry has shifted toward low-lead brass, the presence of lead, however minimal, remains a concern. With federal mandates for lead service line inventories and replacement programs underway across the country, utilities are under increased pressure to identify and eliminate any components that could pose a risk. Beyond the health concerns, brass is a heavy material—making it expensive to ship and costly to retrieve for service or replacement. And because brass and other metals are mined from finite resources, their long-term viability as a sustainable solution is increasingly in question.

In response, many meter manufacturers began transitioning to plastic or nylon-based composite bodies. While this shift promised lighter weight and reduced cost, the industry's initial use of suboptimal polymer compounds led to well-documented failures: cracking under stress, cross-threading during installation, and premature structural degradation in the field. These early missteps left utilities skeptical of plastic-bodied meters and gave polymers a lingering reputational "black eye."

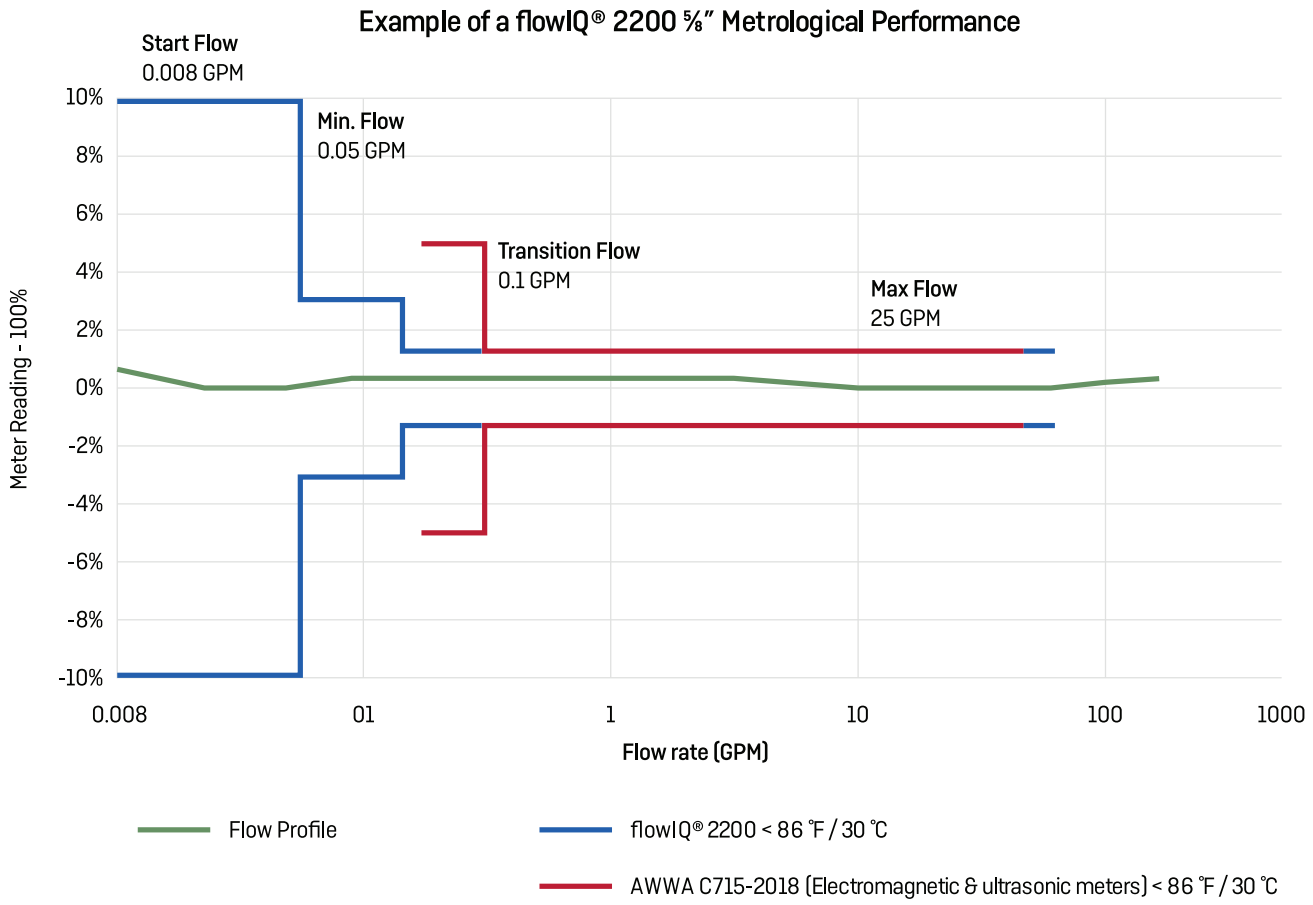
Not all polymers are created equally, and Kamstrup's approach is fundamentally different. **Kamstrup's meters are constructed with a 40% fiberglass-reinforced polyphenylene sulfide (PPS) composite, a high-performance polymer known for its exceptional chemical resistance, mechanical strength, and dimensional stability.** PPS is often referred to as "the metal of plastics" and is used in demanding industrial applications such as automotive components, aerospace systems, and chemical processing equipment. Unlike lower-grade polymers, PPS will not soften, degrade, or deform over time, even in the harshest water system environments. In addition, Kamstrup utilizes a unibody flow tube and cup to maximize the structural integrity and strength of the meter, as shown in *Figure 2: A Stronger Design.*

Figure 2:
A Stronger Design

Another design feature unique to Kamstrup is our intelligent adaptive battery optimization. With this unique feature, our integrated radios can dial their power up or down based on their reception strength, enabling meters to potentially extend their battery life beyond 20 years. This feature provides further value to the utility, extending the lifecycle of the meter and increasing the potential return on investment (ROI) for each individual unit.

The design choices that Kamstrup has made have led to a more reliable meter with impressive performance. With a return rate of just 0.25%, Kamstrup has the lowest return rate of any meter manufacturer in North America. In addition, our residential meters have a start flow of just 0.008 GPM, along with a max pressure of 250 PSI. *Figure 3: Setting The Standard* shows how our meters not only meet the AWWA C715-718 guidelines for static meters—we exceed them.

Figure 3: Setting the Standard



For decades, the water metering industry has accepted premature meter failures as unavoidable realities. These persistent challenges have placed an ongoing operational and financial burden on utilities. Kamstrup takes a fundamentally different approach by rethinking meter design from the ground up, prioritizing sealed components, durable materials, and long-term reliability over short-term fixes. The result is a metering solution that addresses the root causes of failure, rather than treating them as an inevitability. However, while design is the foundation of quality, it is only the first step. Even the most well-engineered meter will fail to meet expectations if quality is not carried through to how the meter is built. The next section will explore how Kamstrup's manufacturing approach ensures that our quality standards are upheld at every stage of production.

Part 2 Built for Quality

Kamstrup's North American HQ in Cumming, Georgia

MANUFACTURING FOR QUALITY AND THE CHALLENGES UTILITIES FACE

Quality begins with design, but it doesn't stop there. Manufacturing is where that design comes to life, and it's the next critical step in ensuring long-term meter reliability. Even the strongest of designs will falter without a strict commitment to quality control during the manufacturing process, and it is here where many of the industry's most persistent challenges emerge.

The absence of traceability is one of the most significant risks introduced by outsourcing. When meter production and assembly is outsourced to third-party remote facilities, linking a failure back to its origin becomes an extremely difficult, if not impossible task. Utilities often experience this firsthand during recalls, where manufacturers are unable to pinpoint exactly which meters are affected, resulting in mass replacements rather than targeted action. Much like failures caused by poor design, manufacturers will often replace these meters with replacement units, but the utility is left with the costs associated with replacing the meter. Not only does this erode the trust between the utility and the vendor, but these issues erode trust between the public and the utility itself, with replacements leaving residents wondering if they can truly trust the accuracy of their bill.

Another step in the manufacturing process that is crucial to ensuring quality but is often overlooked is the testing process. Too often, meter manufacturers rely on sample-based testing rather than subjecting every meter to comprehensive accuracy and durability tests. This approach leaves utilities exposed to the risk of undetected flaws entering the field, creating the same cycle of premature failures, warranty claims, and operational strain that design failures do.

Ensuring true meter reliability requires more than a sound design; it demands a manufacturing process that prioritizes control, consistency, and accountability at every stage. This is where the difference between compromise and confidence is made.

MANUFACTURING WITHOUT COMPROMISE

Over the past several decades, outsourcing has become a common strategy across U.S. manufacturing as companies sought to cut costs by moving production to countries with lower labor costs across the globe. The water meter industry is no exception, with many manufacturers shifting labor and production to third-party facilities overseas. Kamstrup takes a fundamentally different approach: all of our meters are manufactured in Kamstrup facilities. This enables us to maintain full control over every stage of production. By eliminating the uncertainty that comes with outsourcing production, we ensure complete transparency and accountability.

Our manufacturing facility seamlessly integrates robotic automation with human oversight at critical stages, ensuring consistency in our manufacturing to maintain the highest quality possible. Automation minimizes the variability associated with manual assembly, ensuring every meter is built to the exact same high-quality standard. For steps that require human interaction, extreme caution is exercised. A major point of concern in static meter manufacturing is electrostatic discharge (ESD) damage. Any movement of components can generate electrostatic charges, potentially damaging electronic components. To avoid this issue, Kamstrup follows stringent ESD protection guidelines based on the IEC 61340 and IPC J-STD-001 standards.

Kamstrup also holds multiple ISO certifications, and our ISO 9001 certification speaks to our quality management. ISO 9001:2015 specifically mentions "identification and traceability", and Kamstrup meets and exceeds the ISO standards for quality management systems.

Kamstrup's internal traceability policies and procedures enable us to keep a comprehensive upstream and downstream record of traceability for components, embedded software versions, configuration parameters, and bench measurement data for every meter. This end-to-end traceability ensures that every meter in the field can be uniquely identified and connected back to its full production history, providing utilities with exceptional transparency and the ability to resolve issues quickly and accurately.

Our manufacturing team has implemented a Root Cause Analysis process for analyzing failure reports from our production process. This process specifically targets areas with the highest disposal costs or greatest number of failures, with our team identifying issues, evaluating proposed actions, and implementing countermeasures to continuously improve our processes. Follow-up reviews are then conducted to assess the effectiveness of those measures. These high standards have led to no product recalls for Kamstrup since entering the North American market in 2013.

EXTENSIVE TESTING

Meter manufacturers have long relied on sample-based testing for their meters, meaning they only test a sample of each meter batch. In addition to this, they often test meters at one or two flow ranges. This approach to testing means that poor quality meters that would have failed testing end up being delivered to utilities with problems right out of the box.

Kamstrup ensures the reliability of every meter through rigorous testing in our ISO 17025 certified flow laboratory. Every Kamstrup meter that leaves our facility is tested at three critical flow ranges:

Minimum Flow (Qmin)	Validates performance at the lowest detectable flow rates.
Transition Flow (QT)	Ensures smooth and accurate measurements during flow rate changes.
Maximum Flow (Qmax)	Confirms reliability at peak capacities.

Our comprehensive testing ensures that every meter that leaves our facility not only meets but exceeds the AWWA C715-718 standards for ultrasonic meters. Kamstrup provides calibration certificates upon request for every meter, providing proof of accuracy without the need for additional testing.

By uniting thoughtful design with consistent, high-quality manufacturing, Kamstrup ensures that every meter delivers the durability, accuracy, and reliability that utilities expect. Yet even the most robust meter is only as valuable as the data it produces. The next section will explore how Kamstrup's approach to data quality empowers utilities to maximize operational efficiency and enhance customer trust.

Part 3 Data You Can Trust

Erroneous billing is what gets people fired...You must have accurate data. You must be able to trust the data, and your customers must be able to trust that data."

JC DAVIS
DIRECTOR OF CUSTOMER CARE & FIELD SERVICES
LAS VEGAS VALLEY WATER DISTRICT

DATA INACCURACIES AND THE ISSUES UTILITIES FACE

While precision in design, materials, and manufacturing build the foundation of a quality meter, the true value of a metering system is realized through the accuracy and reliability of the data it delivers. Historically, data collection relied on manual reads that were written down or keyed into systems, a process prone to both unintentional errors, and in some cases, deliberate manipulation. Even small inaccuracies could cascade into billing disputes and operational inefficiencies, often leading to damaged public relations and staff accountability.

Additional challenges arise with systems that use multiple devices rather than an integrated unit. Different configurations of meters and radios can compromise data accuracy and reliability, potentially introducing errors that result in incorrect readings that lead to billing errors. Some systems rely on interpolation of data rather than a true reading—for example, a radio might obtain a reading from a meter every three hours, and the reading may show 300 gallons. That system may then average that data across the previous three hours, showing 100 gallons were used per hour, rather than the true hourly consumption. Interpolation of data in this way obscures the true pattern of consumption, diminishing the analytical value of the data. These practices not only compromise data integrity but also limit the potential for proactive utility management.

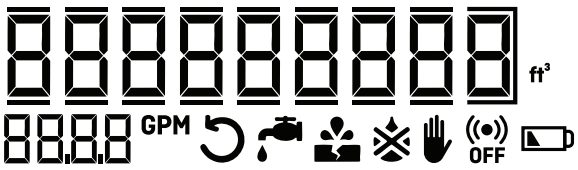
In many cases, metering solutions offer minimal data logging capabilities, and many of those that do require physical access to the meter to extract that data. This not only increases operational burden but also restricts the utility's ability to perform timely analysis or verify events after the fact. For AMR (drive-by) customers, infrequent readings—sometimes just once per quarter—can lead to prolonged leaks or anomalies on the customer side that can go undetected for weeks or months, resulting in wasted water, high bills for the resident, and reactive operations rather than proactive. Even in AMI systems with hourly readings, missed readings without an easy way to backfill or obtain data logs can lead to the aforementioned issues.

> *"Having the knowledge... the data... to present to either council, the customers, us, just to see how things work. It's just really cool...But just hearing the residents and just how grateful and how thankful...Especially the seniors. I mean, everybody's budgets are tight right now, but those who are on a fixed income, just that little bit of help goes a long way and they're extremely grateful for that."*
>
> **KATIE HARRISON**
> WATER BILLING ADMINISTRATOR
> CITY OF STREETSBORO, OHIO

THE IMPORTANCE OF RELIABLE DATA

Historically, one of the greatest challenges in data quality has been the reliance on manual entry. When meter reads are written down in the field or keyed into a system, errors—whether accidental or intentional—can easily occur. Even a single mistyped digit can create billing discrepancies, customer disputes, and a loss of trust in both the meter and utility. Kamstrup eliminates this vulnerability by ensuring that manual entries are not possible within our READy head-end system. All consumption data flows directly from the meter to the utility through encrypted data, ensuring the preservation of the integrity of the data and removing a longstanding source of inaccuracy in the process.

Another challenge with many metering systems is the reliance on multiple devices, such as a separate meter and radio, which can introduce synchronization issues, interface failures, and opportunities for data loss or manipulation. Some solutions rely on interpolation of data, averaging usage across a timespan, obscuring true usage patterns.



Kamstrup avoids these pitfalls with a single, fully integrated unit that unifies measurement and communication in one sealed device. This single unit design is crucial to maintaining data integrity, ensuring that every reading is generated, stored, and transmitted consistently without dependence on external hardware. This results in accurate, true hourly consumption data rather than derived estimates, providing extremely valuable data that can be analyzed by the utility.

Kamstrup's metering system offers great flexibility with configuration options, as well as extensive data logging capabilities. We offer utilities the ability to configure different meters in their system to different specifications, with the ability to change the unit of measurement and number of decimals for both the volume display and flow display.

In addition, utilities can configure the thresholds for the different alarms in our meters, such as the leak and burst alarms and temperature alarms. Kamstrup's flowIQ® meters also store 460 days of daily logs, along with 2400 hours (100 days) of hourly logs, and these logs are easily obtainable through radio, so there is no need to gain access to a meter and physically make contact with it. This means that even customers without an AMI solution can reap some of the benefits that come with the ability to access data with this level of granularity.

STREETSBORO, OHIO

The City of Streetsboro, Ohio faced many of the challenges that come with poor quality data with their previous metering system. These challenges led to billing disputes, a high non-revenue water (NRW) percentage, and the inability to maximize their revenue potential. With quarterly billing, customer-side leaks would often go undetected, leading to high bills, irate customers, and billing adjustments that often meant the City of Streetsboro ate the costs associated with the undetected leaks. With the challenges they were facing and a NRW percentage of 24%, they decided to make a change, switching the entire system over to a Kamstrup AMI system.

After implementing a mass meter changeout of 5,200 meters, the benefits of their new Kamstrup system quickly became apparent. In just the first half of 2025, Streetsboro had already found and repaired 17 leaks using Kamstrup's Acoustic Leak Detection feature embedded in our meters. The combination of finding those leaks and improved meter accuracy has led to a massive reduction in NRW, dropping from 24% to less than 5%. The Kamstrup system has also led to a drastic increase in revenue, as shown in *Figure 4: Streetsboro's Revenue Recovery.*

Figure 4: Streetsboro's Revenue Recovery

Q4 2023:	$920,807.89
Q4 2024	$1,023,759.70
Increase:	**$102,941.81 or 11.18%**
Q1 2024	$1,020,250.17
Q1 2025	$1,111,952.20
Increase:	**$81,702.03 or 7.93%**

> *"We're finding that because we're being proactive about the alerts we're getting, we don't seem to have as many irate customers."*

LINDA HARTMAN
WATER CLERK
CITY OF STREETSBORO, OHIO

COLUMBIA, PENNSYLVANIA

Columbia Water in Pennsylvania is another utility that has begun a gradual changeout to Kamstrup meters. Facing many of the aforementioned issues with another meter system, they decided a few years ago that it was time to "rip off the Band-Aid" and move on from their longstanding relationship with the previous manufacturer.

Initially, Columbia began with Kamstrup's encoded meters using another manufacturer's radio, but they quickly made the switch to Kamstrup's integrated meters. Beginning with an AMR drive-by system, Columbia began to explore the possibility of an AMI system and requested a propagation study from Kamstrup that showed a need for three data collectors. Columbia gradually began installing these collectors over the course of three years, one collector each year.

In late 2024/early 2025, Columbia Water faced a billing dispute with one of their largest customers. This particular meter was a 4" meter that was still in their AMR section of their system, so they did not initially have hourly or daily consumption data. Using Kamstrup's mobile READy app and converter, Columbia was able to remotely retrieve daily and hourly consumption data from this meter, which enabled them to resolve this massive billing dispute.

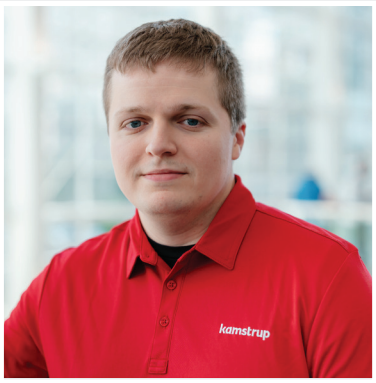
> *Kamstrup has the amazing ability to personalize individual meters for the correct application. You can manipulate the register's decimal location to get larger register readings. One of our largest customers had a billing dispute. Luckily, we had installed a new 4" Kamstrup meter the year prior. We data logged hourly data and daily data. We went to our customer with all the data proving their consumption was correct and they paid their bill in full. It was indisputable. We couldn't have done that without Kamstrup. They really got us out of a jam and had our back throughout the whole process."*

DAN ZEAMER
METER TECHNICIAN
COLUMBIA WATER COMPANY

Part 4 Conclusion

The water meter industry has long accepted compromise—whether through design flaws, poor manufacturing practices, or data inaccuracies—as an unavoidable reality. Kamstrup demonstrates that these challenges can be addressed through smarter and innovative design choices, controlled in-house manufacturing, and reliable data that cannot be manipulated. With fully sealed, durable components, a strong PPS unibody design, rigorous manufacturing standards, and extensive testing, Kamstrup minimizes failure points and places a strong emphasis on quality and reliability.

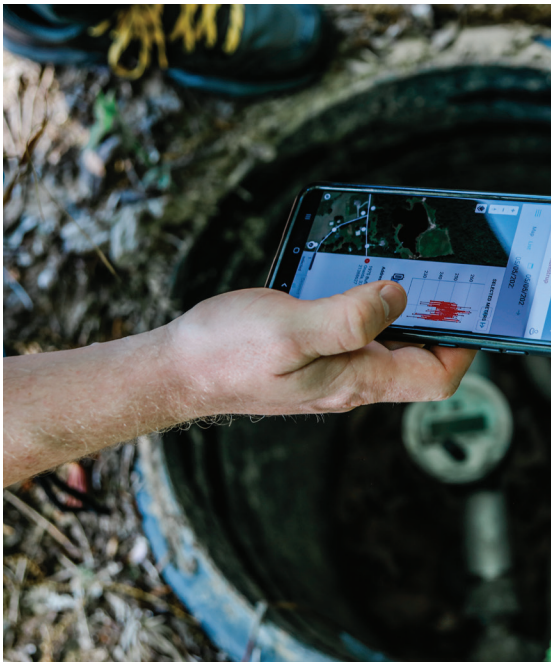
Ultimately, Kamstrup's approach proves that reliability, accuracy, and operational efficiency are not mutually exclusive. Utilities that adopt meters engineered for quality at every stage—design, manufacturing, and data—can move beyond compromise, achieving long-term performance, cost savings, and confidence in both their infrastructure and customer relationships.



JAKE PICCIONI

SOLUTIONS MANAGER, KAMSTRUP NORTH AMERICA

Jake Piccioni is Kamstrup's Solutions Manager for the Northeastern United States, providing utilities and Kamstrup's distribution partners with technical expertise and support to ensure the successful deployment of Kamstrup AMI and AMR systems. He regularly presents at industry events and brings both technical depth and practical field experience to every engagement. Prior to joining Kamstrup, Jake worked as a Meter Specialist for Core & Main, where he provided technical support to utilities deploying Kamstrup meter solutions in Pennsylvania and Delaware. Jake is based in Elizabethtown, Pennsylvania.



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