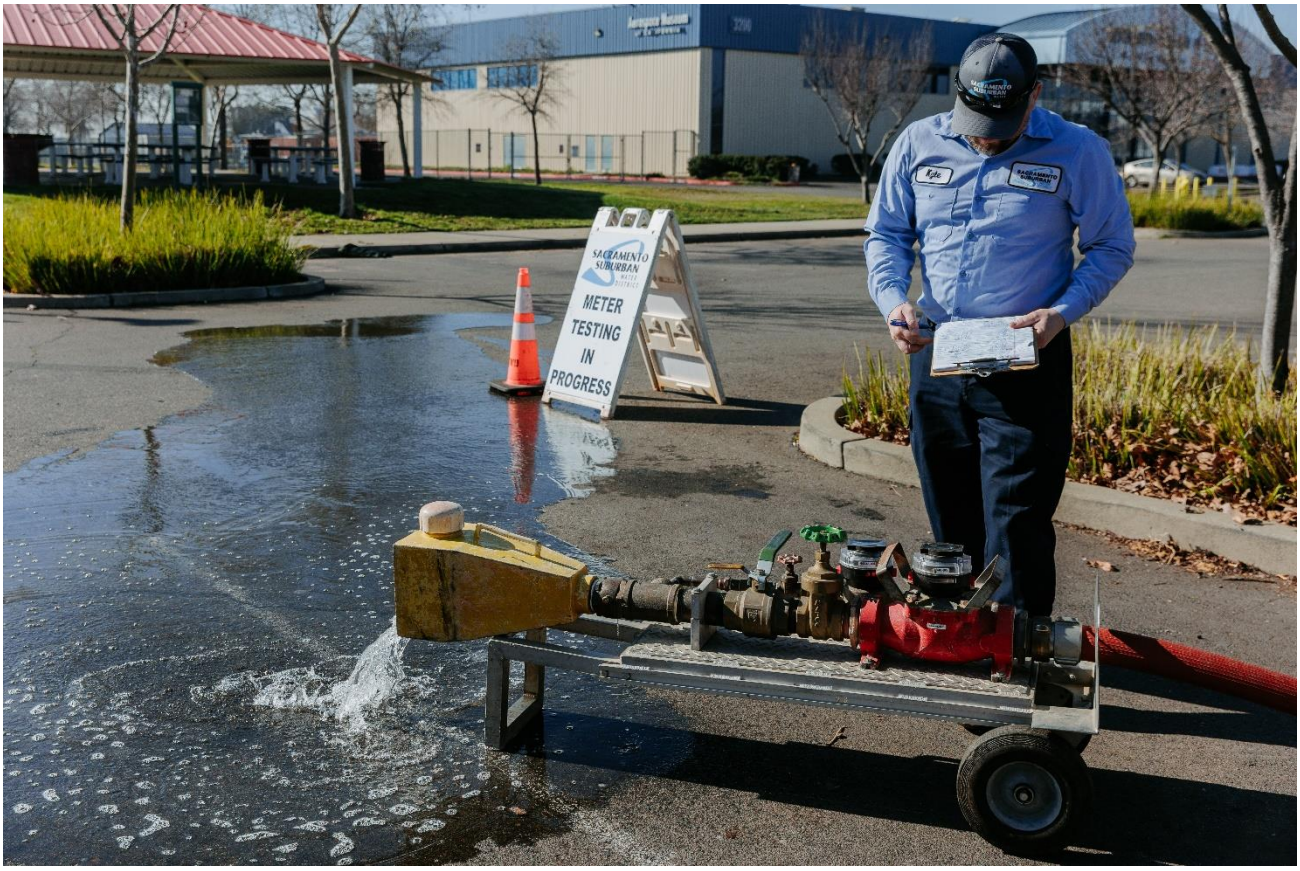
REPORT | Prepared for
Sacramento Suburban Water District



Water Meter Asset Management Plan

March 20, 2023

Final Report

Acknowledgements

Utility Metering Solutions (UMS) acknowledges the important contributions made by Sacramento Suburban Water District (SSWD) in the development of this Water Meter Asset Management Plan.

UMS recognizes the following individuals at SSWD for their assistance:

- Matt Underwood, Assistant General Manager
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Executive Summary

Throughout the process of evaluating the metering assets, the staff at SSWD has been extremely helpful and collaborative. There is ample evidence in testing records, process analysis and best practices to conclude that a strong and competent team is running a lean and efficient operation. While retirements and attrition can certainly affect future performance, the contents in this document should aid new staff members in orientation to the metering assets and the associated processes for operations and maintenance.

In addition, SSWD may leverage this report in their annual planning process to create more tactical actions around the improvement opportunities outlined in Section 9. As the system build-out reaches 100% with the Sensus and Badger networks, there will be opportunity to mine and share data at unprecedented levels. This should enable the teams in metering to deliver more value to both customers and to internal stakeholders in utility operations.

The key findings in the report include:

- The teams in Field Service and Preventive Maintenance have done an excellent job modernizing metering assets over the last several years. As such, much of the time and attention of utility was focused on selecting the right equipment, configuring it properly and installing new devices in the service territory. The focus in upcoming years should be around the optimization of the system and data usage to drive value to customers and to improve internal operations.
- The strategies and rationale behind the equipment selection from both an expansion and risk perspective are sound. The manufacturer's performance, warranty and maintenance requirements are defined and budgeted appropriately.
- The approach to ongoing O&M and staffing levels are reasonable and aligned with budget forecasts.
- The Capital expenditures outlined are appropriate to upgrade aging equipment to maintain accuracy of water consumption and reliable data transmission.
- The risks and mitigation strategies outlined in Section 8 should be considered in annual planning efforts. The list of opportunities in Section 9 provides SSWD with improvement initiatives that can be executed with internal resources or external contractors. Most of the suggestions have minor impact on budget but offer substantial benefit to the utility and should be considered in annual planning efforts.

In conclusion, the status of the metering assets, the competency of the team and the approach to meter asset planning rank among the best in the industry, including utilities with considerably more size and resources.

1. Introduction

Purpose

The purpose of this Meter Asset Management Plan (Meter AMP) is to define Sacramento Suburban Water District's (SSWD's) approach to managing metering assets. It documents current asset condition and the rationale and direction that supports the management of these assets into the future.

More specifically, the Meter AMP supports specific objectives of the utility including:

- Maximizing the performance of the district's existing metering asset investments
- Defining best-practice criteria for testing, rebuilding, and replacing meters
- Developing accurate cost models for maintenance and replacement (CIP) budgets
- Leveraging the metering assets to support conservation and customer service
- Fostering knowledge transfer from an aging workforce to the next generation of leadership

Scope

In-scope assets include metering assets for water flow measurement for: consumption meters, intertie meters, and hydrant meters. In addition, the Meter AMP includes the two primary meter reading systems referred to as Advanced Meter Infrastructure (AMI). AMI consists of meter endpoints, network devices, and related software required to monitor and transmit data related to the meter.

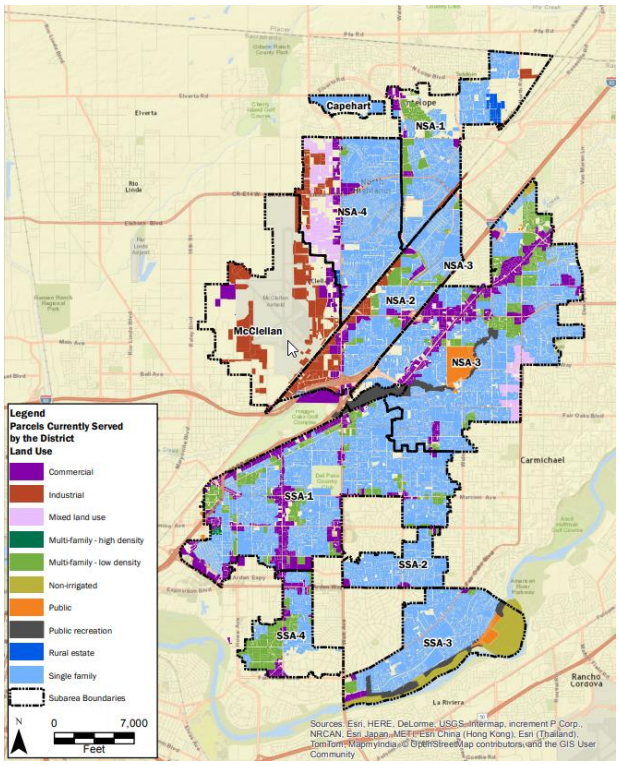
As part of the study, a high-level Application Relationship Diagram (ARD) was developed with SSWD's Information Technology (IT) department. The ARD is a visual diagram that serves to document the present asset-related systems and existing integrations that support operational activities. Supplemental documentation provides the interface name, description, data concept, transmission frequency, and transmission direction.

Utility Background

As one of the twenty-seven water purveyors for Sacramento County, the Sacramento Suburban Water District, hereby referenced as SSWD or the District, currently provides water service at approximately 47,000 service connections. The utility has a history of growth and consolidation with other utility districts that has influenced metering asset preferences and practices over time. The following chronology is provided for historical context to some of the strategies that are referenced in the plan:

- *April 1954 – Arcade Water District was established.*
- *September 1956 – Ben Ali Water Company was purchased by Arcade Water District*
- *November 1956 – Northridge Water District was established.*
- *October 31, 1986 – Arvin Water Company purchased by Northridge Water District.*
- *November 1, 1998 – Northridge Water District assumes operations of McClellan Air Force Base and Military Housing*

- *February 1, 2002 – Arcade Water District and Northridge Water District combine into Sacramento Suburban Water District.*



2. Metering Assets

Overview

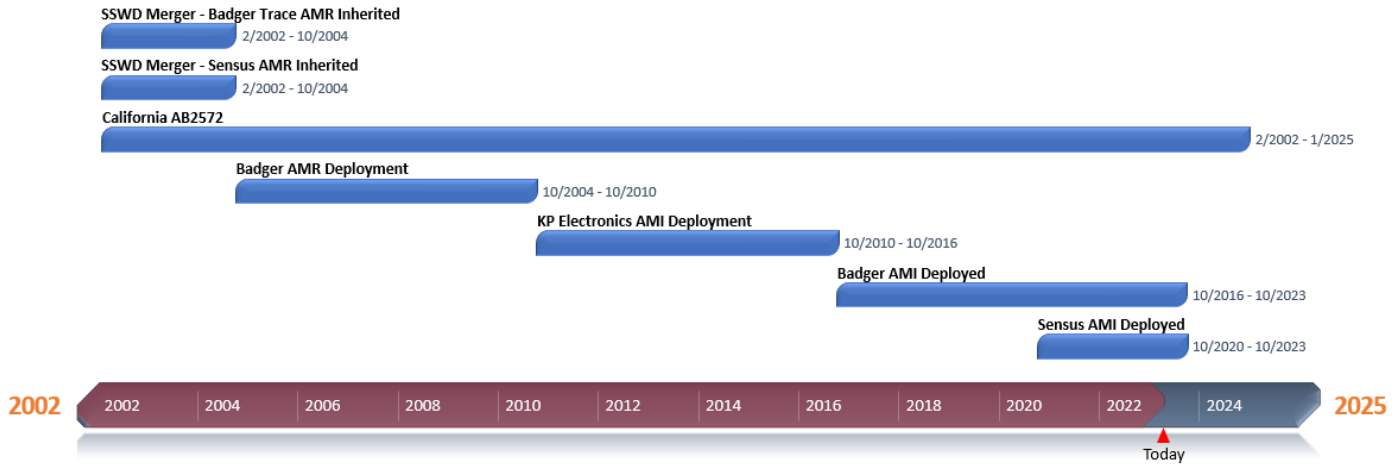
The entire metering population is described in this section. Each metering asset has an Advanced Metering Infrastructure (AMI) transmission device or Endpoint attached to it that transmits data multiple times per day over a network, which enables SSWD to monitor and track individual meter asset performance remotely. The components referenced in this section comprise the core elements of the metering asset plan.

SSWD does have an opt-out option for customers that do not want an Endpoint device monitoring their service location, but less than 5 customers have selected this option due to the additional manual read and service fees applied to non-AMI meters.

Consolidation Impacts

Figure 1.0 below provides a general timeline of events that had an impact on meter asset selection over time. SSWD assets were initially a consolidation of the Arcade Water District and Northridge Water Districts. Upon consolidation, SSWD inherited two separate Automated Meter Reading (AMR) systems – Sensus AMR via the Arcade Water District and Trace AMR via Northridge Water District.

Figure 1.0



SSWD committed to an AMI deployment of KP Electronics (subsequently acquired by Mueller Systems, LLC) in 2010 to establish a true AMI network and halted that installation in 2016 due to high failure rates, which eventually led the utility to evaluate alternative solutions. During this process, two important decisions emerged that influenced the current management approach of metering assets:

Decision 1: SSWD did not want to be dependent on a single manufacture for metering. After extensive investigation, two of the more mature products in the AMI Space—Sensus Flexnet and Badger Orion Cellular were selected. While “true interoperability” between meters and endpoints is not feasible between vendors in the industry, this two-vendor approach lowers risk and increases flexibility for SSWD. The utility is currently on a path to replace all legacy KP/Mueller equipment in 2023.

Decision 2: In parallel to the decision on vendor technologies, there was a secondary, strategic decision related to the level of advanced meter functionality that was built into the meter. For example, both Sensus and Badger offer solid state meters with advanced features such as remote shut off valves, pressure sensors and extremely low reading resolution to detect small leaks. After careful study, SSWD chose to standardize on more common Positive Displacement meters, that when paired with a reliable network, could transmit consumption, event, and alarm data into a comprehensive, "smart" software suite. While the positive displacement meters may have fewer sensors and logic onboard, the approach was to invest more heavily in software and analytics packages to "mine the value" of the meter data to achieve the desired business results. Numerous utilities have adopted this approach.

Consumption Meters

SSWD has consumption meters ranging in size from 5/8"-10". Of the active meter population, small meters (5/8"-1") make up the majority and are primarily manufactured by Badger Meter. This meter population is comprised of 5/8" Badger Recordall (Model M25), 3/4" Badger Recordall (Model M35) and 1" Badger Recordall (Model M70) positive displacement type meters.

Meters assemblies are composed of a meter body with measuring chambers and a separate High Resolution Encoder (HR-E), more commonly referred to as a register. The most common units have six digits of registration in cu-ft units. There are functional differences between electronic registers, for example between the Badger Absolute Digital Encoder (ADE), the Badger mechanical HRE, and the Badger electronic HR-E LCD. There are specific programing requirements to ensure that units of measure are properly communicated. Typically, meter bodies and registers are purchased as a single unit from the factory.

Observations, considerations, and improvement opportunities regarding consumption meters are identified in Section 9. The manufacturer's relevant installation, operations, maintenance, and warranty documents are found in Appendix A.3-Vendor Documentation.

Table 1.0 provides a breakdown of meters by size and by type of Q1/2023:

Table 1.0

Asset	Type	Quantity Deployed
5/8" Meter	Consumption Meter	2,463
3/4" Meter	Consumption Meter	37,397
1" Meter	Consumption Meter	3,727
1.5" Meter	Consumption Meter	1,031
2" Meter	Consumption Meter	1,416
3" Meter	Consumption Meter	348
4" Meter	Consumption Meter	104
6" Meter	Consumption Meter	28
8" Meter	Consumption Meter	6
10" Meter	Consumption Meter	1

3" Hydrant Meter	Hydrant Meter	54
Various Size Intertie Meters	Intertie Meter	20*

*Note that only 20 of the 48 interties are metered.

Hydrant Meters

SSWD currently owns fifty-four (54) hydrant meters that are available for District or customer use. These meters are primarily used for temporary construction purposes. Each hydrant meter has its own account in the billing system, and upon approval, the customer is responsible for paying a deposit and installing the meter on the hydrant.

The Distribution Department oversees the hydrant meter program. All hydrant meters in inventory are the 3" Badger Meter Recordall Turbine type (model 450) meter equipped with HR-E registers and backflow prevention assemblies. All hydrant meters are equipped with the Badger Orion® Cellular endpoint and are activated at the time of inventory acceptance.

Intertie Meters

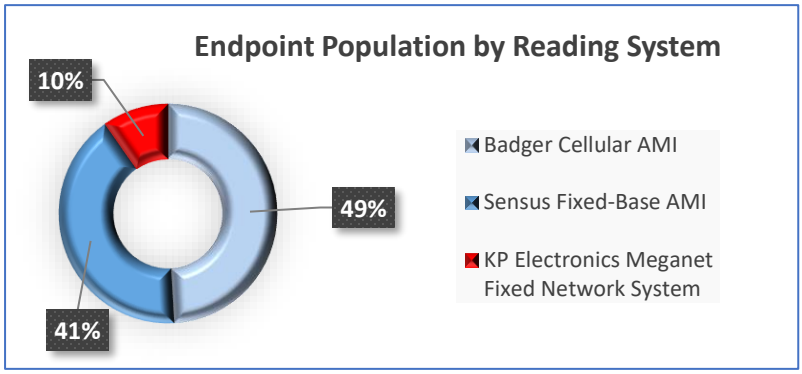
Existing interties are jointly owned by the two agencies they serve. Any costs related to improvements, such as installing meters, are a shared cost. Opening the interties requires the approval of both agencies.

Intertie valves allow adjoined districts to share water and track consumption when metered. Tied districts can request interties to be opened. Written agreements exist with the adjoining districts for emergency or special situation usage. Of the forty-eight (48) currently active interties, twenty (20) are metered. These meters are vaulted and are part of the physical infrastructure.

AMI Systems (Endpoints, Network Devices, Software)

Since metering assets are being monitored through AMI devices, a "best practice" is to include the AMI system as a part of the Meter AMP. The following section provides the current state of those devices.

There are currently three separate AMI systems in place that transmit interval and billable reads to the utility. The current meter reading landscape is comprised of the Mueller Systems (Mueller) Meganet fixed-base AMI system, Badger Orion cellular AMI system, and Sensus FlexNet® fixed-base AMI system.



Deployed in October of 2010, the Mueller Meganet reading system is a proprietary fixed-based AMI system acquired by Mueller Systems from KP Electronics in 2017. Shortly after deployment, SSWD began to experience mass reading failures with this system. The Meganet AMI system is currently reading approximately 3,000 remaining endpoints and is being phased out of operation. For the purposes of this report, detailed analysis of the Meganet components was intentionally omitted since the equipment is being phased out.

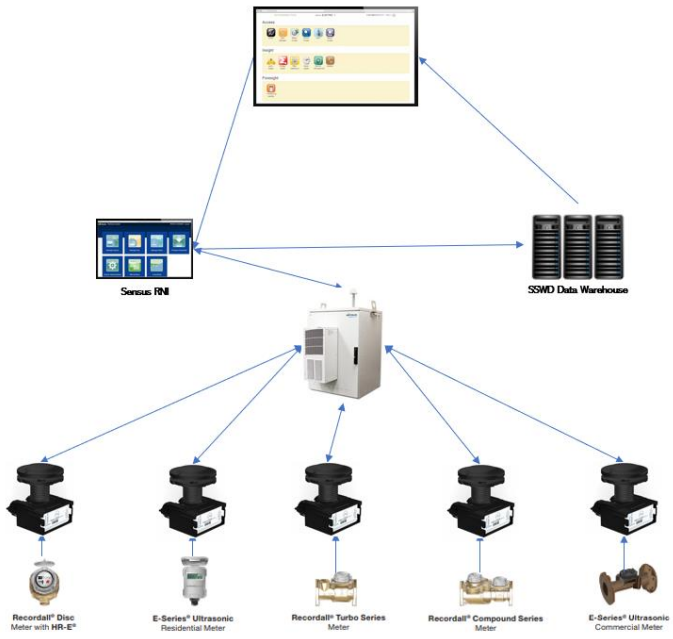
Full decommissioning of this read system is expected to be complete by the end of 2023. It is anticipated that all remaining Meganet endpoints will be replaced with Sensus FlexNet SmartPoints. After the Meganet decommissioning and FlexNet SmartPoint retrofitting, SSWD will have roughly a 50/50 percent split between the Badger and Sensus meter reading systems as planned.

The following table lists the components of the current AMI meter reading networks:

Meter Reading Network Assets Table 2.0				
Endpoints				
Asset	**Manufacturer**	**Model**	**Approx. Quantity Deployed**	**Average Age**
Endpoint	Badger	Orion Cellular Endpoint	22,600	6
Endpoint	Sensus	Sensus Smart Point	19,500	3
Endpoint				
Collector Stations				
Asset	**Manufacturer**	**Model**	**Approx. Quantity Deployed**	**Average Age**
Base Station	Sensus	R-100	5	3
Base Station	Sensus	M-400	4	3

Sensus FlexNet AMI Reading System

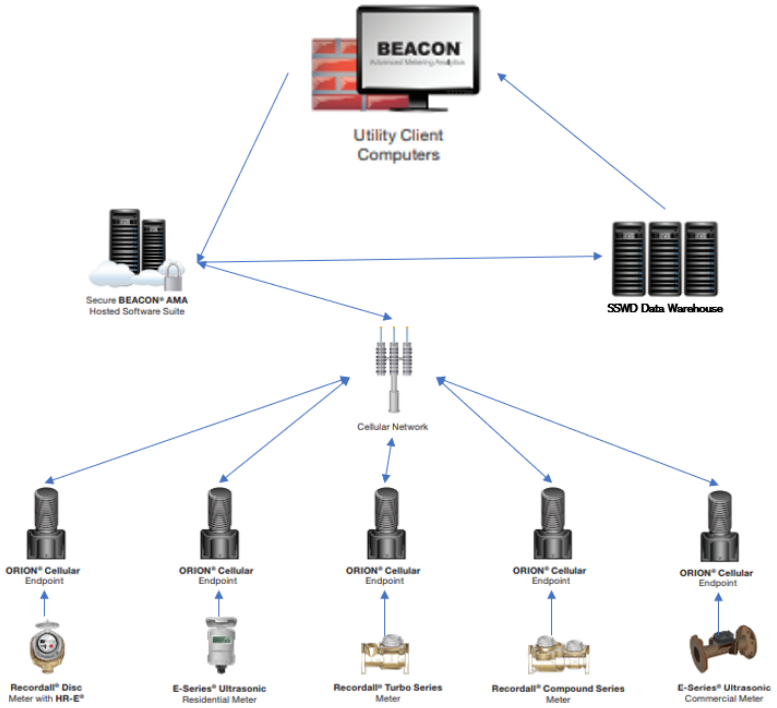
The Sensus FlexNet communication network is a fixed-based AMI system that transmits meter data (reads, events, alarms) via a non-replaceable, battery-powered Endpoint device attached to a meter via a Nicor connector. The FlexNet communication network uses a private FCC-licensed spectrum to mitigate transmission interference. The endpoint transmits one hour interval reads once every four hours.



SSWD purchased Sensus network devices and has assumed responsibilities for operations and maintenance. This approach can be contrasted to a Network as a Service (NaaS) Contract. A NaaS contract is typically one in which the vendor owns, operates, and maintains the network components, while the owner maintains the endpoint devices. Therefore, the base stations require periodic maintenance and upgrades every 7-10 years. Improvement recommendations to this situation are referenced to this in Section 9.

Badger Orion AMI system

The Badger Orion AMI communication network is a cellular-based AMI system using two-way communication via a non-replaceable, battery-powered endpoint attached to a meter via a nicor connector. The Orion cellular endpoint is configured to transmit 15-minute reads and device data four times each workday. It utilizes a direct connection to the AT&T or Verizon public wireless network. Badger provides specific performance and warranty measures around network uptime via their contracts with the wireless carriers. The Beacon software features a configurable schedule that enables utility customers to select call-in times that best support their processes all managed through Badger's proprietary BEACON Software.

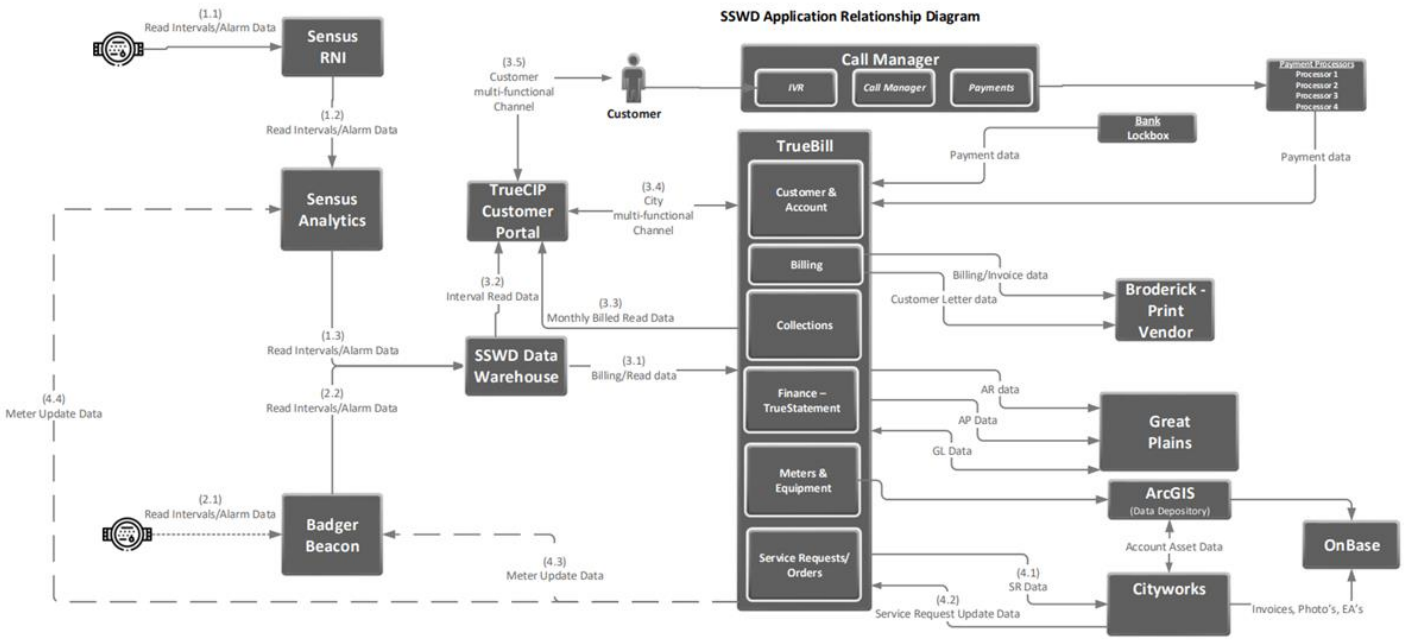


Regarding the Badger network, it can be considered a NaaS operation since Badger is taking responsibility for managing and maintaining the contract with Verizon or AT&T. The performance warrantees and service uptime are typically addressed in Badger contract documents.

Additional observations, considerations, and improvement opportunities regarding the Sensus and Badger Metering Assets are identified in Section 9. Each manufacturer's relevant installation, operations, maintenance, and warranty documents are found in Appendix A.4-Vendor Documentation.

Software Considerations

The Metering Assets are managed by several software packages that work together to perform key business functions for the utility. These packages are graphically illustrated in the following Application Relationship Diagram*.



*The Mueller Meganet software is omitted since it will be removed from service by the end of 2023.

AMI Headend Software

SSWD utilizes two systems, each of which contains several modules. The Sensus software package utilized by SSWD is made up of two modules-- the Regional Network Interface (RNI) and Sensus Analytics. The RNI is the nerve center of the FlexNet® communication network. Functionally, the RNI communicates with endpoints and provides SSWD with a wide range of data point and configurable setting for the utility system. The RNI gathers and processes network and metrology data, and it is equipped with self-diagnostic tools essential to managing the health of the AMI system.

Sensus Analytics is a separate meter data management module that provides SSWD with essential meter data on the FlexNet system. Sensus offers three tiers of Sensus Analytics: Essential, Enhanced and Advanced. SSWD currently operates via the Enhanced Analytics platform providing access to Billing Access, Device Access, Meter Insight, Report Access, Alert Manager and Alarm Insight. This application presents data on dashboards and allows SSWD to monitor their system for real-time alerts and historical consumption patterns.

The Badger Beacon system functions similarly monitoring network performance for both metering devices and other sensors that are compatible with the network. Beacon also contains a data repository of where information can be analyzed and transmitted to other systems including those which may impact customer notifications.

Data Warehouse / CIS / GIS

SSWD has created a data warehouse where raw reads are consumed from the Sensus and Badger AMI systems and then transferred from the data warehouse to other utility systems. The data warehouse provides numerous, long-term benefits for the utility, but it also adds elements of complexity. For example, there are several integration points between systems that must be maintained.

The management of the information provided by these meter reading networks are centralized around the TrueBill Customer Information System (CIS), the ESRI Graphical Information System (GIS), the Cityworks Computerized Maintenance Management System (CMMS) and the data warehouse which was established by internal resources. This collection of critical systems is used to:

1. Monetize the reading data and provide inventory control through the CIS
2. Provide location and spatial management of assets through GIS
3. Support work order and maintenance tracking of assets in CMMS
4. Centralize the collection of reading data from the various deployed networks in the custom data warehouse

With these disparate systems, integration becomes vital. Each connection point becomes its own failure point within the system. The maintenance and support of these systems and their integration points are critical to maximizing the value of SSWD's AMI infrastructure investments.

3. Inventory Considerations

Metering Asset Inventory Practices

SSWD has a high degree of inventory accuracy through defined check in/out processes and frequent counts. SSWD metering inventory is safeguarded with a full-time Purchasing Specialist position and an active work order requirement for any items to be checked out. Material inventory is largely maintained within their warehouse except for limited quantities of items in “on-truck” inventory.

In the absence of the Purchasing Specialist, several administrative positions have an ability to approve inventory in or out, including:

- *Assistant General Manager*
- *Operations Manager*
- *Distribution Superintendent*
- *Production Superintendent*

A full count of inventory is performed twice per year by Operations staff. The resulting "stock status” report and random spot counts performed at the first of every month provide a high level of inventory control. As of July 2022, the last five (5) full count cycles have resulted in less than $200 in annual unaccounted for inventory loss.

4. Replacement and Maintenance Requirements

Maintenance and Testing Approach

Preventive Maintenance (PM) is the primary way the utility is extending the useful life of this asset class, reducing repair costs, and providing revenue assurance for the utility. Beginning in 2007, SSWD began Meter PM in Field Services. In 2019, the SSWD combined the Field Services Department and Distribution Department under one Distribution Superintendent. At that time, a PM division was created in the newly formed Water Distribution department that combined Meter PM and Distribution PM.

Proactive measures are being taken by staff to prevent unplanned, emergency repairs and replacements. This reduces any potential interruptions in services for customers and creates a safer working environment for SSWD employees.

A PM schedule is created annually at the beginning of each year intended to focus on three key areas in the following order:

1. Meter Testing
2. Meter Rebuild
3. Meter Replacement

Replacement Strategy

The following strategy on meter replacement will apply:

- Small Meters
    - 5/8", ¾" and 1" meters will be replaced on a 20-year schedule (~1000 annually today; however, the utility will ramp up to ~2000 annually in the next several years. These may vary annually based on install years (age of meters)
- Intermediate Meters
    - 1.5" and 2" meters will be rebuilt every ten years (~245 meters annually)
- Large Meters
    - 3" and 4" meters will be tested every 5 years and rebuilt if the meters are operating outside AWWA standards (~85 meters annually)
    - 6" or larger meters will be tested annually and rebuilt if the meters are operating outside AWWA standards (currently 39 in the system)

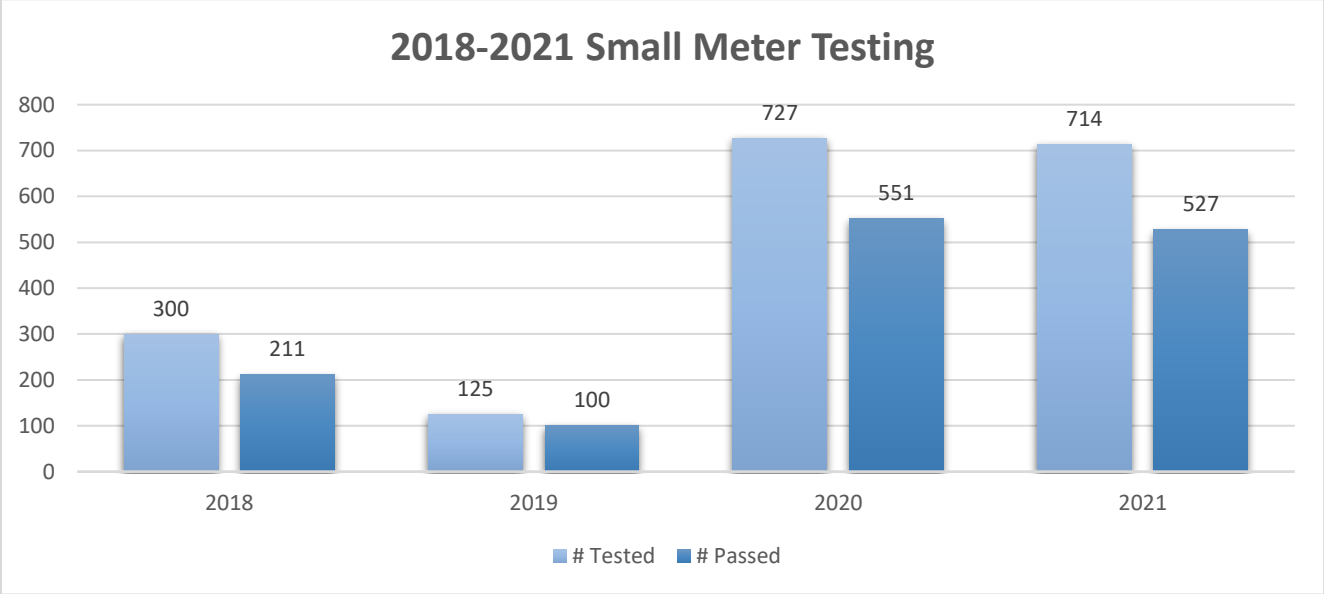
Meter Testing

To keep up with the goals set forth by SSWD, the expectation is that the meter PM team will spend the first half of the year performing large meter testing. Once complete, the team will spend the remainder of the year rebuilding 1.5" and 2" meters and replacing small meters that have met the current twenty-year replacement threshold.

All meter testing, regardless of size, references AWWA Manual M6 Test requirements for cold-water meters (ANSI/AWWA C700 and C710) and establishes a 98.5-101.5% standard for pass/fail criteria. A meter can fail if

testing is under or over the AWWA standard. Currently, SSWD is outsourcing all small meter testing for meters that have met the replacement criteria. It is SSWD's current goal to test at least 50% of the meters changed out due to age.

A sample of testing results between 2018-2021 is provided below.



The current criteria for large meter testing are as follows: 3" and 4" meters are tested every 5 years; units will be re-built if they fail the AWWA test. All 6" and larger sized meters are tested annually; units will be re-built if they fail the AWWA test. In case of failure, it is SSWD's preference to rebuild these meters in the field at the time of a failed test. Once rebuilt, the meter is retested again for accuracy. In the past five years, there has not been a scenario where a rebuild due to failed testing has resulted in a need for meter replacement post-rebuild.

SSWD currently has thirty-nine (39) meters that are 6" and larger that are tested annually. SSWD currently has (426) 3" and 4" meters that are on a five-year testing plan, approximately 85 tested annually.

Meter / Endpoint Disposal

SSWD does participate in recycling old meters and endpoints. Small meters are recycled by SSWD after they are replaced. If sending off for testing, some of their test vendors will provide flat rate credits to their testing charge to recycle.

Sensus will provide a disposal credit to SSWD towards their Smart Points when they exchange failed endpoints for new endpoints, regardless of the failed endpoint manufacturer.

5. Growth Requirements

The SSWD service area is generally built-out with no major plans for service area expansion. However, there will occasionally be “fill-in” subdivisions or new developments. In this case the developer is required to purchase the meter. While the budget established in Section 7 can accommodate minor purchases for damaged meters, there should be an assessment and revision of the forecast for any contemplated system expansions through acquisition or consolidation.

6. Labor Requirements

Overview

The primary labor force managing the Meter AMP is primarily split between the Preventive Maintenance Division and the Field Services Division with some oversight from senior management. There is one Superintendent splitting time in thirds between Preventive Maintenance, Field Services, and Distribution. Based on the labor division in each department below, the labor force associated with the Meter AMP is approximately 8.33 full time equivalents in following breakdown:

Staffing	**FTE**	**Comments**
Superintendent	.33	Splitting time between groups
Preventive Maintenance Division		
• 1 Distribution Foreman	.5	Splitting time between Meter PM and Distribution PM
• 2 Operators	2	Dedicated to Meter PM
Field Services Division		
• 1 Distribution Foreman	1	
• 5 Operators	5	
Total	8.83	

Staffing Levels

The current staffing levels appear to be adequate for the services being provided. This judgment considers:

- Transaction volumes
- Process maps and activities
- Testing results

Adding additional staff in future years is not recommended unless there is a significant change in size of the meter population.

7. Investment Requirement

Investment Overview

In general, SSWD capitalizes most material purchases related to the Meter AMP. Expenditures for labor as referenced in the previous section largely comprise the Operation and Maintenance (O&M) cost for metering related assets.

Key Assumptions:

- Shared services from other departments.
    - The following departments support aspects of the Meter AMP:
        - IT Department (Date Warehouse, Software Hosting, Integration support)
        - Fleet Vehicles (For various aspects of maintenance and operations)
        - Warehousing / Material Storage
        - Tools and Equipment
- The labor used to install the Capital Expenditure (Capital) equipment is provided through the labor force associated with the Operations and Maintenance (O&M) budget.
- Capital and O&M has been modeled for 20 years which is an appropriate timeline for these assets.
- If SSWD wants to implement improvement opportunities outside of the material and labor listed in this report, there may need to be adjustments to this budget. For example, adding additional test equipment.

Capital and O&M Budget

Year	Meters	End Points/Other	Capital (Material Only)	O&M
2023	$ 407,200		$ 407,200.00	$ 1,827,000.00
2024	$ 419,416		$ 419,416.00	$ 1,881,810.00
2025	$ 431,998		$ 431,998.48	$ 1,938,264.30
2026	$ 444,958		$ 444,958.43	$ 1,996,412.23
2027	$ 458,307		$ 458,307.19	$ 2,056,304.60
2028	$ 472,056		$ 472,056.40	$ 2,117,993.73
2029	$ 486,218		$ 486,218.10	$ 2,181,533.55
2030	$ 500,805	$ 200,000	$ 700,804.64	$ 2,246,979.55
2031	$ 515,829		$ 515,828.78	$ 2,314,388.94
2032	$ 531,304		$ 531,303.64	$ 2,383,820.61
2033	$ 547,243	$ 1,382,314	$ 1,929,556.74	$ 2,455,335.23
2034	$ 563,660	$ 1,423,783	$ 1,987,443.44	$ 2,528,995.28
2035	$ 580,570	$ 1,466,497	$ 2,047,066.75	$ 2,604,865.14
2036	$ 597,987	$ 1,510,492	$ 2,108,478.75	$ 2,683,011.09
2037	$ 615,927	$ 1,555,807	$ 2,171,733.11	$ 2,763,501.43
2038	$ 634,404	$ 1,602,481	$ 2,236,885.10	$ 2,846,406.47
2039	$ 653,436	$ 1,650,555	$ 2,303,991.66	$ 2,931,798.66
2040	$ 673,040		$ 673,039.56	$ 3,019,752.62
2041	$ 693,231		$ 693,230.74	$ 3,110,345.20
2042	$ 714,028		$ 714,027.66	$ 3,203,655.56
2043	$ 735,448		$ 735,448.49	$ 3,299,765.23

** The proposed 7-year Endpoint replacement period mirrors the original 7-year end point deployment period. This period can be compressed or extended depending on battery performance and the size of labor force used.

Figure 2.0

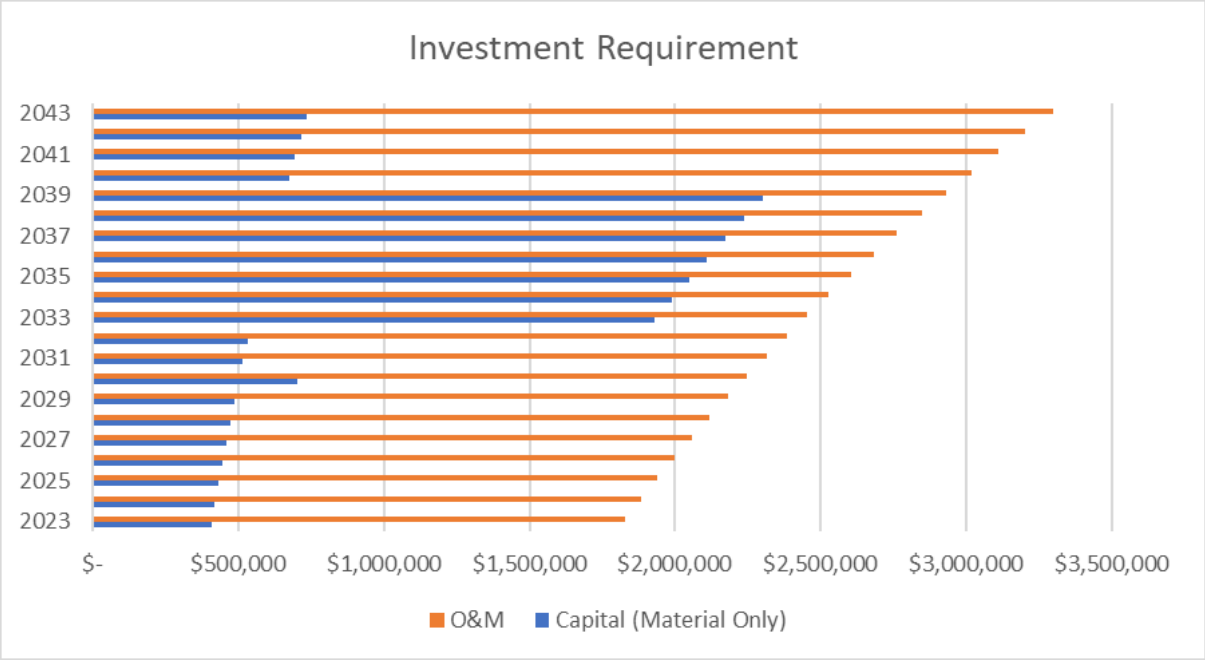


Figure 2.0 above assumes the baseline 2023 approved budgetary figure for O&M and Capital, as well as a 3% cost escalation factor. The Sensus network components will require maintenance and upgrades around years 7-10. For the purposes of this plan, approximately $200,000 capital budget is estimated at year 10 of system deployment. Based on estimated expected twenty-year endpoint life, SSWD is budgeting for a seven-year, phased approach for endpoint changeout beginning in 2033. This approach could be time-compressed by using third party installation labor. SSWD should closely monitor battery performance beginning in year 15 and adjust the schedule accordingly.

8. Risk Assessment

By taking calculated actions in the last several years, SSWD has dramatically reduced the risk in their Meter AMP. The products being used have a strong industry track record with literally more than 1,000 successful installations. By staggering the product installation dates, additional risk was removed from having a defective product batch and there is little chance of wide-spread failure.

Other risks identified are considered minor, but the risk mitigation concept offered could be converted into an improvement action in the SSWD annual planning process:

	Risk	**Mitigation**	**Comment**	**Target Date for Completion**
1)	Network Failure Points	Consider a service agreement on spare collector items for Sensus.	Badger is really a NaaS option. Monitor their performance monthly and annually	September 2023
2)	Over the air firmware updates: From time to time, the vendors will encourage this. It is mostly a positive event; however, an unplanned or haphazard update can cause major system problems.	Set clear ground rules with Sensus and Badger about how these firmware updates occur.	Hire a subject matter expert if you are uncertain.	September 2023
3)	Management of Integration Points to the Data Warehouse	While primary responsibility is with the IT department, the use of the data warehouse by a variety of stakeholders seeking meter-related data will increase over time. All integrations should be maintained as systems are upgraded over time.	Included in improvement recommendations.	Ongoing

9. Improvement Opportunities

During the Meter AMP development, the following improvement opportunities were identified.

	Improvement Opportunity	Target Date for Completion
1)	Determine system of record for Sensus collection Equipment and maintenance record such as CMMS	September 2023
2)	Create a central data repository, such as SharePoint site, for all related Meter AMP documentation including contract and warranty information for easy reference.	June 2023
3)	Sensus network review all Sensus contract terms including performance commitments. Consider a formal network service agreement. Other considerations:	October 2023
	a. Establish local inventory of critical parts or a complete collector assembly.	September 2023
	b. Schedule periodic collector maintenance.	September 2023
	c. Ensure SSWD has all necessary tools, equipment, and process to read meters in drive-by mode should a network failure occur.	September 2023
	d. Define any budgetary gaps between what Sensus is providing and what is needed.	December 2023
	e. Cross train SSWD personnel for emergency maintenance if the standard Sensus response times are inadequate.	December 2023
	f. Monitor the network performance and periodically meet with Sensus to discuss any network "tuning" that may be needed to variables that may affect RF transmission.	September 2023
4)	Badger Beacon Network. Review all contract items specifically determine contacts for emergency calls and verify level of service agreements and response times.	September 2023

	a. SSWD has prepaid for several years of service credits, but the utility should have a clear understanding remaining value of credits and how those credits may apply to upgrades or other functionality.	September 2023
	b. The Badger system should be able to be read in drive-by mode during emergency situations. Verify all necessary components are in place if the utility desires this backup functionality.	September 2023
5)	Network expansion. Both Sensus and Badger are constantly releasing new monitoring devices that are compatible with their respective networks. SSWD should periodically evaluate the application and value of such devices. These may include pressure sensors and remote disconnect.	Ongoing
6)	Establish internal process responsibility for managing the warranty process for all Sensus and Badger components.	September 2023
7)	Establish specific strategies or procedures around equipment upgrades, software and firmware updates and the maintenance of all integration points to other system.	December 2023
8)	Event/Alarm/Report Rationalization. Examine the management of the data between the Data Warehouse and the core modules within Badger and Sensus. The aim is to ensure SSWD is delivering the appropriate event/alarm/reports to the right people at the right time. This can be accomplished through analysis, configuration, and testing of all the standard actions in each AMI headend software.	December 2023
9)	Test bench establishment. While buying an internal test bench is an improvement possibility, there is little evidence to support the financial investment. In-house testing options for testing are not factored into the current financial forecasts, but sample testing in years 10-15 could be worthwhile, whether that takes place in-house or through a third-party.	September 2023
10)	Interties. While there are often ownership and operational challenges associated with interties, it is recommended that SSWD meter and monitor all sources that could affect major points of water input and output to the system. Consider cooperative endeavors with other utilities to share in the cost of metering installation.	September 2023

Appendix

A.1. Financial Snapshots

Current Budgets

Expected Revenue (2022)	**$51,361,000.00**
Capital Budget (2022)	$24,752,000.00
Operations and Maintenance Budget (2022)	$23,811,000.00
Debt Service (2022)	$7,503,000.00

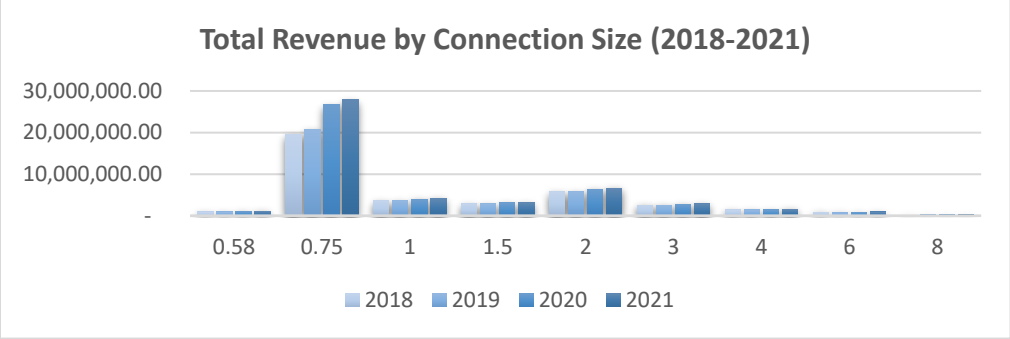
Monthly Rates

$94.28	**Representative metered residential with 1" metered service & 20 units of consumption (1 unit = 748 gallons)**
$57.06	Representative metered residential with 3/4" metered service & 10 units of consumption (1 unit = 748 gallons)

Historical Metering Revenue

Total Revenue by Connection Size				
	2018	**2019**	**2020**	**2021**
5/8”	$903,310.35	$909,834.70	$1,059,539.37	$1,109,698.51
3/4”	$19,495,350.53	$20,644,747.45	$26,697,201.87	$27,927,155.81
1”	$3,622,746.58	$3,613,626.73	$3,955,816.45	$4,179,216.71
1.5”	$2,866,437.14	$2,872,952.77	$3,102,869.13	$3,179,589.11
2”	$5,736,515.45	$5,733,916.41	$6,334,156.55	$6,654,855.28
3”	$2,531,399.31	$2,524,609.53	$2,784,636.67	$2,881,509.71
4”	$1,380,665.55	$1,377,940.28	$1,481,912.75	$1,576,873.64
6”	$862,889.54	$776,760.89	$839,018.58	$908,548.35
8”	$167,131.95	$170,528.09	$189,157.15	$ 180,781.45
Total	**$37,566,446.40**	**$38,624,916.85**	**$46,444,308.52**	**$48,598,228.57**

Revenue by Size



A.2. Asset-Related Workflows

Onsite discovery sessions were conducted to document processes relevant to asset-related operational functions. These workflows were used to understand the operating environment and provides supplemental documentation of how SSWD staff, equipment and material assets are physically utilized. Processes mapped in the scope of this project are:

- A.2. Asset Related Workflows.pdf
- A.2.1 Cycle Billing.pdf
- A.2.2 High Bill Inquiry Field Investigation.pdf
- A.2.3 Meter Testing.pdf
- A.2.4 Inventory In.pdf
- A.2.5 Inventory Out.pdf
- A.2.6 Mid Year Annual Inventory Count.pdf
- A.2.7 Current State ARD.pdf

A.3. Vendor Documentation

- A.3. Vendor Documentation.pdf
- A.3.1 Recordall Turbo Series Meters Models 160, 200, 450, 1000, 2000, 3500, 5500, 6200 Product Data Sheet.pdf
- A.3.2 Recordall Turbo Series Meter Model 450 Fire Hydrant Meter 3 in Product Data Sheet.pdf
- A.3.3 Recordall Lead-Free Bronze Alloy Disc M25,M35, M55, M70 Product Data Sheet.pdf
- A.3.4 S-DS-00078-EN Recordall Compound Meter Lead-Free Bronze Alloy, Sizes 2, 3, 4 & 6 Inch Product Data Sheet.pdf
- A.3.5 ORION Cellular Water Endpoints Product Data Sheet.pdf
- A.3.6 ORION Cellular LTE Endpoint Data Sheet.pdf
- A.3.7 BEACON AMA Welcome Billing Integration.pdf
- A.3.8 BEACON AMA Onboarding Billing Vendor Integration Best Practices Quick Guide.pdf
- A.3.9 BEACON Advanced Metering Analytics with ORION NaaS Product Data Sheet (BEA-DS-00554-EN).pdf
- A.3.10 Badger HR-E High Resolution Encoder Product Data Sheet.pdf
- A.3.11 Badger ADE Product Data Sheet.pdf
- A.3.12 Software Overview Solution Brief.pdf
- A.3.13 Smart Utility Analytics Viewpoint.pdf
- A.3.14 Sensus Essential Analytics Brochure.pdf
- A.3.15 M400B2 Data Sheet.pdf
- A.3.16 FlexNet SmartPoint 520M Pit Set Data Sheet.pdf
- A.3.17 510M and 520M Compatibility Quick Guide.pdf

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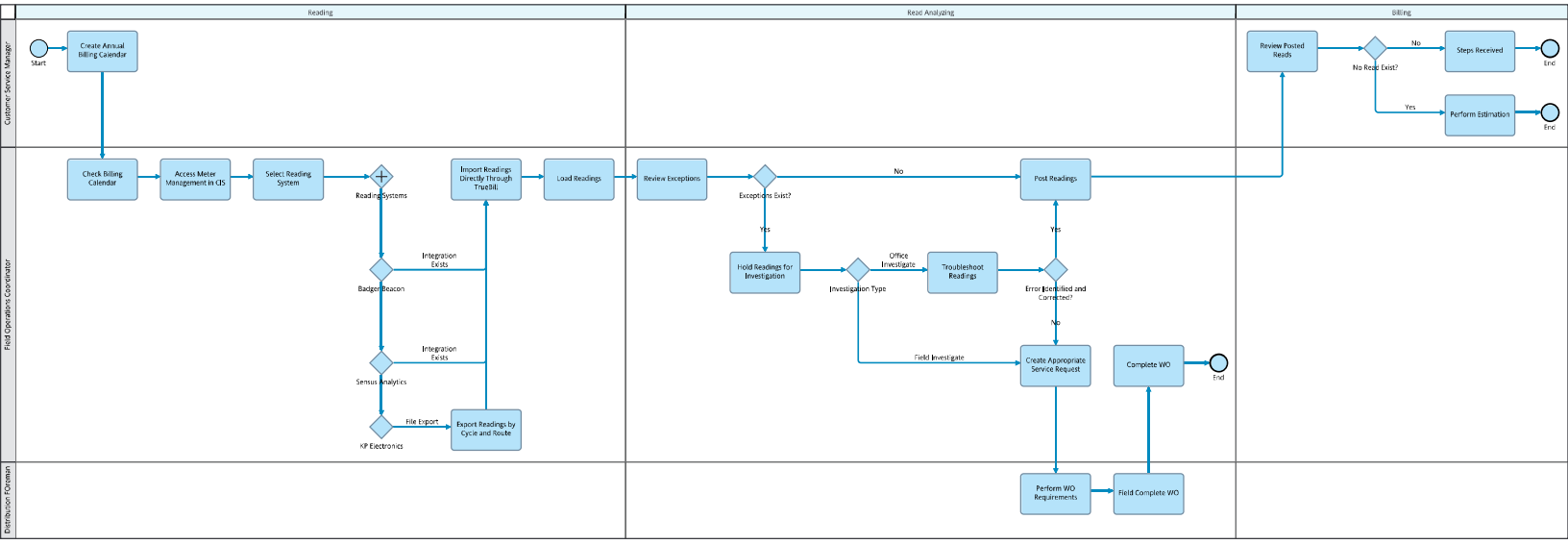

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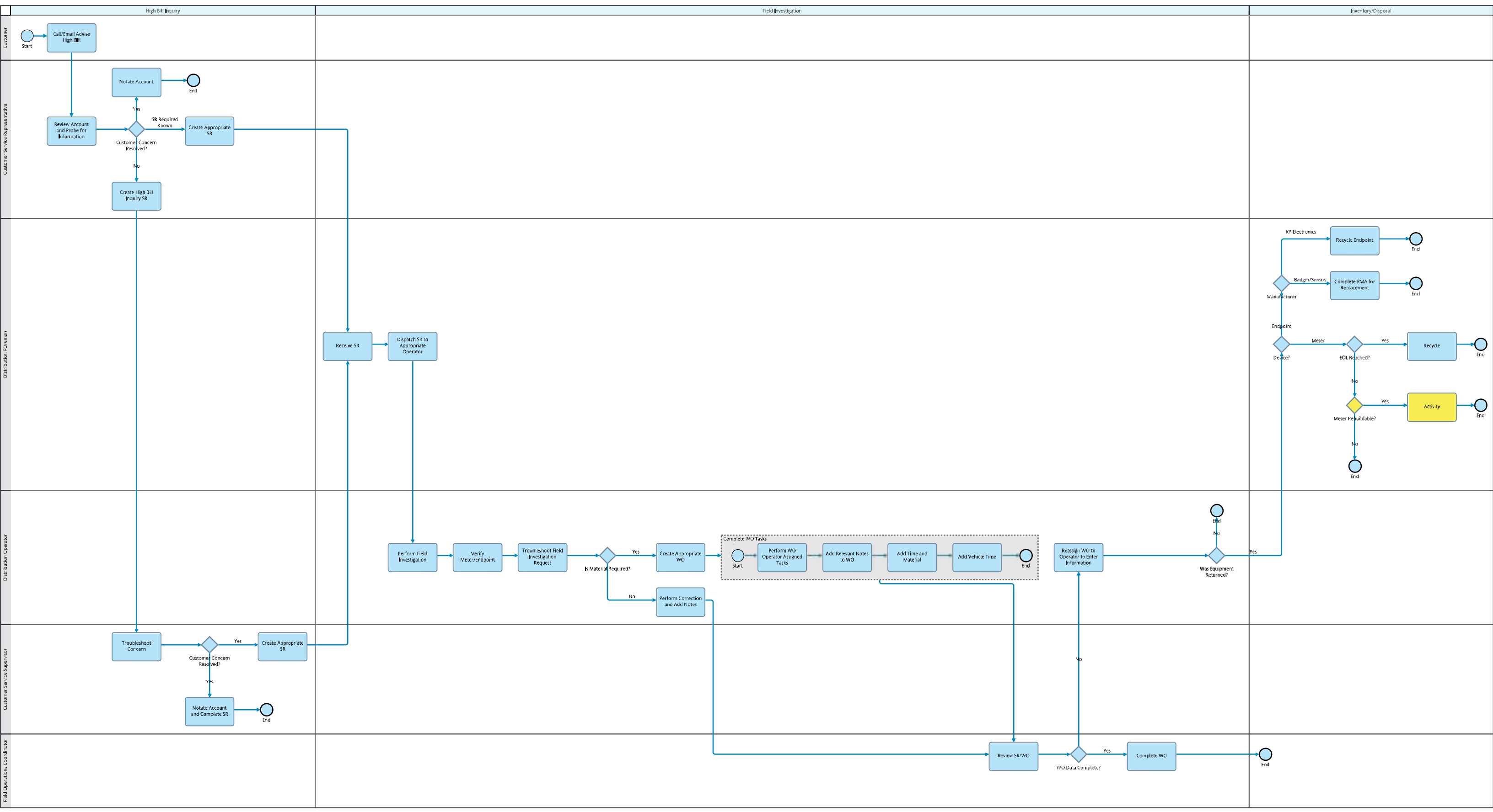

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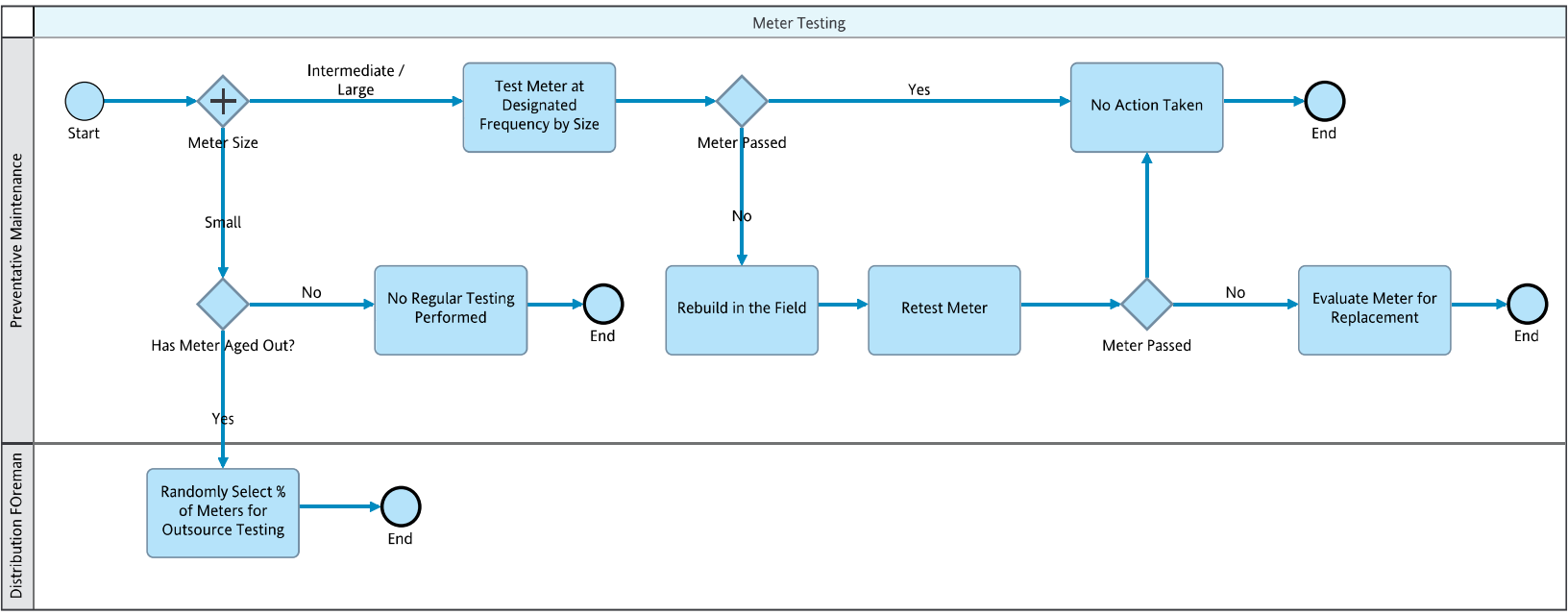

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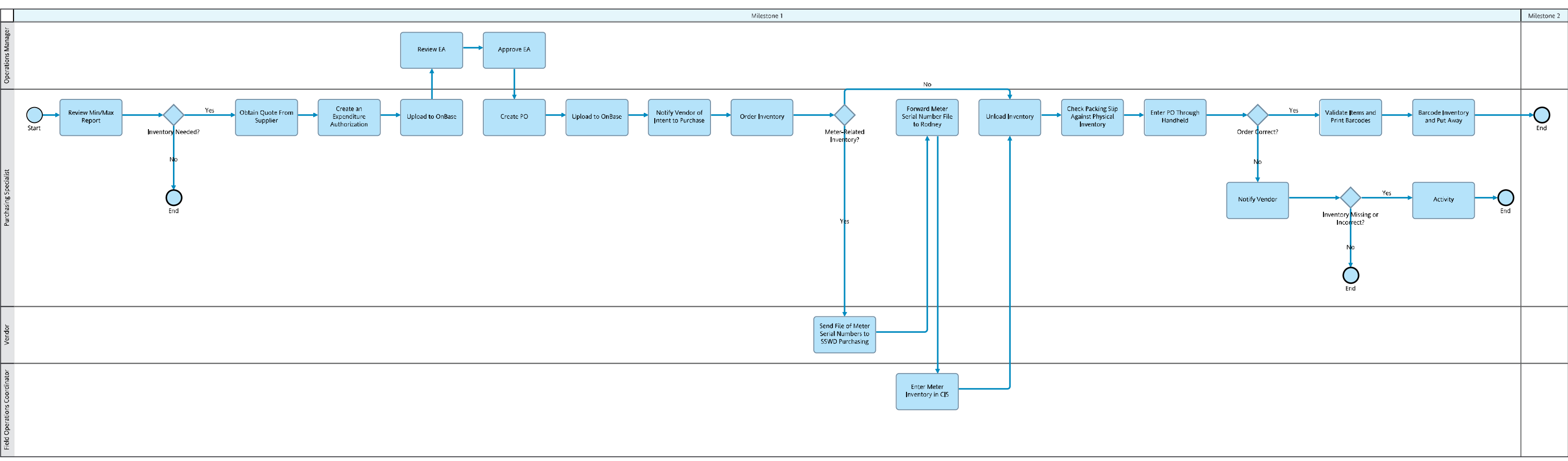

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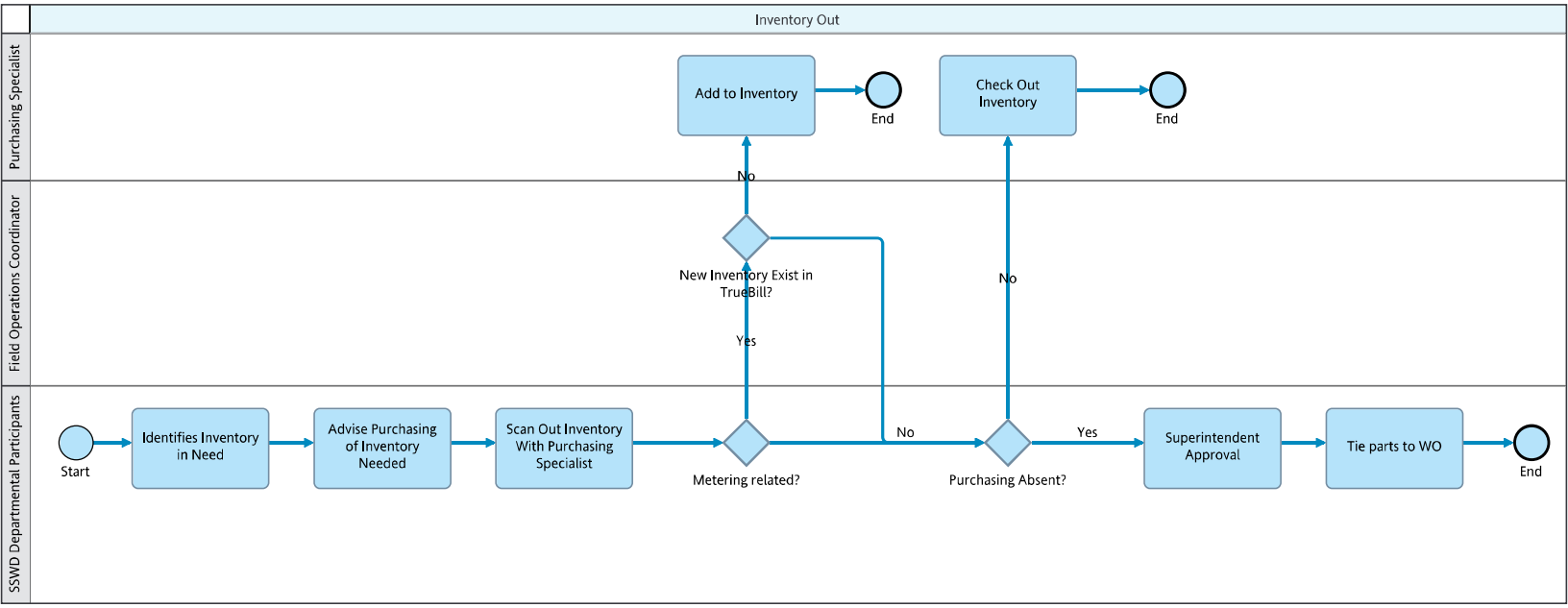

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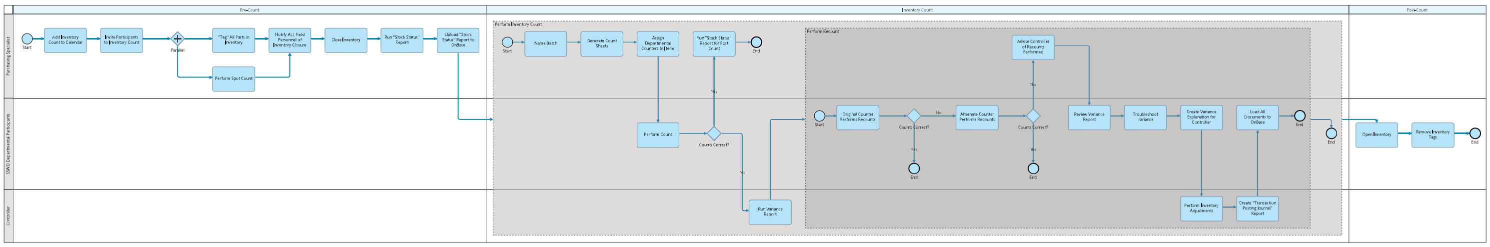
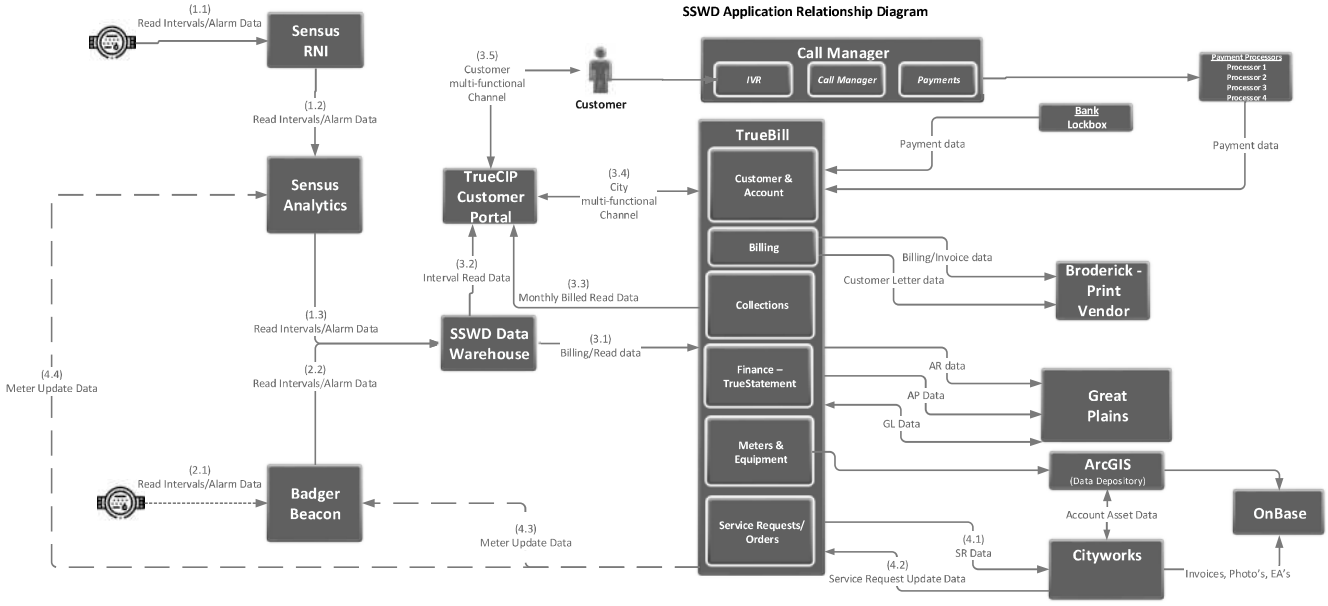
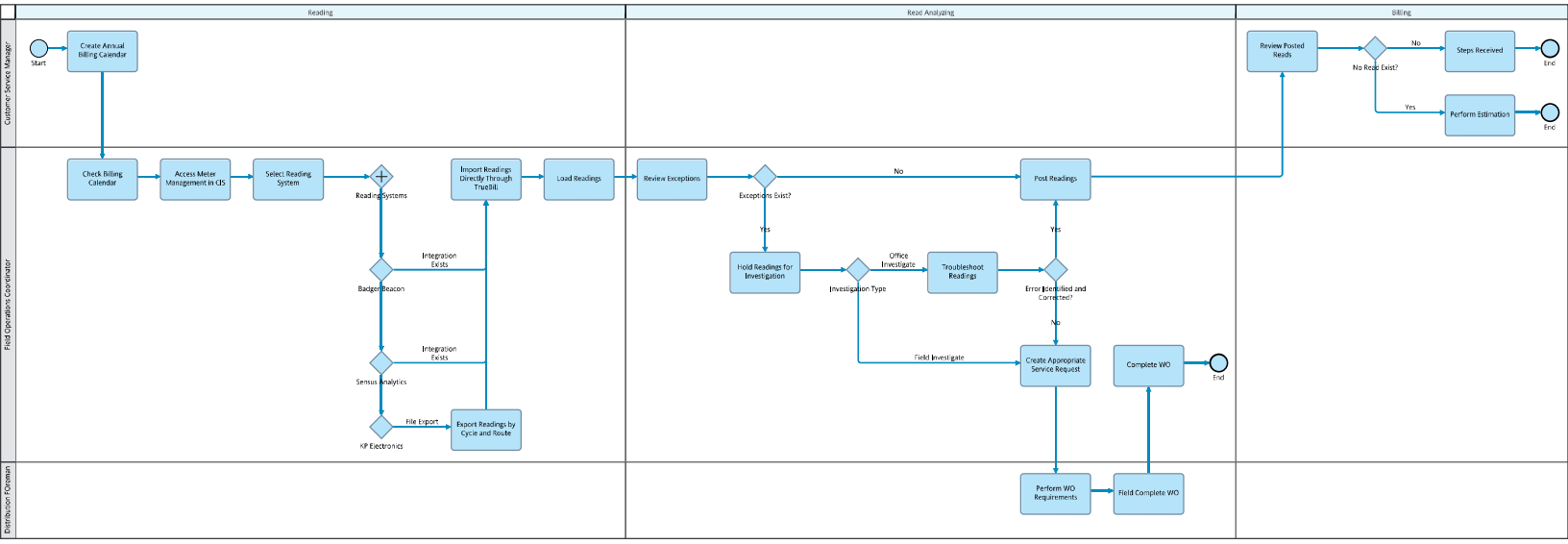



SSWD Application Relationship Diagram
(1.1)
Read Intervals/Alarm Data
Sensus RNI
(1.2)
Read Intervals/Alarm Data
Sensus Analytics
(1.3)
Read Intervals/Alarm Data
(2.2)
Read Intervals/Alarm Data
(4.4)
Meter Update Data
(2.1)
Read Intervals/Alarm Data
Badger Beacon
(4.3)
Meter Update Data
(3.5)
Customer multi-functional Channel
Customer
Call Manager
IVR
Call Manager
Payments
Payment Processors
Processor 1
Processor 2
Processor 3
Processor 4
Bank Lockbox
Payment data
Payment data
TrueCIP Customer Portal
(3.4)
City multi-functional Channel
(3.2)
Interval Read Data
(3.3)
Monthly Billed Read Data
SSWD Data Warehouse
(3.1)
Billing/Read data
TrueBill
Customer & Account
Billing
Collections
Finance – TrueStatement
Meters & Equipment
Service Requests/ Orders
Billing/Invoice data
Customer Letter data
Broderick - Print Vendor
AR data
AP Data
GL Data
Great Plains
ArcGIS
(Data Depository)
Account Asset Data
OnBase
(4.1)
SR Data
(4.2)
Service Request Update Data
Cityworks
Invoices, Photo's, EA's

Cycle Billing (ID: 179f143174) https://us001.blueworxlive.com/scr/processes/179f143174
SSWD space, Last modified on Jan 16, 2023 6:59 PM



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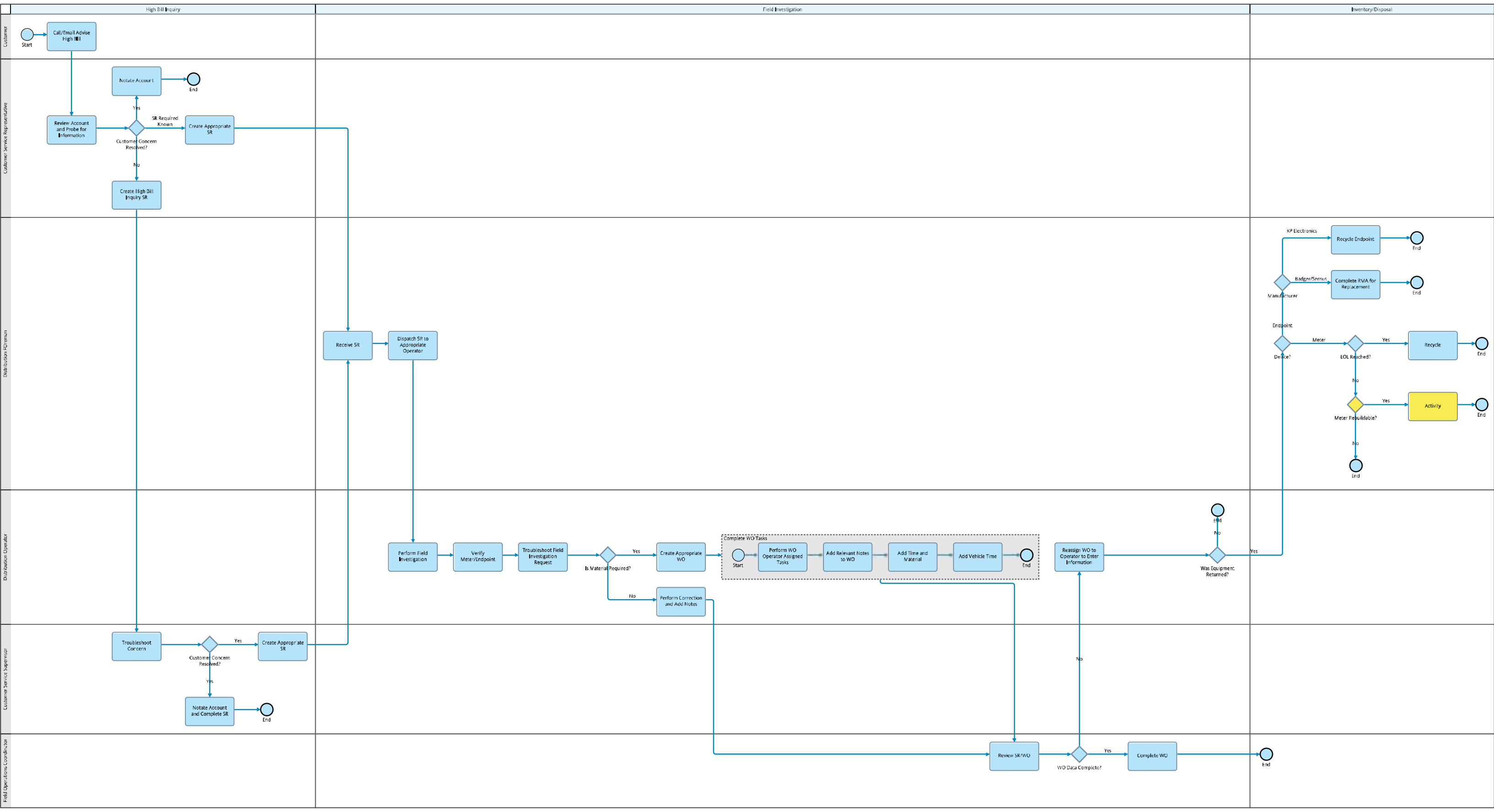

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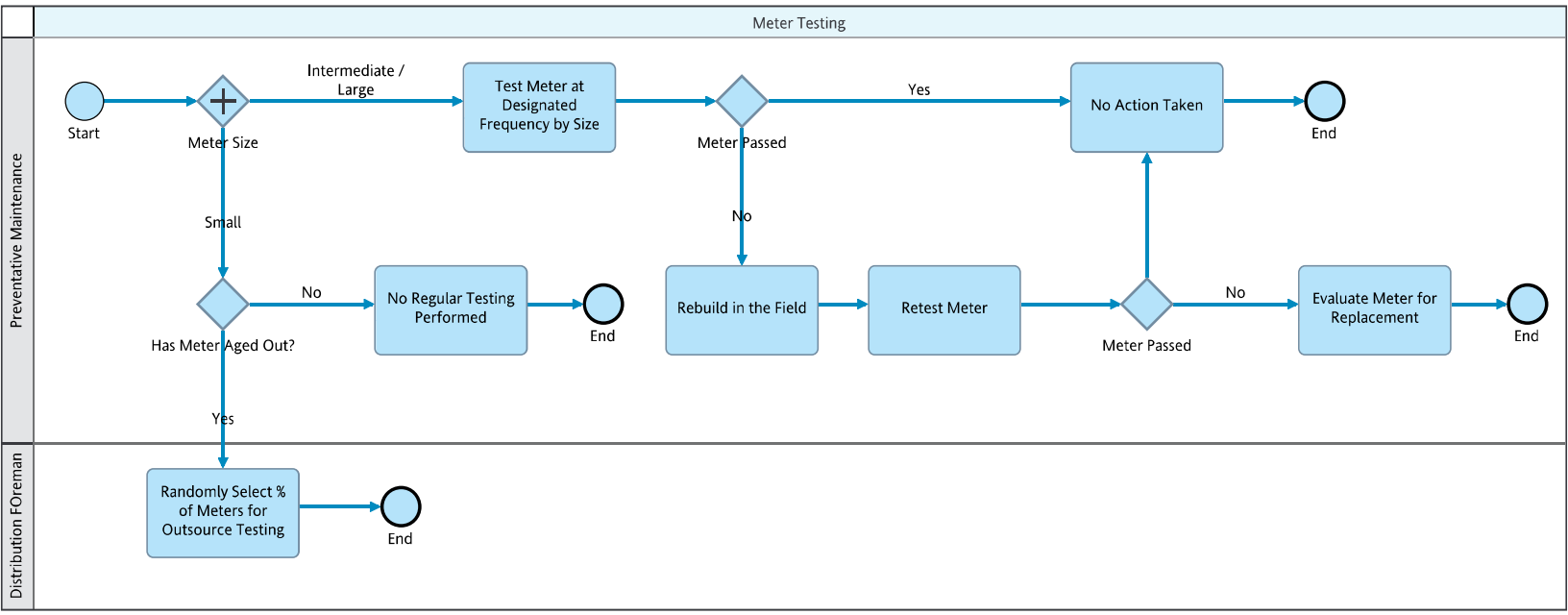
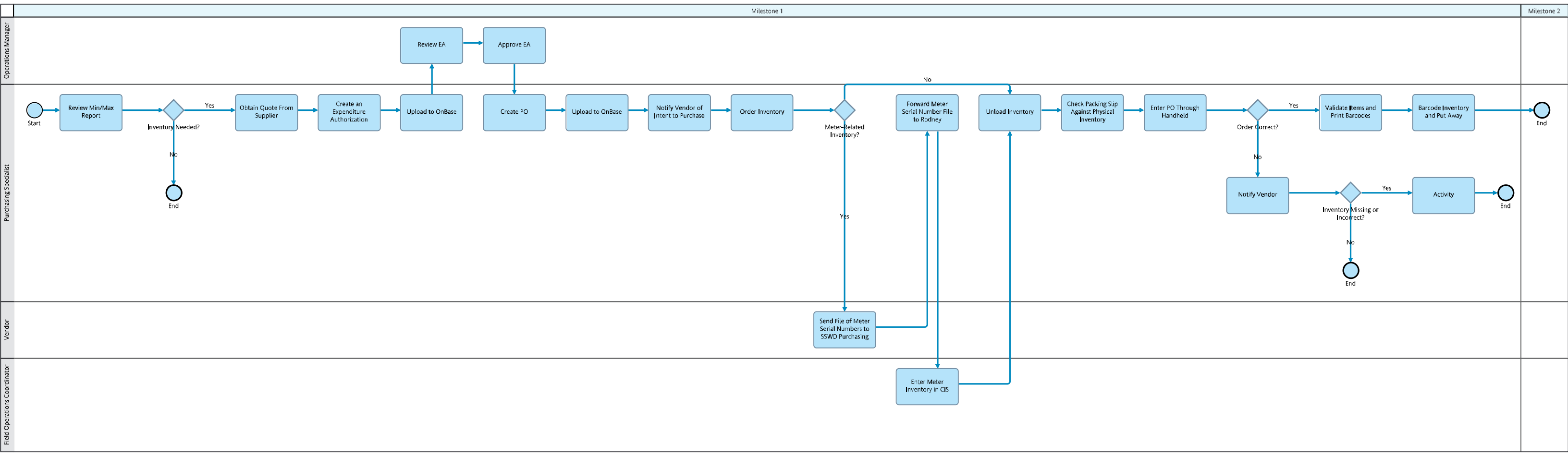
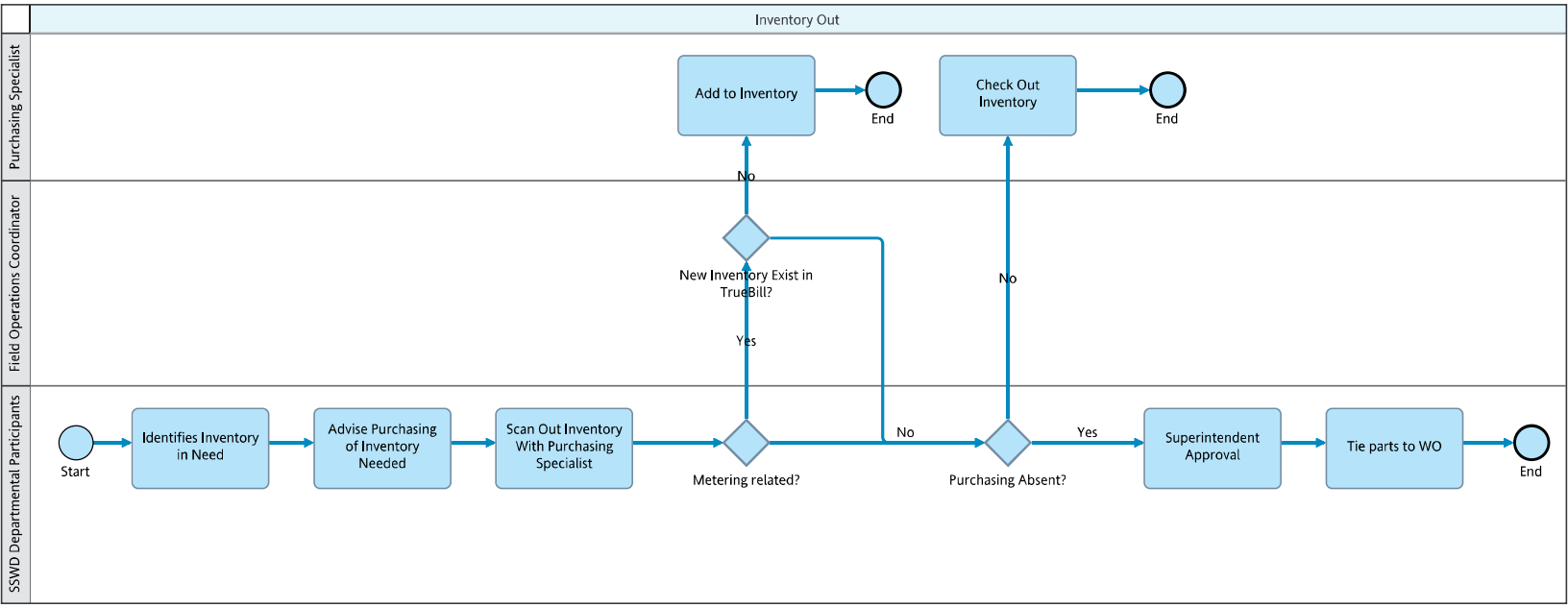



Milestone 1
Milestone 2
Operations Manager
Purchasing Specialist
Vendor
Field Operations Coordinator
Start
Review Min/Max Report
Inventory Needed?
Yes
No
End
Obtain Quote From Supplier
Create an Expenditure Authorization
Upload to OnBase
Review EA
Approve EA
Create PO
Upload to OnBase
Notify Vendor of Intent to Purchase
Order Inventory
Meter-Related Inventory?
No
Yes
Send File of Meter Serial Numbers to SSWD Purchasing
Forward Meter Serial Number File to Rodney
Enter Meter Inventory in CIS
Unload Inventory
Check Packing Slip Against Physical Inventory
Enter PO Through Handheld
Order Correct?
Yes
No
Validate Items and Print Barcodes
Barcode Inventory and Put Away
End
Notify Vendor
Inventory Missing or Incorrect?
Yes
No
Activity
End
End

Inventory Out (ID: 7b9f134058) https://us001.blueworkslive.com/scr/processes/7b9f134058
SSWD space, Last modified on Jan 16, 2023 7:04 PM



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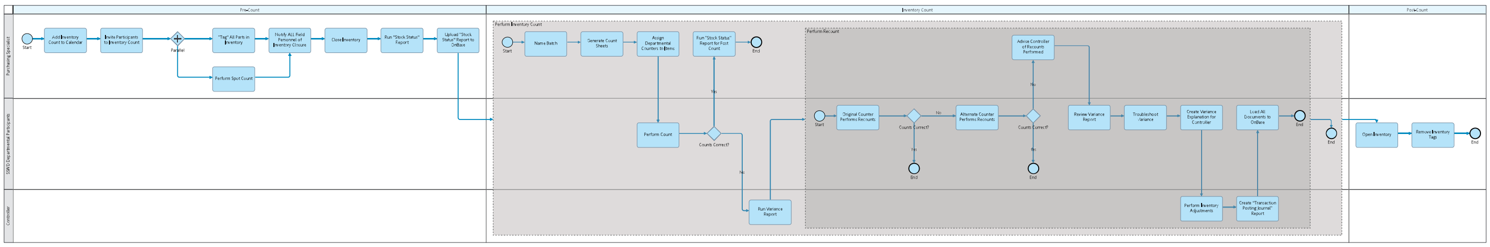

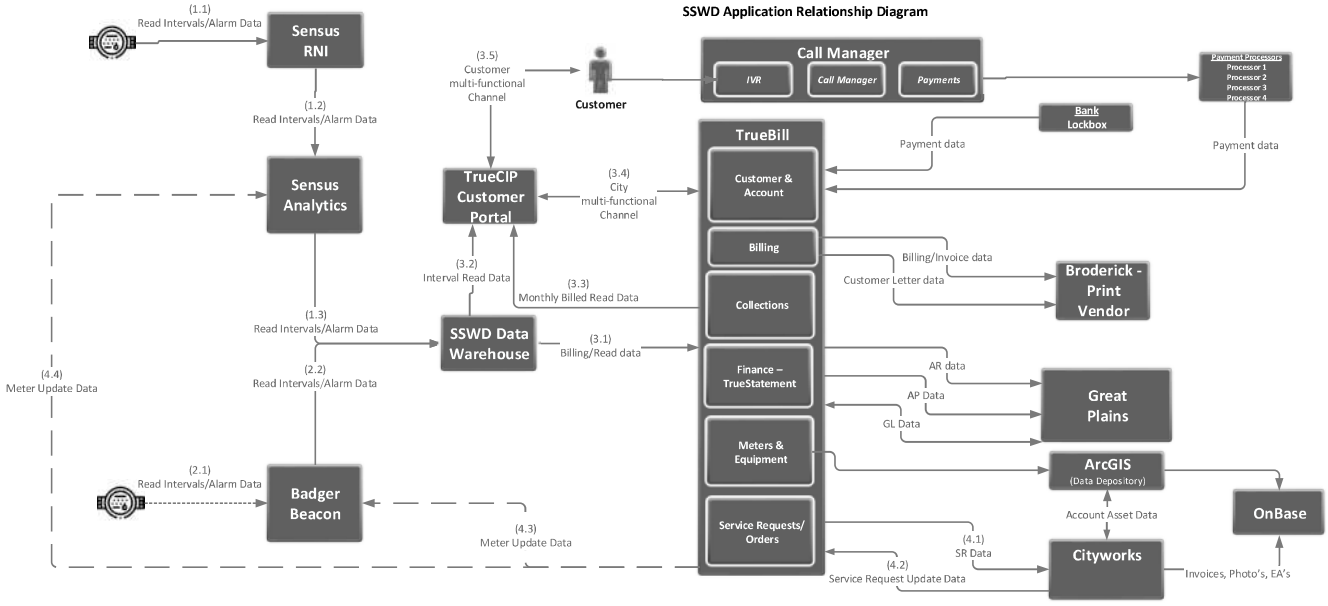
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Badger Beacon
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Meter Update Data
(3.5)
Customer multi-functional Channel
Customer
Call Manager
IVR
Call Manager
Payments
Payment Processors
Processor 1
Processor 2
Processor 3
Processor 4
Bank Lockbox
Payment data
Payment data
TrueCIP Customer Portal
(3.4)
City multi-functional Channel
(3.2)
Interval Read Data
(3.3)
Monthly Billed Read Data
SSWD Data Warehouse
(3.1)
Billing/Read data
TrueBill
Customer & Account
Billing
Collections
Finance – TrueStatement
Meters & Equipment
Service Requests/ Orders
Billing/Invoice data
Customer Letter data
Broderick - Print Vendor
AR data
AP Data
GL Data
Great Plains
ArcGIS
(Data Depository)
Account Asset Data
OnBase
(4.1)
SR Data
(4.2)
Service Request Update Data
Cityworks
Invoices, Photo's, EA's

Recordall
RCDL | Mechanical Flow Meters

Recordall® Turbo Series Meters

Models 160 (1-1/2 in.), 200 (2 in.), 450 (3 in.), 1000 (4 in.), 2000 (6 in.), 3500 (8 in.), 5500 (10 in.) and 6200 (12 in.) NSF/ANSI/CAN Standards 61 and 372 Certified

DESCRIPTION

Recordall Turbo Series meters meet or exceed the most recent revision of AWWA Standard C701 Class II Standards and are available in a lead-free bronze alloy for sizes 1-1/2 in. through 10 in. and cast iron for 12 in. meters. Turbo Series meters comply with the lead-free provisions of the Safe Drinking Water Act. Sizes 1-1/2 in. through 12 in. meters are also certified to NSF/ANSI/CAN Standards 61 and 372 (Trade Designation: Turbo Series LL-NS) and carry the NSF-61 mark on the housing. All components of the lead-free alloy meter (housing, measuring element, seals and so on) comprise the certified system.

Models 160 through 6200 are designed for 1-1/2 in. through 12 in. applications. These meters feature:

- Direct coupled turbine based on an exclusive "floating rotor" design that reduces bearing friction—and associated wear and tear.
- Low pressure loss for improved system efficiency.
- Exceptional registration accuracy across low flow rate, normal operating flow rate and maximum continuous operation flow.
- Permanently sealed, tamper-resistant register or encoder.
- Integral strainer helps protect your system from damaging debris and related downtime. Integral strainer is standard on 1-1/2 in. meter, and optional on 2 in. through 4 in. meters.
- Meters and encoders are compatible with Badger Meter AMR/AMI meter reading systems and other approved reading technologies.

Applications: Recordall Turbo Series meters are designed for cold water, commercial and industrial applications where flows are consistent medium to high flows. Applications include hotels, apartment buildings, irrigations centers and manufacturing and processing plants. Turbo Series meters help reduce day-to-day maintenance costs while delivering accurate and efficient performance.

Operation & Performance: Direct magnetic drive is achieved when the magnet carrier is driven by a gear train coupled to the rotor. The gear train consists of two sets of gears connected by a vertical transmission shaft. One gear set is at the magnet carrier, the other is a worm gear set at the rotor shaft. When water flows into the Turbo Series meter measuring element, it contacts the multi-vaned rotor. The resulting rotor rotation is then transmitted by magnetic coupling to a sealed register or encoder. The direct magnetic drive is built to provides a reliable meter-to-registration coupling.

Tamper-Proof Features: Unauthorized removal of the register or encoder is inhibited by the option of a tamper detection seal wire screw, TORX® tamper-resistant seal screw or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

Construction: The Recordall Turbo Series meter is constructed in compliance with ANSI and AWWA C701 standards. It consists of the following basic components: meter housing, interchangeable, unitized measuring element and permanently sealed direct reading registers or encoders.

The measuring element consists of the transmission coupling, rotor, inlet and outlet straightening vanes with nose cones, and calibration ring assembly. The unique inlet and outlet straightening vanes minimize swirl from piping arrangements upstream as well as downstream.

A strainer is recommended to help ensure optimal flow conditioning and protection for the measuring element. The integral strainer is standard on the 1-1/2 in. meter and an available option on the 2 in. through 4 in. meters. The stainless steel strainer is built into the inlet end and includes a removable cover plate to permit easy access for routine cleaning. External strainers are available in sizes 2 in. through 12 in.

To simplify maintenance, the registers or encoders and measuring elements can be removed without removing the meter housing. Interchangeability of certain parts between meters also minimizes spare parts inventory investment.

Meter Installation: The meter is designed for installations where flow is in one direction only. Companion flanges for installation of meters on various pipe types and sizes are available in cast iron or NL bronze as an option. See the *Recordall Turbo Series Meters User Manual* available at *badgermeter.com* for specific instructions.

SPECIFICATIONS

Turbo Series Model	**160** 1-1/2 in. (40 mm)	**200** 2 in. (50 mm)	**450** 3 in. (80 mm)	**1000** 4 in. (100 mm)	**2000** 6 in. (150 mm)	**3500** 8 in. (200 mm)	**5500** 10 in. (250 mm)	**6200** 12 in. (300 mm)
Meter Flanges AWWA 125 Pound Class	Elliptical	Elliptical or Round	Round	Round	Round	Round	Round	Round AWWA 125 lb class
Typical Operating Range (100% ± 1.5%)	4…200 gpm (0.9…45.4 m^3/h)	4…310 gpm (0.9…70.4 m^3/h)	5…550 gpm (1.1…124.9 m^3/h)	10…1250 gpm (2.3…284 m^3/hr)	20…2500 gpm (4.5…568 m^3/h)	30…4500 gpm (6.8…1022 m^3/h)	50…7000 gpm (11.4…1590 m^3/h)	90…8800 gpm (20.5…1998 m^3/h)
Typical Low Flow (95% min.)	2.5 gpm (0.6 m^3/h)	2.5 gpm (0.6 m^3/h)	4 gpm (0.9 m^3/h)	6 gpm (1.4 m^3/h)	12 gpm (2.7 m^3/h)	20 gpm (4.5 m^3/h)	30 gpm (6.8 m^3/h)	65 gpm (14.8 m^3/h)
Max. Continuous Flow	160 gpm (36 m^3/h)	200 gpm (45.4 m^3/h)	450 gpm (102.2 m^3/h)	1000 gpm (227.1 m^3/h)	2000 gpm (454 m^3/h)	3500 gpm (795 m^3/h)	5500 gpm (1250 m^3/h)	6200 gpm (1408 m^3/h)
Maximum Intermittent Flow	200 gpm (45.4 m^3/h)	310 gpm (70.4 m^3/h)	550 gpm (124.9 m^3h)	1250 gpm (284 m^3h)	2500 gpm (568 m^3/h)	4500 gpm (1022 m^3/h)	7000 gpm (1590 m^3h)	8800 gpm (1988 m^3/h)
Pressure Loss at Max. Continuous Flow	3.8 psi (0.26 bar)	3.1 psi (0.21 bar)	1.8 psi (0.12 bar)	7.3 psi (0.50 bar)	4.8 psi (0.33 bar)	2.5 psi (0.17 bar)	1.6 psi (0.11 bar)	0.8 psi (0.05 bar)
Pressure Loss at Max. Continuous Flow: With Integral Strainer	9.9 psi (0.68 bar)	8.3 psi (0.57 bar)	5 psi (0.43 bar)	17.8 psi (1.2 bar)	—			
Max. Operating Pressure	150 psi (10 bar)							
Max. Operating Temperature	120° F (49° C)							
Integral Strainer	Optional on 2 in. through 4 in. meters. Built into inlet end. Removable cover plate permits access to strainer for cleaning.				—			
Optional External Strainer	—	Available for Models 200, 450, 1000, 2000, 3500, 5500 and 6200.						
NPT Test Port	Standard with integral strainer; optional for other models.				Optional for Models 2000 and 3500.		—	

MATERIALS

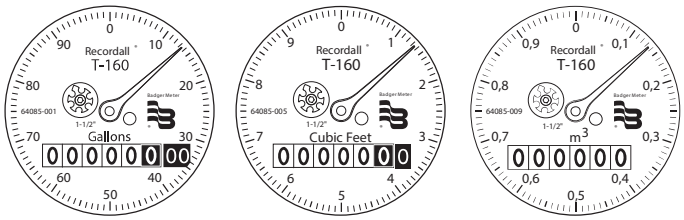
Meter Housing	Lead-free alloy (**EXCEPTION**: Model 6200 meter housing is blue epoxy-coated cast iron)
Turbo Head	Lead-free alloy
Nose Cone & Straightening Vanes	Thermoplastic
Rotor	Thermoplastic
Rotor Radial Bearings	Lubricated thermoplastic
Rotor Thruster Bearing	Sapphire jewels
Rotor Bearing Pivots	Passivated 316 stainless steel
Calibration Mechanism	Stainless steel & thermoplastic
Magnet	Ceramic
Trim	Stainless steel
Register Housing & Cover	Thermoplastic or bronze
Integral Strainer & Trim	Stainless steel

REGISTERS / ENCODERS

Standard—Sweep-Hand Registration

The standard register is a straight-reading, permanently sealed magnetic drive register. Dirt, moisture, tampering and lens fogging problems are eliminated. The register has a six-odometer wheel totalization display, 360° test circle with center sweep hand, and flow finder to detect leaks. Register gearing is made of self-lubricating engineered polymer, which minimizes friction and provides long life. The multi-position register simplifies meter installation and reading. The register capacity for the 1-1/2 in., 2 in., 3 in. and 4 in. meters is 100,000,000 gallons (10,000,000 ft^3, 1,000,000 m^3). The register capacity for the 6 in., 8 in., and 10 in. meters is 1,000,000,000 gallons (100,000,000 ft^3, 10,000,000 m^3). The high-flow register capacity for the 12 in. meter is 10,000,000,000 gallons (1,000,000,000 ft^3, 10,000,000 m^3).

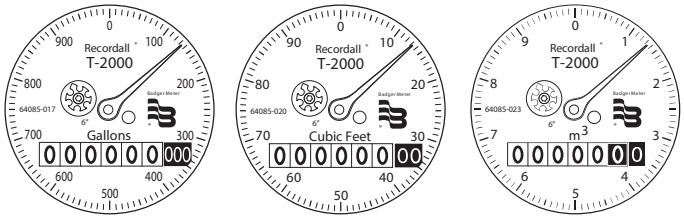
Registers for 1-1/2 in., 2 in., 3 in. and 4 in. Meters



Sweep Hand Revolution

Meter Model	Gallon	Cubic Feet	Cubic Meter
160	100	10	1
200	100	10	1
450	100	10	1
1000	100	10	1

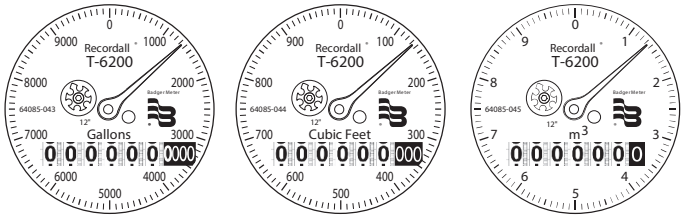
Registers for 6 in., 8 in. and 10 in. Meters



Sweep Hand Revolution

Meter Model	Gallon	Cubic Feet	Cubic Meter
2000	1000	100	10
3500	1000	100	10
5500	1000	100	10

Registers for 12 in. Meters



Sweep Hand Revolution

Meter Model	Gallon	Cubic Feet	Cubic Meter
6200	10000	1000	10

Optional—Encoders for AMR/AMI Reading Solutions

AMR/AMI solutions are available for all Recordall Disc Series meters. All reading options can be removed from the meter without disrupting water service. Badger Meter encoders provide years of reliable, accurate readings for a variety of applications and are also available pre-wired to Badger Meter approved AMR/AMI solutions. See details at *badgermeter.com*.

PHYSICAL DIMENSIONS OF METERS WITHOUT STRAINER

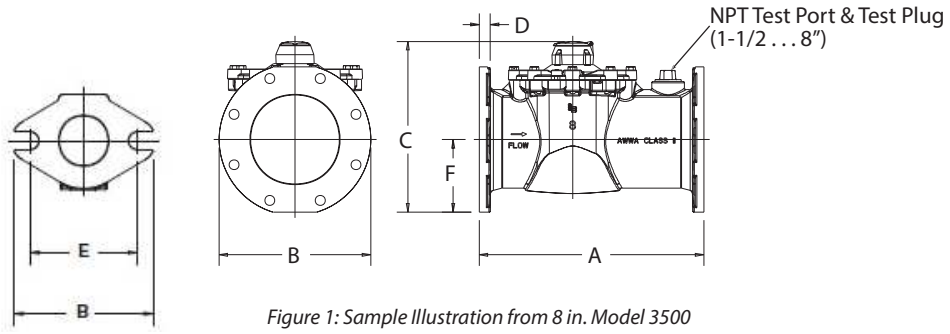


Figure 1: Sample Illustration from 8 in. Model 3500

Turbo Series Model	200	200	450	1000	2000	3500	5500	6200
Meter Flanges	2 in. Elliptical	2 in. Round	3 in. Round	4 in. Round	6 in. Round	8 in. Round	10 in. Round	12 in. Round
Meter & Pipe Size	2 in. (50 mm)	2 in. (50 mm)	3 in. (80 mm)	4 in. (100 mm)	6 in. (150 mm)	8 in. (200 mm)	10 in. (250 mm)	12 in. (300 mm)
Net Weight	14.9 lb (6.8 kg)	17.4 lb (7.9 kg)	31 lb (14.1 kg)	40 lb (18.1 kg)	77 lb (35 kg)	123 lb (55.7 kg)	210 lb (95.3 kg)	262 lb (118.8 kg)
Shipping Weight	16.4 lb (7.4 kg)	18.9 lb (8.6 kg)	34 lb (15.4 kg)	45 lb (20.4 kg)	89 lb (40.4 kg)	147 lb (66.6 kg)	235 lb (106.6 kg)	286 lb (129.7 kg)
Qty. of Bolts	2	4	4	8	8	8	12	12
NPT Test Port (optional)	1-1/2 in. (40 mm)	1-1/2 in. (40 mm)	2 in. (50 mm)	2 in. (50 mm)	2 in. (50 mm)	2 in. (50 mm)	—	—
Length (A)	10 in. (254 mm)	10 in. (254 mm)	12 in. (305 mm)	14 in. (356 mm)	18 in. (457 mm)	20 in. (508 mm)	26 in. (660.4 mm)	19-11/16 in. (500 mm)
Width (B)	5-27/32 in. (148 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)	9 in. (229 mm)	11 in. (280 mm)	13-1/2 in. (343 mm)	16 in. (406.4 mm)	19 in. (482 mm)
Height (C)	6-1/2 in. (165 mm)	7-3/32 in. (180 mm)	8-11/16 in. (220 mm)	9-21/32 in. (245 mm)	13-5/16 in. (338 mm)	15-3/16 in. (385 mm)	17-15/32 in. (443 mm)	19-11/16 in. (500 mm)
Flange (D)	25/32 in. (20 mm)	5/8 in. (16 mm)	3/4 in. (19 mm)	13/16 in. (21 mm)	7/8 in. (22 mm)	1 in. (25 mm)	1-1/16 in. (27 mm)	1.26 in. (32 mm)
Bolt Circle (E)	4-1/2 in. (114 mm)	4-3/4 in. (121 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)	9-1/2 in. (241 mm)	11-3/4 in. (298 mm)	14-1/4 in. (362 mm)	17 in. (432 mm)
Centerline (F)	2-1/16 in. (52 mm)	2-5/8 in. (67 mm)	3-11/32 in. (85 mm)	4-5/16 in. (109 mm)	5-1/4 in. (133 mm)	6-3/8 in. (162 mm)	7-7/8 in. (199.4 mm)	8-7/8 in. (226 mm)

PHYSICAL DIMENSIONS OF METERS WITH INTEGRAL STRAINER

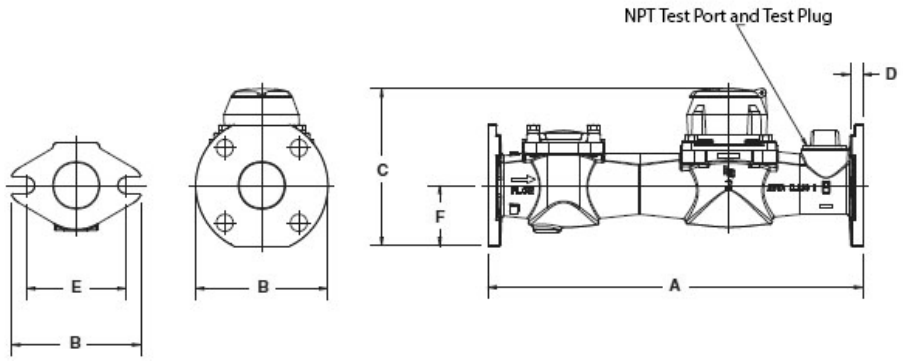
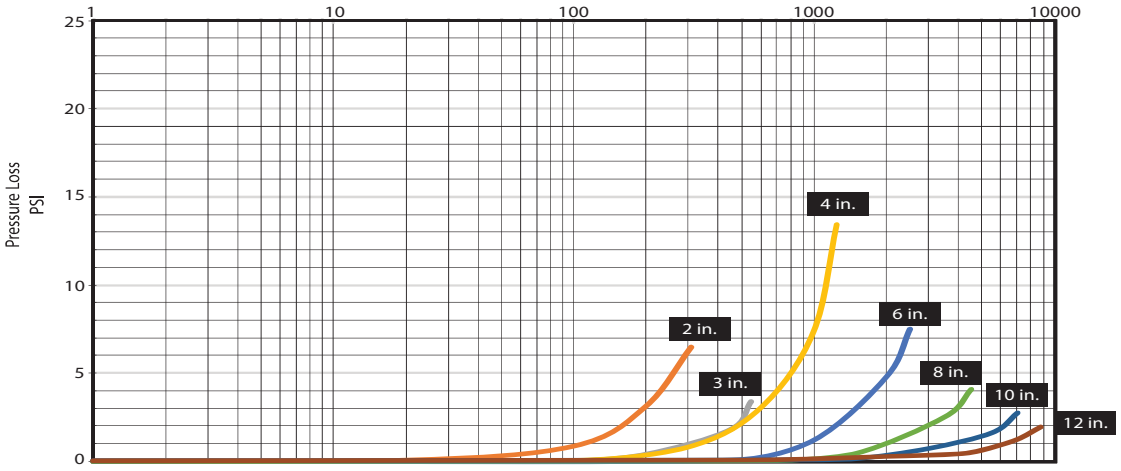


Figure 2: Physical dimensions

Turbo Series Model	160	200	200	450	1000
Meter Flanges	Elliptical	Elliptical	Round	Round	Round
Meter & Pipe Size	1-1/2 in. (40 mm)	2 in. (50 mm)	2 in. (50 mm)	3 in. (80 mm)	4 in. (100 mm)
Net Weight	14.3 lb (6.5 kg)	24 lb (11 kg)	26 lb (12 kg)	49 lb (22 kg)	60 lb (27.22 kg)
Shipping Weight	16.8 lb (7.6 kg)	28 lb (13 kg)	30 lb (14 kg)	55 lb (25 kg)	70 lb (31.75 kg)
Number of Bolts	2	2	4	4	8
NPT Test Port (Standard)	1 in. (25.4 mm)	1-1/2 in. (40 mm)	1-1/2 in. (40 mm)	2 in. (50 mm)	2 in. (50 mm)
Length (A)	13 in. (330 mm)	17 in. (432 mm)	17 in. (432 mm)	19 in. (483 mm)	23 in. (584 mm)
Width (B)	5-7/32 in. (133 mm)	5-27/32 in. (148 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)	9 in. (229 mm)
Height (C)	6-9/32 in. (159 mm)	6-1/2 in. (165 mm)	7-3/32 in. (180 mm)	8-15/16 in. (227 mm)	9-21/32 in. (245 mm)
Flange (D)	51/64 in. (20 mm)	27/32 in. (47 mm)	5/8 in. (16 mm)	27/32 in. (21 mm)	13/16 in. (21 mm)
Bolt Circle (E)	4 in. (102 mm)	4-1/2 in. (114 mm)	4-3/4 in. (121 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)
Centerline (F)	1-27/32 in. (47 mm)	2-1/16 in. (52 mm)	2-5/8 in. (67 mm)	3-19/32 in. (91 mm)	4-5/16 in. (109 mm)

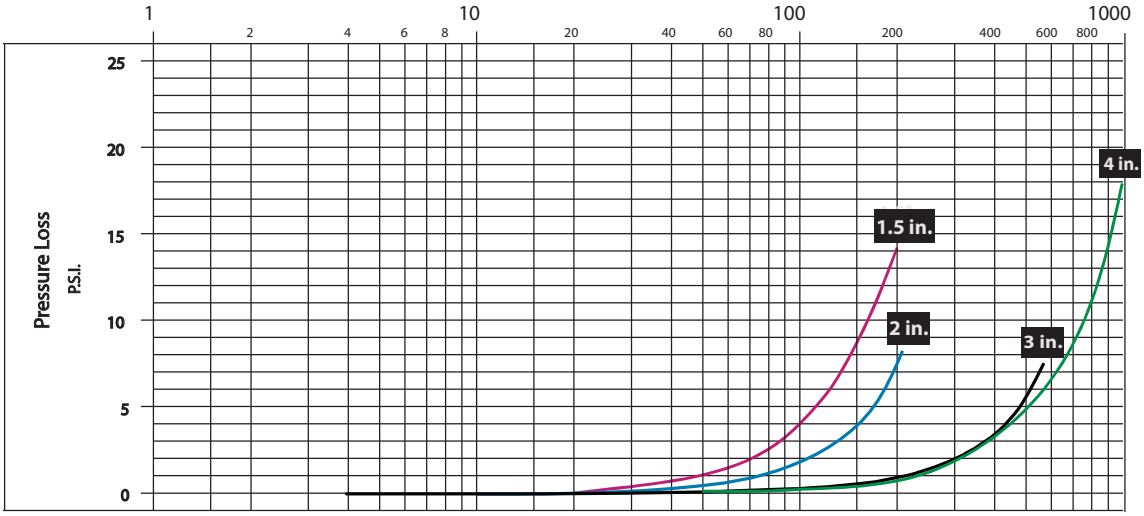
PRESSURE LOSS CHART FOR METERS WITHOUT STRAINER

Rate of flow in gallons per minute (gpm)



PRESSURE LOSS CHART FOR METERS WITH INTEGRAL STRAINER

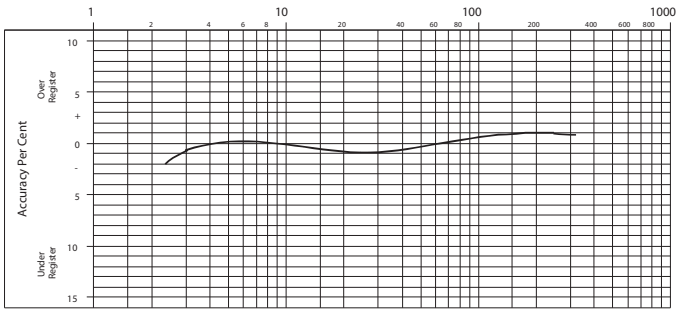
Rate of flow in gallons per minute (gpm)



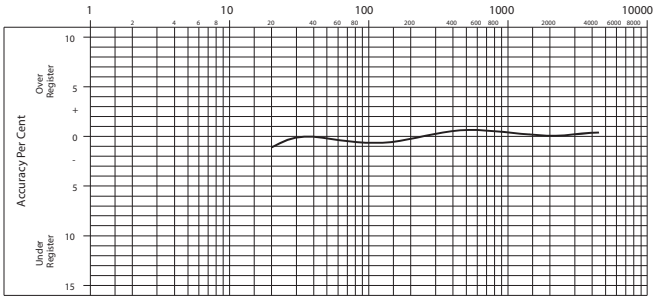
ACCURACY CHARTS FOR METERS WITHOUT STRAINER

Rate of flow in gallons per minute (gpm)

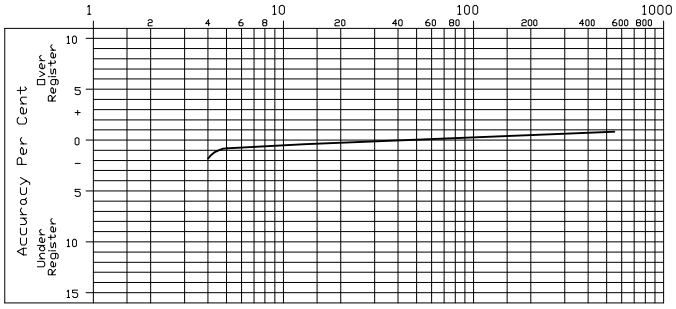
2 in. Meter



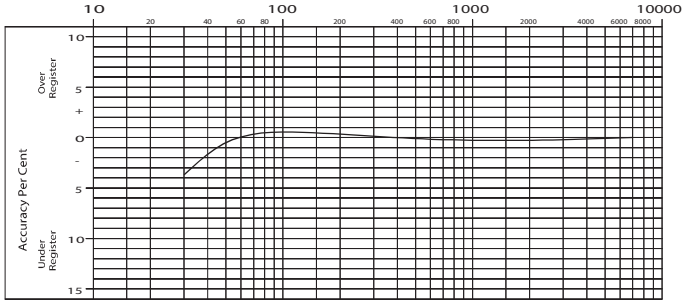
8 in. Meter



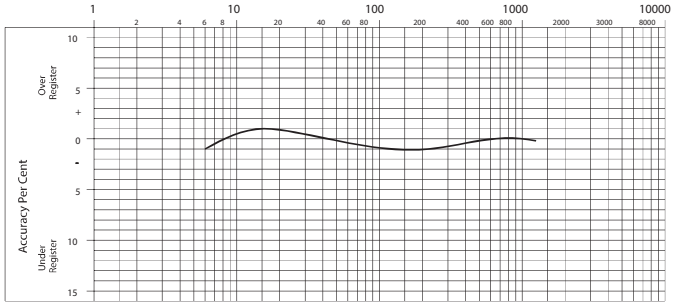
3 in. Meter



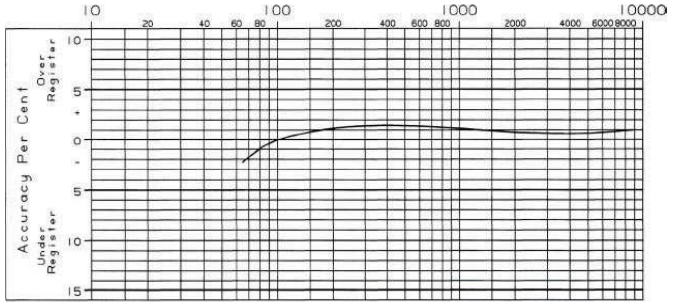
10 in. Meter



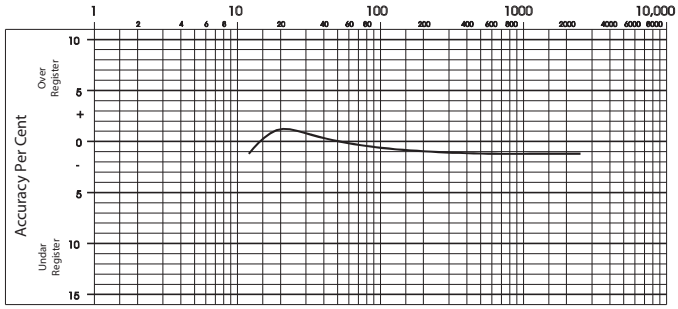
4 in. Meter



12 in. Meter



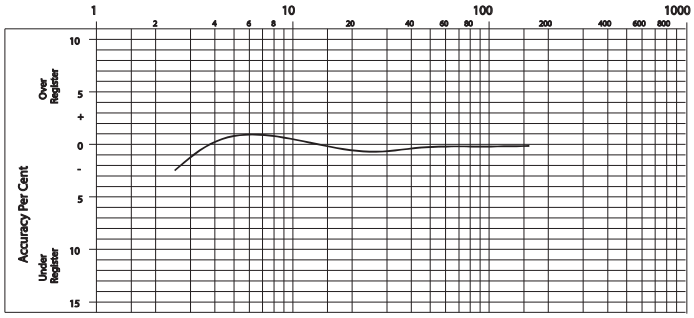
6 in. Meter



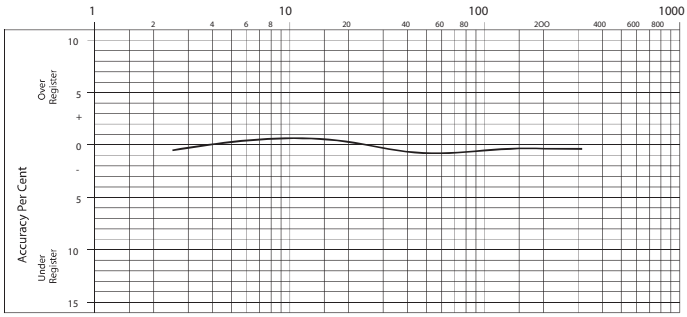
ACCURACY CHARTS FOR METERS WITH INTEGRAL STRAINER

Rate of flow in gallons per minute (gpm)

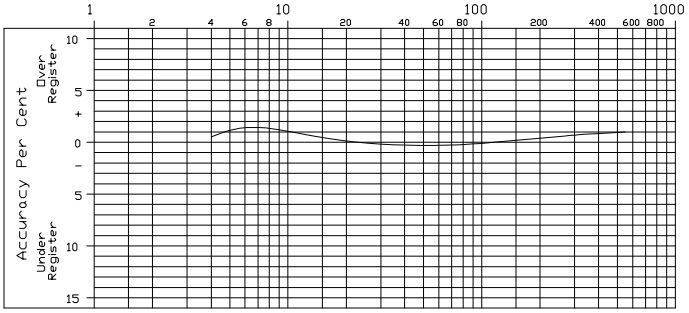
1-1/2 in. Meter



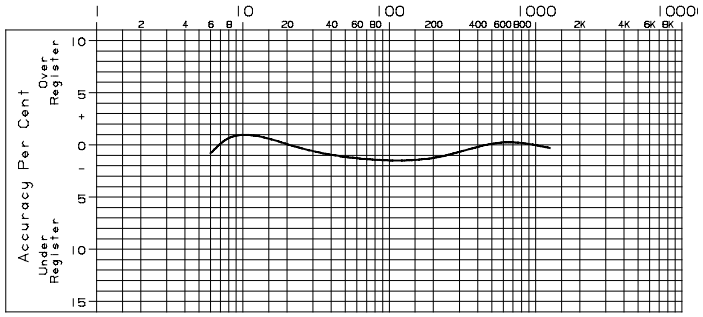
2 in. Meter



3 in. Meter



4 in. Meter



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Legacy Document Numbers: RTS-T-1-1/2. 3. 4. 6. 8. 10 and 12; RTS-T-I 1-1/2, 2, 3, and 4

Recordall®
RCDL | Mechanical Flow Meters

Recordall® Turbo Series Meter

Model 450 Fire Hydrant Meter 3 inch

DESCRIPTION

The Badger Meter Model 450 fire hydrant meter is designed for use in measuring cold water from a fire hydrant or other non-permanent installation where flow is in one direction.

Operation

Water flows into the meter's measuring element where flow readings are obtained by rotor revolutions transmitted by magnetic drive coupling through the meter's cover plate to the sealed register. Magnetic drive is achieved by a right angle worm drive, coupling the rotor to the vertical transmission spindle. A ceramic magnet on the spindle rotates around the vertical axis. Through the magnetic coupling, rotor rotation is transmitted to a follower magnet which transmits rotation to the register gearing.

Operating Performance

The Model 450 fire hydrant meters meet or exceed registration accuracy for the low flow rate, normal operating flow rate, and maximum continuous operation flow rate as specifically stated in AWWA Standard C701.

Construction

The Model 450 fire hydrant meter construction consists of three basic components: meter housing, measuring element, and permanently sealed register. The housing is light-weight heat treated aluminum alloy, compact and easy to handle. The measuring element consists of the transmission coupling, measuring element insert, rotor, straightening vane, and calibration vane assembly. The straightening vanes minimize swirl from piping arrangements upstream.

Magnetic Drive

Direct magnetic drive, through the use of high-strength magnets, provides positive, reliable and dependable register coupling.

Restriction Plate

A permanent orifice, positioned in the outlet side of the meter housing, limits the maximum flow of water through the meter. This is provided to protect the measuring element from overspeeding when the meter discharges to atmosphere.

Sealed Register

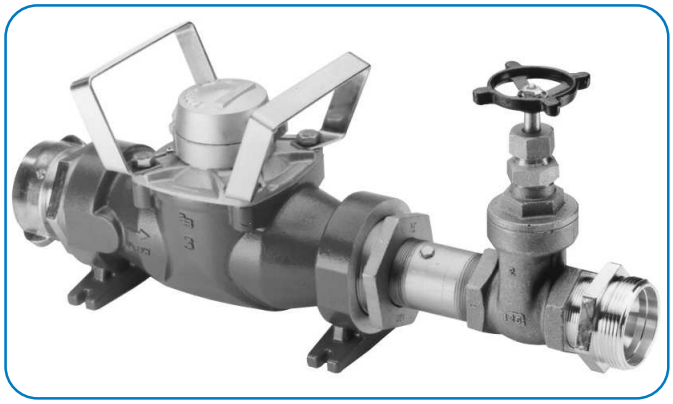
The standard register consists of a straight-reading odometer-type totalization display, 360° test circle with center sweep hand and flow finder to detect leaks. Register gearing consists of self-lubricating thermoplastic gears to minimize friction and provide long life. Permanently sealed; dirt, moisture, tampering and lens fogging problems are eliminated. Multi-position register simplifies meter installation and reading.

Tamper-Resistant Features

Removal of the register to obtain free water is prevented when the tamper detection seal wire screw or TORX® tamper-resistant seal screw is added to the meter. A tamper-resistant calibration plug seal provides protection from unauthorized personnel use.

Strainer

A compression fit double layer stainless steel strainer is installed in the inlet housing tube. The strainer insures optimum long-term field performance.



Maintenance

The Model 450 fire hydrant meters are designed and manufactured to provide long-term service with minimal maintenance. When maintenance is required, it can be performed easily either at the meter installation or at any other convenient location. As an alternative to repair by the utility, Badger Meter offers various maintenance and meter component exchange programs to fit the needs of the utility.

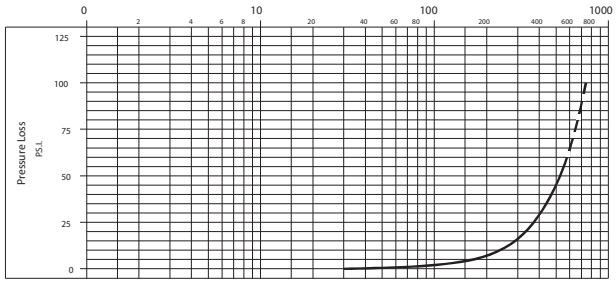
Hose Couplings

The meter is available with standard (2-1/2 in. – 7-1/2 NST) fire hose swivel couplings, unless otherwise specified. Complete thread specifications (listed on the back page of this document) must be furnished for special fire hose fittings.

Options: 2 in. or 2-1/2 in. gate valve, check valve.

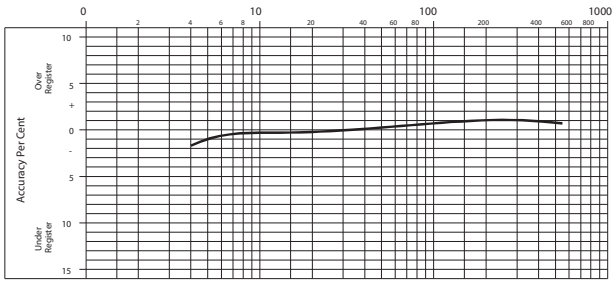
Pressure Loss Chart

Rate of flow in gallons per minute (gpm)



Accuracy Chart

Rate of flow in gallons per minute (gpm)



Badger Meter

RTS-DS-00546-EN-03 (September 2021)

Product Data Sheet

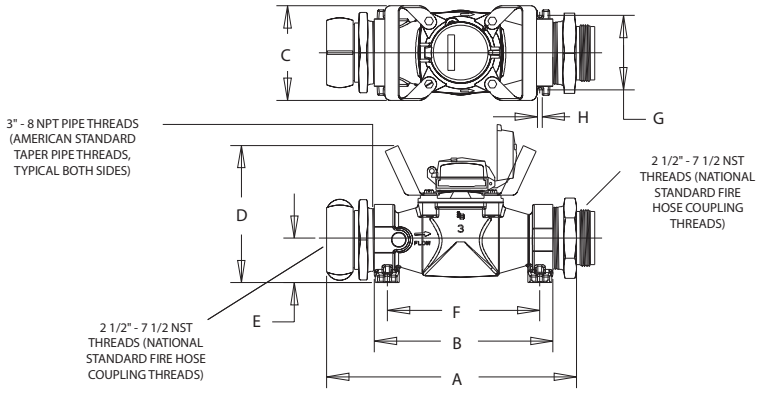
SPECIFICATIONS

Typical Operating Range (100%±1.5%)	5…660 gpm (1.1…150 m^3/hr)
Maximum Continuous Flow	500 gpm (102 m^3/hr)
Maximum Intermittant Flow	660 gpm (150 m^3/hr)
Typical Low Flow (Min. 95%)	4 gpm (0.9 m^3/hr)
Pressure Loss at Max. Continuous Operation	37 psi @ 450 gpm (2.55 bar @ 102 m^3/hr) (standard couplings with orifice and screen) **Note:** 27 psi @ 350 gpm
Maximum Operating Pressure	150 psi (10 bar)
Standard Hose Coupling	2-1/2 in. – 7-1/2 NST threads (78P – 3.4 mm) (National standard fire hose coupling thread)
Register	Straight-reading, permanently sealed magnetic drive standard.
Registration	100,000,000 gallons; 100 gallons/sweep hand revolution.
	10,000,000 cubic feet; 10 cubic ft/sweep hand revolution.
	1,000,000 m^3; 1 m^3/sweep hand revolution.
Flow Restriction (Orifice)	Limits flow through the meter to 660 gpm @ 85 psi (150 m^3/hr @ 59 bar) system pressure with standard couplings.

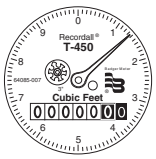
Materials

Housing	Heat treated aluminum alloy
Nose Cone and Straightening Vanes	Thermoplastic
Rotor	Thermoplastic
Rotor Radial Bearings	Lubricated thermoplastic
Rotor Thrust Bearings	Sapphire jewels
Rotor Bearing Pivots	Passivated 316 stainless steel
Calibration Mechanism	Stainless steel and thermoplastic
Magnet	Ceramic
Register Cover	Bronze
Options	2 in. gate valve, 2-1/2 in. gate valve, 2 in. check valve, bronze
Trim	Stainless steel
Inlet Screen	Stainless steel with Elastomer

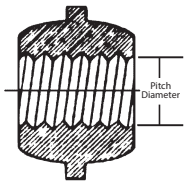
DIMENSIONS



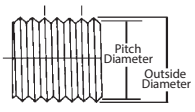
Meter & Pipe Size	Length w/coupl. A	Length w/o coupl. B	Width C	Height D	Ctrline E	F	G	H	Net Weight w/o Fittings	Net Weight w/Fittings	Net Weight w/Valve	Shipping Weight w/o Fittings	Shipping Weight w/Fittings	Shipping Weight w/Valve
3" (DN 80)	17 in. (432 mm)	12 in. (305 mm)	6-3/8 in. (162 mm)	9.0 in. (229 mm)	2-15/16 in. (73 mm)	10-1/4 in. (260 mm)	5 in. (127 mm)	11/32 in. (9 mm)	14.2 lb (6.44 kg)	20.6 lb (9.34 kg)	31.6 lb (14.33 kg)	17.2 lb (7.80 kg)	23.6 lb (10.7 kg)	34.6 lb (15.7 kg)



Specifications for Special Fire Hose Coupling Threads



Female Threads



Male Threads

Required Information

- Number of threads per inch and thread form, if other than American National Standard.
- Outside diameter of male threads.
- Pitch diameter of male threads.
- Pitch diameter of female threads.

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Legacy Document Number: RTS-T-3FH-EN

Recordall® Disc Meters

Lead-Free Bronze Alloy, Sizes 5/8, 5/8 x 3/4, 3/4 & 1 inch
NSF/ANSI Standards 61 and 372 Certified

Model 25—5/8 in., 5/8 × 3/4 in.

Model 35—3/4 in.

Model 55—1 in.

Model 70—1 in.

DESCRIPTION

The Recordall Disc Series meters meet or exceed the most recent revision of AWWA Standard C700 and are available in a lead-free bronze alloy. The meters comply with the lead-free provisions of the Safe Drinking Water Act, are certified to NSF/ANSI Standards 61 and 372 (Trade Designations: M25-LL, M35-LL, M55-LL, M70-LL) and carry the NSF-61 mark on the housing. All components of the lead-free bronze alloy meter (housing, measuring element, seals, and so on) comprise the certified system.

Applications: For use in measurement of potable cold water in residential, commercial and industrial services where flow is in one direction only.

Operation: Water flows through the meter's strainer and into the measuring chamber where it causes the disc to nutate. The disc, which moves freely, nutates on its own ball, guided by a thrust roller. A drive magnet transmits the motion of the disc to a follower magnet located within the permanently sealed register. The follower magnet is connected to the register gear train. The gear train reduces the disc nutations into volume totalization units displayed on the register or encoder face.

Operating Performance: The Recordall Disc Series meters meet or exceed registration accuracy for the low flow rates (95%), normal operating flow rates (100 ±1.5%), and maximum continuous operation flow rates as specifically stated in AWWA Standard C700.

Construction: Recordall Disc meter construction, which complies with ANSI/AWWA standard C700, consists of three basic components: meter housing, measuring chamber and permanently sealed register or encoder. The meter is available in a lead-free bronze alloy with externally threaded spuds. A corrosion-resistant engineered polymer material is used for the measuring chamber.

Magnetic Drive: Direct magnetic drive, through the use of high-strength magnets, provides positive, reliable and dependable register coupling for straight-reading or AMR/AMI meter reading options.

Tamper-Proof Features: Unauthorized removal of the register or encoder is inhibited by the option of a tamper detection seal wire screw, TORX® tamper-resistant seal screw or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

Maintenance: Badger Meter Recordall Disc Series meters are designed and manufactured to provide long-term service with minimal maintenance. When maintenance is required, it can be performed easily either at the meter installation or at any other convenient location.

To simplify maintenance, the register, measuring chamber, and strainer can be replaced without removing the meter housing from the installation. No change gears are required for accuracy calibration. Interchangeability of parts among like-sized meters and meter models also minimizes spare parts inventory investment. The built-in strainer has an effective straining area of twice the inlet size.

Connections: Tailpieces/Unions for installations of meters on various pipe types and sizes, including misaligned pipes, are available as an option.

Meter Spud and Connection Sizes

Model	Size Designation (in.)	×	"L" Laying Length (in.)	"B" Bore Dia. (in.)	Coupling Nut and Spud Thread (in.)	Tailpiece Pipe Thread (NPT) (in.)
25	5/8	×	7-1/2	5/8	3/4 (5/8)	1/2
	5/8 x 3/4	×	7-1/2	5/8, 3/4	1 (3/4)	3/4
35	3/4	×	7-1/2	3/4	1 (3/4)	3/4
	3/4	×	9	3/4	1 (3/4)	3/4
	3/4 x 1	×	9	3/4	1-1/4 (1)	1
55	1	×	10-3/4	1	1-1/4 (1)	1
70	1	×	10-3/4	1	1-1/4 (1)	1

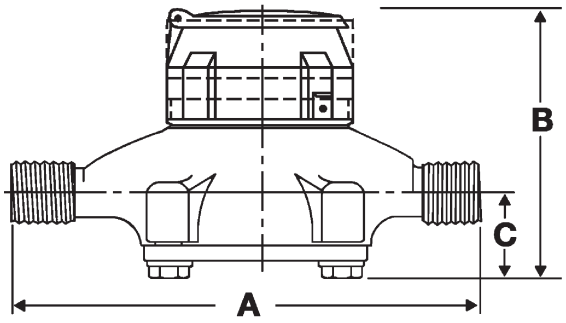
SPECIFICATIONS

	Model 25 (5/8 in. & 5/8 × 3/4 in.)	**Model 35 (3/4 in.)**	**Model 55 (1 in.)**	**Model 70 (1 in.)**
Typical Operating Range (100% ±1.5%)	0.5…25 gpm (0.11…5.7 m^3/hr)	0.75…35 gpm (0.17…7.9 m^3/hr)	1…55 gpm (0.23…12.5 m^3/hr)	1.25…70 gpm (0.28…16 m^3/hr)
Low Flow	0.25 gpm (0.057 m^3/hr) Min. 98.5%	0.375 gpm (0.085 m^3/hr) Min. 97%	0.5 gpm (0.11 m^3/hr) Min. 95%	0.75 gpm (0.17 m^3/hr) Min. 95%
Maximum Continuous Operation	15 gpm (3.4 m^3/hr)	25 gpm (5.7 m^3/hr)	40 gpm (9.1 m^3/hr)	50 gpm (11.3 m^3/hr)
Pressure Loss at Maximum Continuous Operation	**5/8 in. size**: 3.5 psi @ 15 gpm (0.24 bar @ 3.4 m^3/hr) **5/8 × 3/4 in. size**: 2.8 psi @ 15 gpm (0.19 bar @ 3.4 m^3/hr)	5 psi @ 25 gpm (0.37 bar @ 5.7 m^3/hr)	3.4 psi @ 40 gpm (0.23 bar @ 9.1 m^3/hr)	6.5 psi @ 50 gpm (0.45 bar @ 11.3 m^3/hr)
Maximum Operating Temperature	80° F (26° C)			
Maximum Operating Pressure	150 psi (10 bar)			
Measuring Element	Nutating disc, positive displacement			
Meter Connections	*Available in NL bronze and engineered polymer to fit spud thread bore diameter sizes:*			
	5/8 in. size: 5/8 in. (DN 15 mm) **5/8 × 3/4 in. size**: 3/4 in. (DN 15 mm)	3/4 in. (DN 20 mm)	1 in. (DN 25 mm)	1 in. (DN 25 mm)

MATERIALS

	Model 25 (5/8 in. & 5/8 × 3/4 in.)	**Model 35 (3/4 in.)**	**Model 55 (1 in.)**	**Model 70 (1 in.)**
Meter Housing	Lead-free bronze alloy			
Housing Bottom Plates	Cast iron, lead-free bronze alloy, engineered polymer	Cast iron, lead-free bronze alloy		
Measuring Chamber	Engineered polymer			
Disc	Engineered polymer			
Trim	Stainless steel			
Strainer	Engineered polymer			
Disc Spindle	Stainless steel	Stainless steel	Engineered polymer	Stainless steel
Magnet	Ceramic	Ceramic	Ceramic	Ceramic
Magnet Spindle	Engineered polymer	Stainless steel	Engineered polymer	Stainless steel
Register Lid and Shroud	Engineered polymer, bronze			

DIMENSIONS



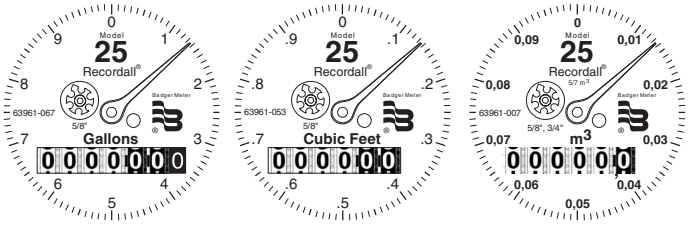
Meter Size	Model	A Laying Length	B Height Reg.	C Centerline Base	Width	Approx. Shipping Weight
5/8 in. (15 mm)	25	7-1/2 in. (190 mm)	4-15/16 in. (125 mm)	1-11/16 in. (42 mm)	4-1/4 in. (108 mm)	4-1/2 lb (2 kg)
5/8 in. × 3/4 in. (15 mm)		7-1/2 in. (190 mm)	4-15/16 in. (125 mm)	1-11/16 in. (42 mm)	4-1/4 in. (108 mm)	4-1/2 lb (2 kg)
3/4 in. (20 mm)	35	7-1/2 in. (190 mm)	5-1/4 in. (133 mm)	1-5/8 in. (41 mm)	5 in. (127 mm)	5-1/2 lb (2.5 kg)
3/4 in. (20 mm)		9 in. (229 mm)	5-1/4 in. (133 mm)	1-5/8 in. (41 mm)	5 in. (127 mm)	5-3/4 lb (2.6 kg)
3/4 in. × 1 in. (20 mm)		9 in. (229 mm)	5-1/4 in. (133 mm)	1-5/8 in. (41 mm)	5 in. (127 mm)	6 lb (2.7 kg)
1 in. (25 mm)	55	10-3/4 in. (273 mm)	6 in. (152 mm)	2-1/32 in. (52 mm)	6-1/4 in. (159 mm)	8-3/4 lb (3.9 kg)
1 in. (25 mm)	70	10-3/4 in. (273 mm)	6-1/2 in. (165 mm)	2-5/16 in. (59 mm)	7-3/4 in. (197 mm)	11-1/2 lb (5.2 kg)

REGISTERS / ENCODERS

Standard—Sweep-Hand Registration

The standard register is a straight-reading, permanently sealed magnetic drive register. Dirt, moisture, tampering and lens fogging problems are eliminated. The register has a six-odometer wheel totalization display, 360° test circle with center sweep hand, and flow finder to detect leaks. Register gearing is made of self-lubricating engineered polymer, which minimizes friction and provides long life. The multi-position register simplifies meter installation and reading. The register capacity is 10,000,000 gallons (1,000,000 ft^3, 100,000 m^3).

A Model 25 register is used in the following example:



Model	Gallon	Cubic Feet	Cubic Meter
25 (5/8 in.)	10	1	0.1/0.01
25 (5/8 × 3/4 in.)	10	1	0.1/0.01
35	10	1	0.1
55	10	1	0.1
70	10	1	0.1

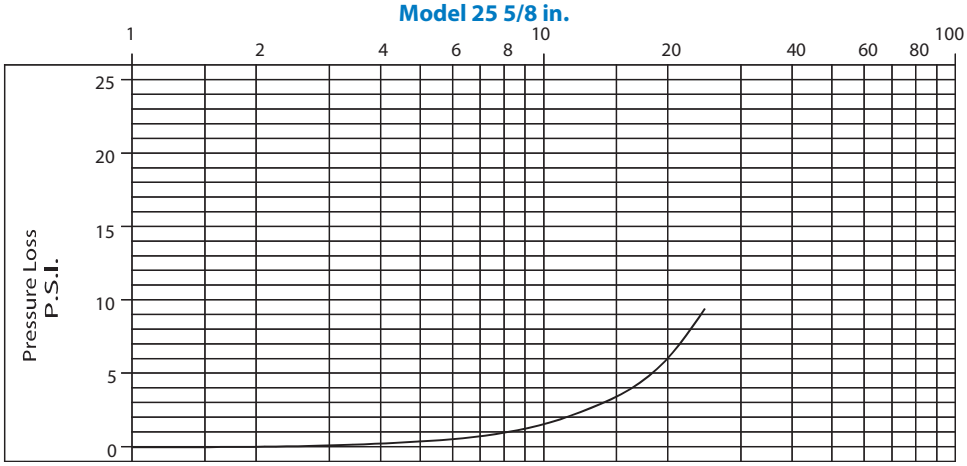
Optional—Encoders for AMR/AMI Reading Solutions

AMR/AMI solutions are available for all Recordall Disc Series meters. All reading options can be removed from the meter without disrupting water service. Badger Meter encoders provide years of reliable, accurate readings for a variety of applications. See details at ***www.badgermeter.com***.

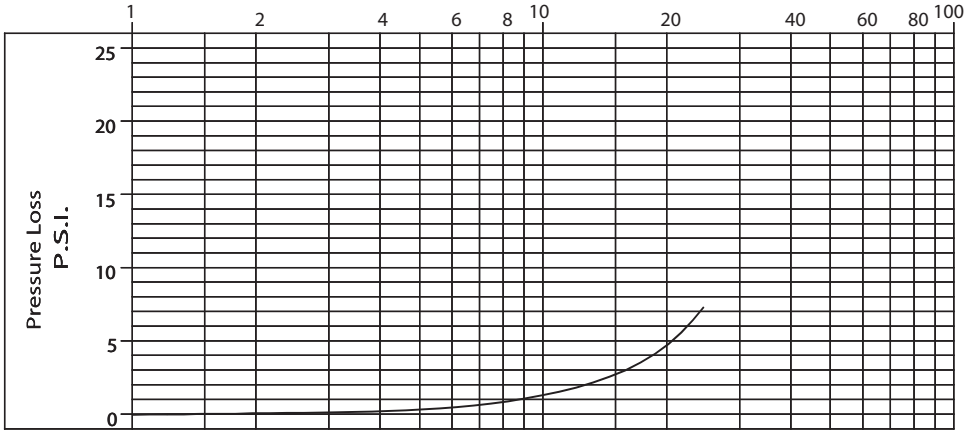
PRESSURE LOSS CHARTS

Rate of Flow in Gallons per Minute

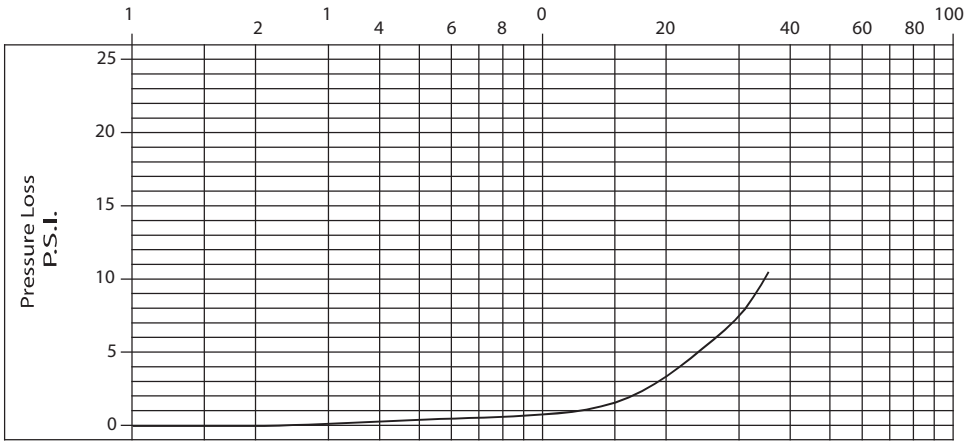
Model 25 5/8 in.



Model 25 5/8 × 3/4 in.



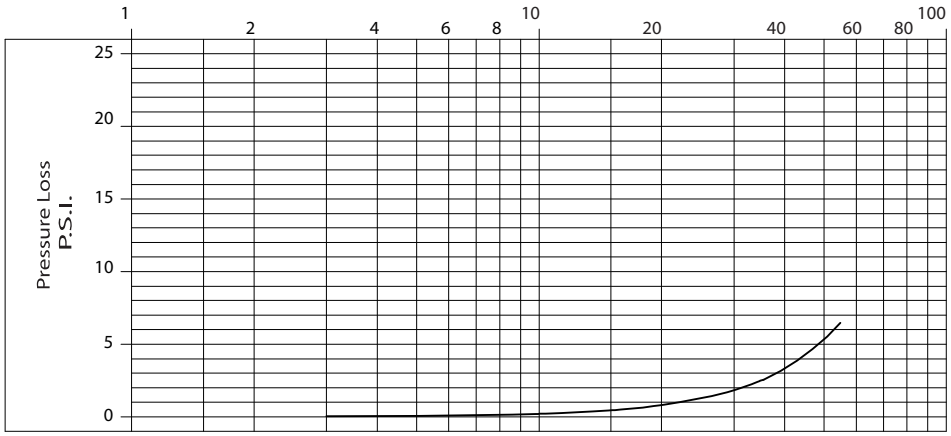
Model 35 3/4 in.



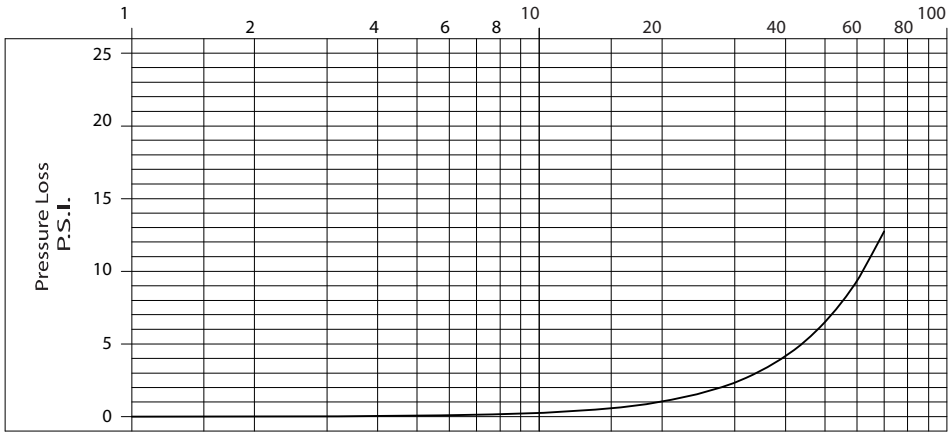
PRESSURE LOSS CHARTS (CONTINUED)

Rate of Flow in Gallons per Minute

Model 55 1 in.

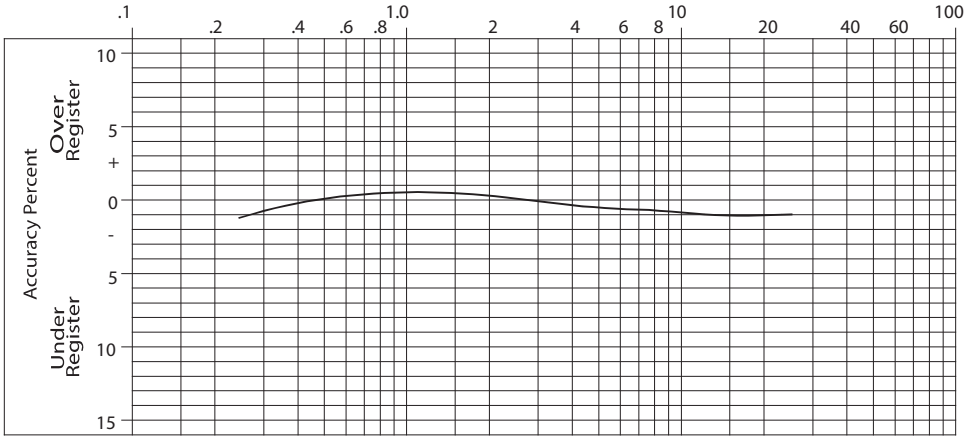


Model 70 1 in.

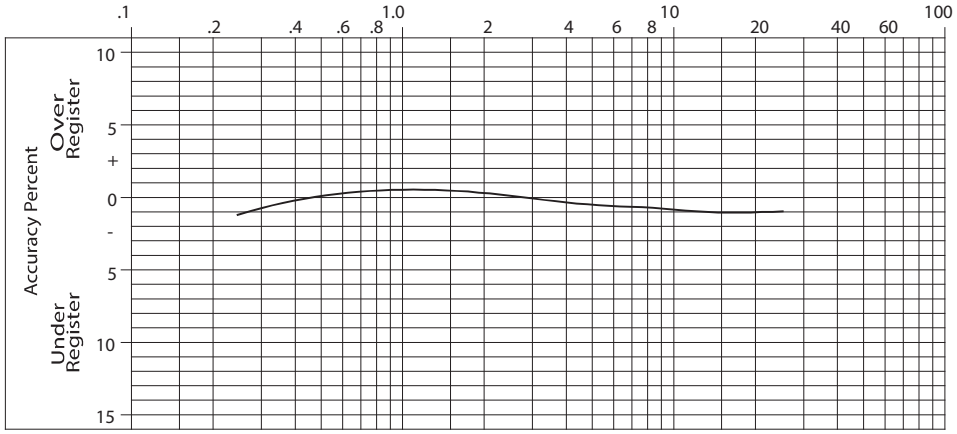


ACCURACY CHARTS

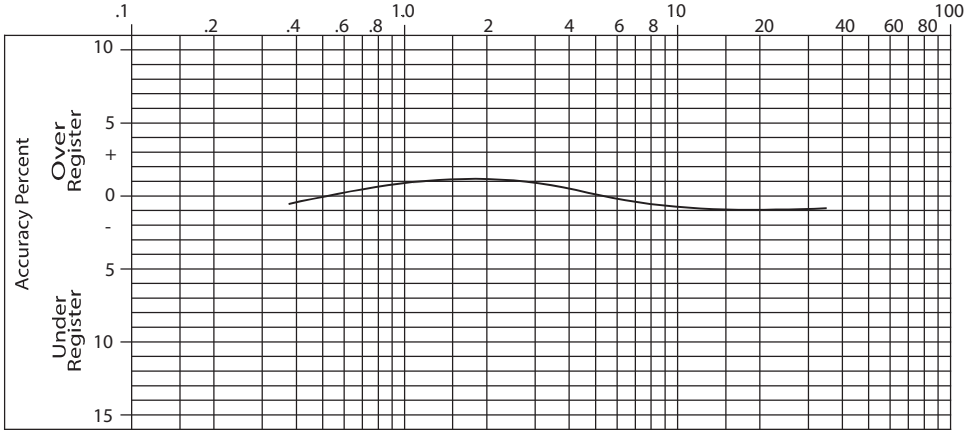
Model 25 5/8 in.



Model 25 5/8 × 3/4 in.

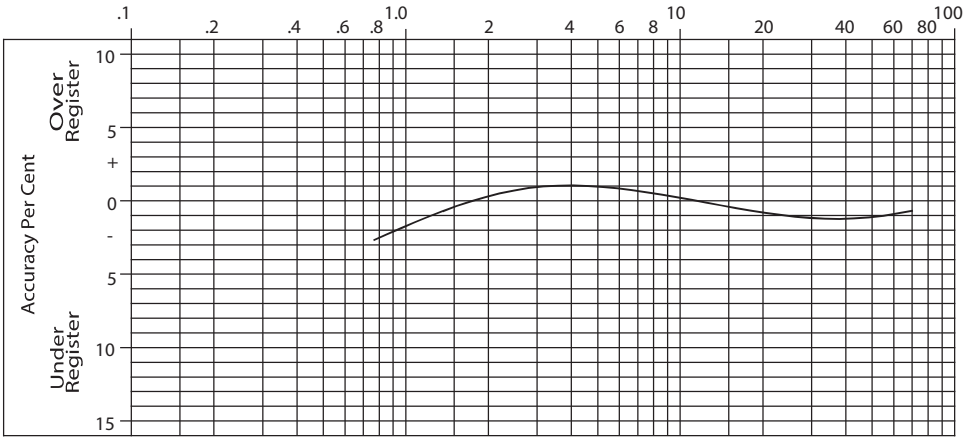


Model 35 3/4 in.

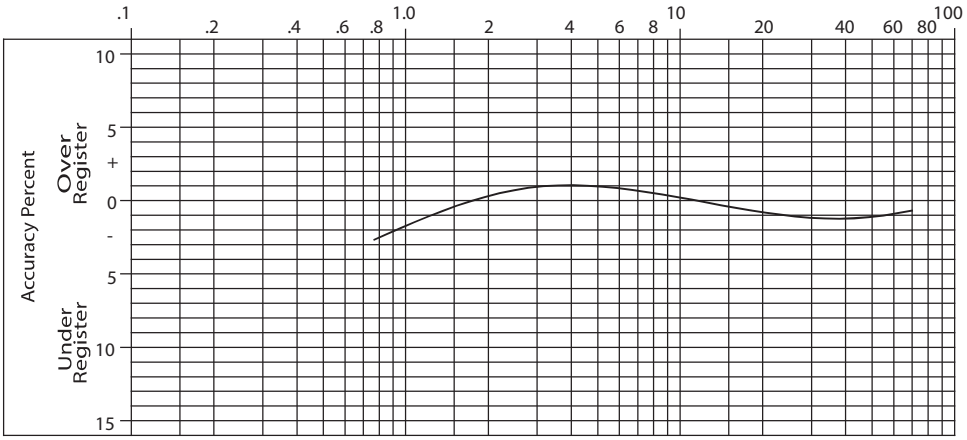


ACCURACY CHARTS (CONTINUED)

Model 55 1 in.



Model 70 1 in.



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Legacy Document Numbers: RDM-DS-00062, 63, 64, 65, 66, and 74

Recordall®
RCDL | Mechanical Flow Meters

Recordall® Compound Series Meter

Lead-Free Bronze Alloy, Sizes 2, 3, 4 & 6 inch
NSF/ANSI/CAN Standards 61 and 372 Certified

DESCRIPTION

The Recordall® Compound Series meters meet or exceed the most recent revision of AWWA Standard C702 and are available in a lead-free bronze alloy. The Compound Series meters comply with the lead-free provisions of the Safe Drinking Water Act, are certified to NSF/ANSI/CAN Standards 61 and 372 (Trade Designation: LL-NS) and carry the NSF-61 mark on the housing. All components of the lead-free bronze alloy meter (housing, measuring element, seals, and so on) comprise the certified system.

Badger Meter Recordall Compound Series meters combine two metering technologies in one innovative package. A positive displacement chamber measures low flow, while a turbine chamber records high flow.

Offered in four sizes, the Compound Series meter features:

- Patented design that eliminates the need for a trigger valve and maintains crossover accuracy
- Permanently sealed, tamper-resistant register or encoder
- Meters and encoders that are compatible with Badger Meter AMR/AMI systems and other approved reading technologies

Badger Meter ORION® and GALAXY® AMR/AMI meter reading systems are available for all Compound Series meters. Itron® ERT reading systems are also available. All register options are removable from the meter without disrupting water service.

TAMPER-PROOF FEATURES

Unauthorized removal of the register or encoder is inhibited by the use of an optional tamper detection seal wire screw, TORX® tamper-resistant seal screw or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

APPLICATIONS

Use the Recordall Compound meter for measuring potable cold water in commercial and industrial applications where flow is in one direction only. The meter is an ideal choice for facilities that experience rapid and wide fluctuations in water demand, such as hospitals, universities, residential complexes and manufacturing or processing facilities.

OPERATION

At low flow rates, the Compound Series meter diverts water up through a bypass to the disc chamber. Leaving the chamber's outlet port, water flows beyond the turbine element and main valve. As the flow rate increases, a pressure differential is created that opens the main valve. The water then flows straight through the turbine chamber. In addition, a portion still flows through the disc chamber before exiting the meter.

Rotor and disc movements are transmitted by magnetic drive couplings to individual register odometers. The direct magnetic drive provides a positive, reliable and dependable register coupling for straight-reading or remote reading options. The self-lubricating thermoplastic register gearing is designed to minimize friction and provide long life.

OPERATING PERFORMANCE

The Recordall Compound Series meets or exceeds registration accuracy for low, normal operating, maximum continuous operation, and changeover flow rates as specified in AWWA Standard C702.

CONSTRUCTION

The Recordall Compound Series meter's construction complies with ANSI and AWWA C702 standards. It consists of three basic components: meter housing, interchangeable measuring elements, and sealed direct reading registers. The measuring element consists of the disc measuring chamber, turbine head assembly, and high flow valve assembly. To simplify maintenance, the registers and measuring elements can be removed without removing the meter housing from the line.

METER INSTALLATION

The meter is designed for installations where flow is in one direction only. A separate strainer is required to ensure optimum flow conditioning and protection of the measuring element. Companion flanges for installation of meters on various pipe types and sizes are available in cast iron or NL bronze as an option.

Badger Meter

RCS-DS-00078-EN-09 (March 2022)

Product Data Sheet

REGISTERS / ENCODERS

Standard—Sweep-Hand Registration

The standard register is a straight-reading, permanently sealed magnetic drive register. Dirt, moisture, tampering and lens fogging problems are eliminated. The register has a six-odometer wheel totalization display, 360° test circle with center sweep hand, and flow finder to detect leaks. Register gearing is made of self-lubricating engineered polymer, which minimizes friction and provides long life. The multi-position register simplifies meter installation and reading. The register capacity is 100,000,000 gallons (10,000,000 ft^3, 1,000,000 m^3).

Optional—Encoders for AMR/AMI Reading Solutions

AMR/AMI solutions are available for all Recordall Compound Series meters. All reading options can be removed from the meter without disrupting water service. Badger Meter encoders provide years of reliable, accurate readings for a variety of applications and are also available pre-wired to Badger Meter approved AMR/AMI solutions. See details at *www.badgermeter.com*.

SPECIFICATIONS

Compound Series Model	2 in. (50 mm)	3 in. (80 mm)	4 in. (100 mm)	6 in. (150 mm)
Meter Flanges, Class 150	2 in. elliptical or round	3 in. round	4 in. round	6 in. round
	(50 mm)	(80 mm)	(100 mm)	(150 mm)
Typical Operating Range (100% ± 1.5%)	0.5…200 gpm (0.1…45 m^3/h)	0.5…450 gpm (0.1…102 m^3/h)	0.75…1000 gpm (0.17…227 m^3/h)	0.75…2000 gpm (0.17…454.4 m^3/h)
Low Flow Registration (95% minimum)	0.25 gpm (0.06 m^3/h)	0.25 gpm (0.06 m^3/h)	0.375 gpm (0.09 m^3/h)	0.375 gpm (0.09 m^3/h)
Maximum Continuous Flow	170 gpm (38.3 m^3/h)	400 gpm (90.3 m^3/h)	800 gpm (181.6 m^3/h)	1500 gpm (340.5 m^3/h)
Pressure Loss at Maximum Continuous Flow	5.4 psi at 170 gpm	6.0 psi at 400 gpm	11.0 psi at 800 gpm	9.3 psi at 1500 gpm
	(0.38 bar at 38.3 m^3/h)	(0.41 bar at 90.3 m^3/h)	(0.75 bar at 181.6 m^3/h)	(0.64 bar at 340.5 m^3/h)
Crossover Flow Rate, Typical	12 gpm (2.73 m^3/h)	12 gpm (2.73 m^3/h)	20 gpm (4.54 m^3/h)	30 gpm (6.81 m^3/h)
Pressure Loss at Crossover	3.5 psi (0.24 bar)	4.0 psi (0.28 bar)	4.0 psi (0.28 bar)	5.0 psi (0.35 bar)
Minimum Crossover Accuracy	97%	97%	97%	95%
Maximum Operating Pressure	150 psi (10 bar)			
Maximum Operating Temperature	105° F (41° C)			
NPT Test Port	1-1/2 in.		2 in.	

Materials

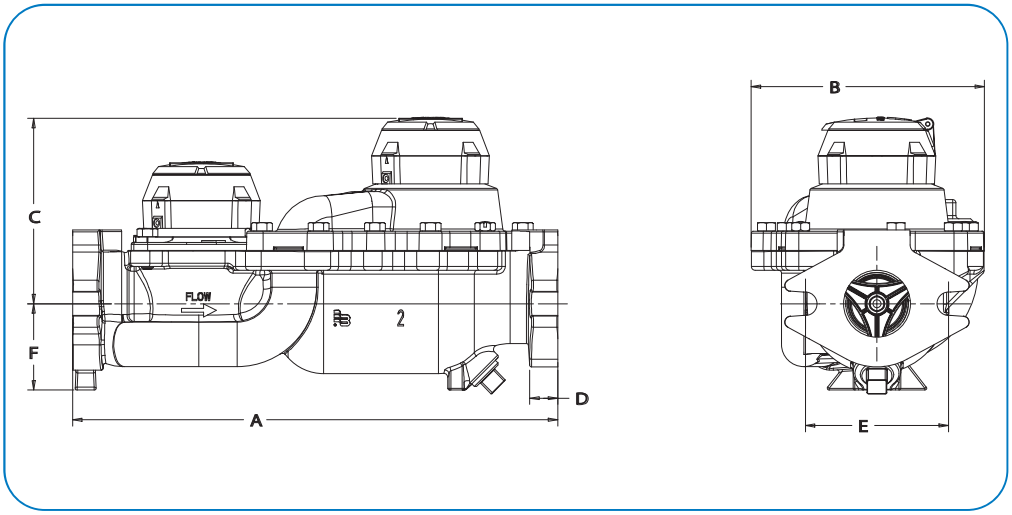
Meter Housing & Cover	Lead-free bronze alloy
Turbo Cast Head	Lead-free bronze alloy
Nose Cone & Straightening Vanes	Thermoplastic
Rotor	Thermoplastic
Rotor Radial Bearings	Lubricated thermoplastic
Rotor Thrust Bearing	Sapphire jewels
Rotor Bearing Pivots	Passivated 316 stainless steel
Calibration Mechanism	Stainless steel & thermoplastic
Measuring Chamber & Disc	Thermoplastic
High Flow Valve	Stainless steel & thermoplastic
Magnets	Ceramic
Register Lens	Glass
Register Housing & Cover	Thermoplastic or bronze
Trim	Stainless steel
Drain Plug (3/4 in.)	Stainless steel or lead-free bronze alloy
Test Plug	Stainless steel or lead-free bronze alloy

PHYSICAL DIMENSIONS

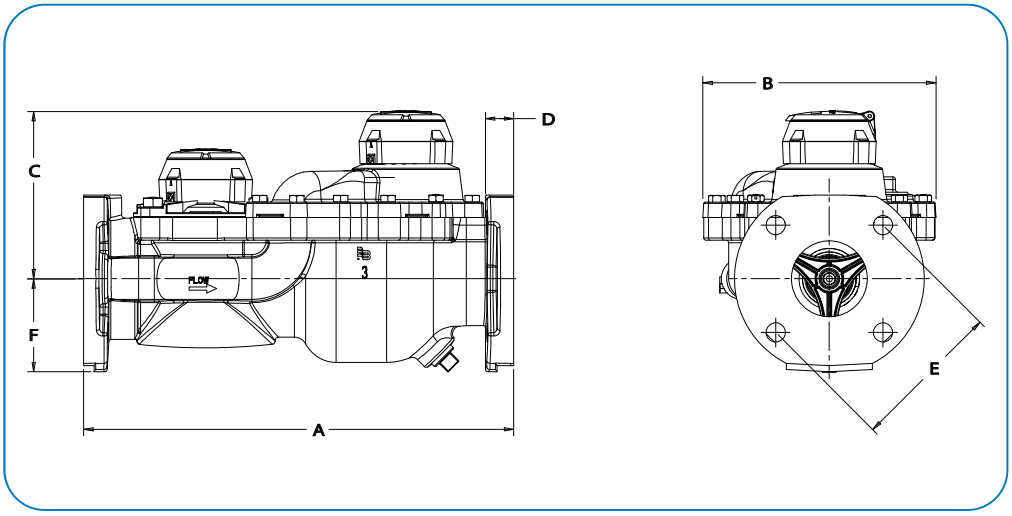
Compound Series Model	2 in. Elliptical (50 mm)	2 in. Round (50 mm)	3 in. (80 mm)	4 in. (100 mm)	6 in. (150 mm)
Meter & Pipe Size	2 in. (50 mm)		3 in. (80 mm)	4 in. (100 mm)	6 in. (150 mm)
Net Weight	45 lb (20 kg)		51 lb (23 kg)	85 lb (38 kg)	152 lb (69 kg)
Shipping Weight	63 lb (29 kg)		79 lb (36 kg)	120 lb (54 kg)	200 lb (90 kg)
Length (A)	15-1/4 in. * (387 mm)		17 in. (432 mm)	20 in. (508 mm)**	24 in. (610 mm)
Width (B)	7-3/8 in. (187 mm)		8-1/2 in. (216 mm)	9-1/8 in. (232 mm)	12-3/8 in. (314 mm)
Height (C)	5-7/8 in. (149 mm)		6-5/8 in. (168 mm)	7-1/4 in. (184 mm)	8-7/8 in. (225 mm)
Flange (D)	5/8 in. (16 mm)		3/4 in. (19 mm)	7/8 in. (22 mm)	15/16 in. (24 mm)
Bolt Circle (E)	4-1/2 in. (114 mm)	4-3/4 in. (121 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)	9-1/2 in. (241 mm)
Centerline (C) to Base (F)	2-3/4 in. (70 mm)		3-5/8 in. (92 mm)	4-1/4 in. (108 mm)	5-3/8 in. (137 mm)
Number of Bolts	2	4	4	8	8

* Adapter available to increase total length to 17 in. (432 mm).
**Adapter available to increase total length to 24 in. (610 mm).

Elliptical Flange (2 in. Only)



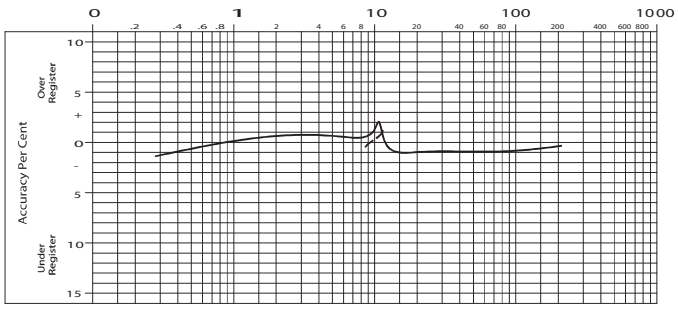
Round Flange



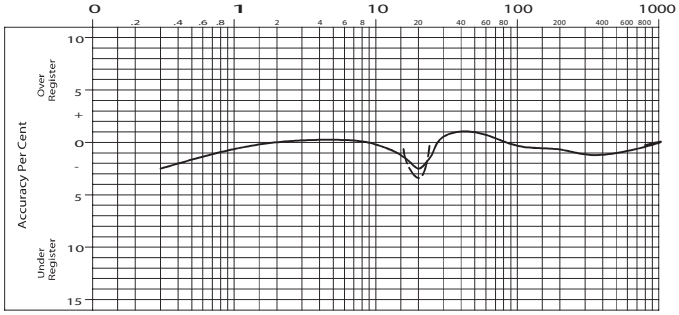
ACCURACY CHARTS

Rate of flow in gallons per minute (gpm). Dashed line on each chart (— — —) represents crossover flow accuracy.

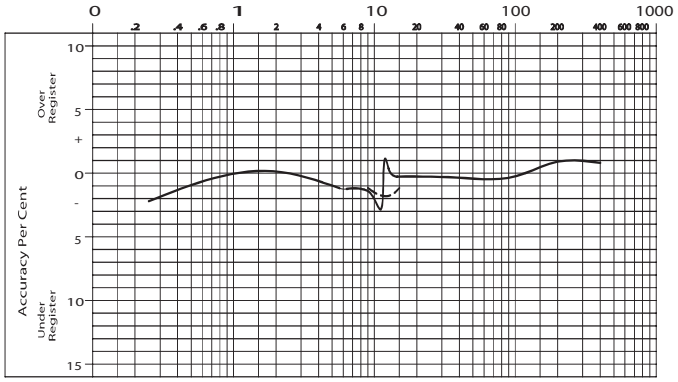
2 in. COMPOUND SERIES METER



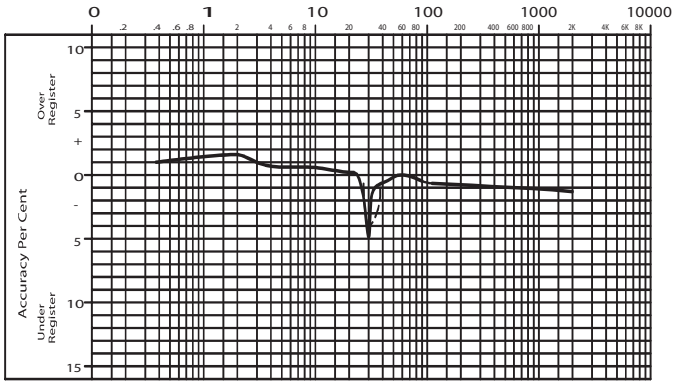
4 in. COMPOUND SERIES METER



3 in. COMPOUND SERIES METER

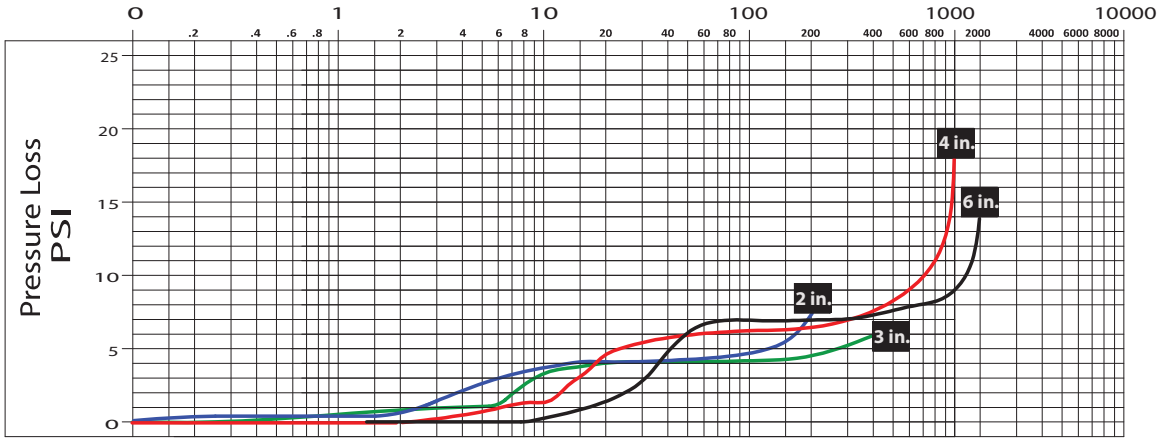


6 in. COMPOUND SERIES METER



PRESSURE LOSS CHART

Rate of flow in gallons per minute (gpm)



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www.badgermeter.com

ORION® Cellular Water Endpoints

DESCRIPTION

ORION® Cellular water endpoints are innovative, two-way endpoints for smart water applications. The endpoints utilize existing IoT (Internet of Things) cellular infrastructure to efficiently and securely deliver meter reading data to the utility in a Network as a Service (NaaS) approach. Leveraging existing cellular infrastructure, the NaaS solution offers all the performance benefits of AMI, while eliminating network-related maintenance and technology concerns and enhancing deployment flexibility.

Cellular endpoints are members of the time-tested ORION family of products from Badger Meter, designed for maximum flexibility. Since 2002, the ORION product family has provided comprehensive Advanced Metering Analytics (AMA) for interval meter reading and data capture using both one-way and two-way communications.

FUNCTIONALITY

Operation: ORION Cellular water endpoints communicate with the encoder and capture 15-minute interval read data and meter status information. The endpoints then automatically broadcast the information, including endpoint status information, via the cellular network to BEACON® Software as a Service (SaaS). ORION NaaS is powered by the proven ORION system for interval data capture and two-way communication. The solution employs cellular endpoints which, as they leverage the public cellular network and require no proprietary gateways to operate, dramatically reduce infrastructure requirements compared to a traditional fixed network. This speeds installations and simplifies expansion as a system evolves.

The endpoints are designed to call in four times each workday and feature a configurable schedule that enables utility customers to select call-in times that best support their processes.

Activation: ORION Cellular water endpoints are shipped in an inactive, non-transmitting state. The Badger Meter IR Communication Device can be used to activate the endpoints and verify the encoder connection. Successful endpoint function can be confirmed through a web app demonstrating that communication has been verified to both the encoder and the network.

Alternatively, the endpoints offer a Smart Activation feature. After installation, the endpoints begin broadcasting data when the encoder senses the first usage of water. No field programming or special tools are required.

Broadcast Mode: ORION Cellular water endpoints broadcast fixed network reading data through the secure cellular network within the service area.

Specific configurations also transmit a radio frequency (RF) message to facilitate troubleshooting in the field. See *"Configurations" on page 2.*

Data Storage: The endpoints store 42 days of 15-minute data.

ORION Cellular C endpoint (pictured)

Output Message: ORION Cellular water endpoints broadcast a unique serial number, meter reading data, and applicable status indicators. As an advanced data security measure, each message is securely transported to BEACON SaaS only via private network and never over the public internet.

APPLICATION

Configurations: ORION Cellular water endpoints are multi-purpose endpoints that can be deployed in indoor, outdoor and pit (non-metal pit lid) applications. The electronics and battery assembly are fully encapsulated in epoxy for environmental integrity. The endpoint is available with a connector assembly for ease of installation.

Meter Compatibility: When attached to a Badger Meter High Resolution Encoder, the ORION Cellular water endpoint is compatible with all current Badger Meter Recordall® Disc, Turbo Series, Compound Series, Combo Series and Fire Service meters and assemblies, and with E-Series G2® Ultrasonic, E-Series® Ultrasonic, E-Series® Ultrasonic Plus, and ModMAG® electromagnetic flow meters.

Encoder Compatibility: The ORION Cellular water endpoint is suitable for use with a Badger Meter High Resolution Encoder as well as the following Badger Meter approved three-wire encoder registers that have a manufacture date within 10 years of the current date as long as the encoder has three wires connected to it and is programmed into the three-wire output mode for AMR/AMI: Honeywell® (Elster) ScanCoder® encoder with Sensus® protocol module and evoQ4 meter (encoder output); Master Meter® Octave® Ultrasonic meter encoder output; Metron-Farnier Hawkeye; Mueller Systems 420 Solid State Register (SSR) LCD; Neptune® ProRead, E-Coder®, ARB-V®, and ProCoder; and Sensus iPerl®.

SPECIFICATIONS

Dimensions	5.125 in. (130 mm) (H) 1.75 in. (44 mm) Diameter at top 2.625 in. (W) x 2.875 in. (D) at base (67 mm (W) x 73 mm (D) at base)
Broadcast Network	LTE-M cellular network (primary communication technology)
	NB-IoT (secondary communication technology for certain variants)
RF Message for Troubleshooting	Where available (see table below) frequency is FCC-regulated 902…928 MHz frequency hopping modulation
Operating Temperature Range	
• Storage, Meter Reading and RF Message (for troubleshooting)	–40…60° C (–40…140° F)
• Cellular Communications	–20…60° C (–4…140° F)
Humidity	0%…100% condensing
Battery	One (1) lithium thionyl chloride D cell (nonreplaceable)

Construction: All ORION Cellular water endpoints are housed in an engineered polymer enclosure with an ORION RF board, battery and antenna. For long-term performance, the enclosure is fully potted to withstand harsh environments and to protect the electronics in flooded or submerged pit applications.

Wire Connections: ORION Cellular water endpoints are available with in-line connectors (Twist Tight® or Nicor®) for easy installation and connection to compatible encoders/meters. The endpoints are also available with flying leads for field splice connections. Other wire connection configurations may be available upon request.

FEATURES

Smart City Ready	Future-proof technology
Communication Type	Two-way
Application Type	Control/Monitor
Endpoint Communication	Configurable call-in schedule, up to four times each workday
Reading Interval Type	15-minute
Encoder Compatibility	Absolute
Fixed Network Reading	✓
Cut-Wire Indication	✓
Encoder Error	✓
Low Battery Indication	✓
Remote Clock Synchronization	✓
Firmware Upgrades	✓

CONFIGURATIONS

Endpoint	Notes
ORION Cellular C	Includes RF and IR messages for troubleshooting
ORION Cellular CS	Secondary carrier; includes RF and IR messages for troubleshooting
ORION Cellular LTE-M	Includes RF and IR messages for troubleshooting
ORION Cellular LTE-MS	Secondary carrier; includes RF and IR messages for troubleshooting
ORION Cellular HLA	Includes IR message for troubleshooting

NOTE: For the ORION Cellular LTE-MP endpoint, see the *ORION Cellular LTE-MP Endpoint product data sheet*, available at *www.badgermeter.com*.

License Requirements: ORION Cellular water endpoints comply with Part 15, Part 22, Part 24, and Part 27 of the FCC Rules. No license is required by the utility to operate an ORION meter reading system. This device complies with Industry Canada license-exempt RSS standard(s).

Transportation: **WARNING**: The operation of transmitters and receivers on airlines is strictly prohibited by the Federal Aviation Administration. As such, the shipping of radios and endpoints via air is prohibited. Please follow all Badger Meter return and/or shipping procedures to prevent exposure to liability.

Warning: To reduce the possibility of electrical fire and shock hazards, never connect the cable from the endpoint to any electrical supply source. The endpoint cable provides SELV low voltage limited energy power to the load and should only be connected to passive elements of a water meter register.

Caution: Endpoint batteries are *not* replaceable. Users should make no attempt to replace the batteries.
Changes or modifications to the equipment that are not expressly approved by Badger Meter could void the user's authority to operate the equipment.

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ORION® Water Endpoints

Cellular LTE Endpoint

DESCRIPTION

The ORION® Cellular endpoint is an innovative, two-way water endpoint that utilizes existing cellular infrastructure to efficiently and securely deliver meter reading data to the utility via the reliable cellular network.

The Cellular endpoint is a member of the time-tested ORION family of products from Badger Meter, designed for maximum flexibility. Since 2002, the ORION product family has provided comprehensive Advanced Metering Analytics (AMA) for interval meter reading and data capture using both one-way and two-way communications.

FUNCTIONALITY

Operation: The endpoint communicates with the encoder and captures 15-minute interval read data and meter status information. On a regular schedule (up to twice per day) the endpoint then automatically broadcasts the information, including endpoint status information, via the cellular network to the BEACON® AMA software.

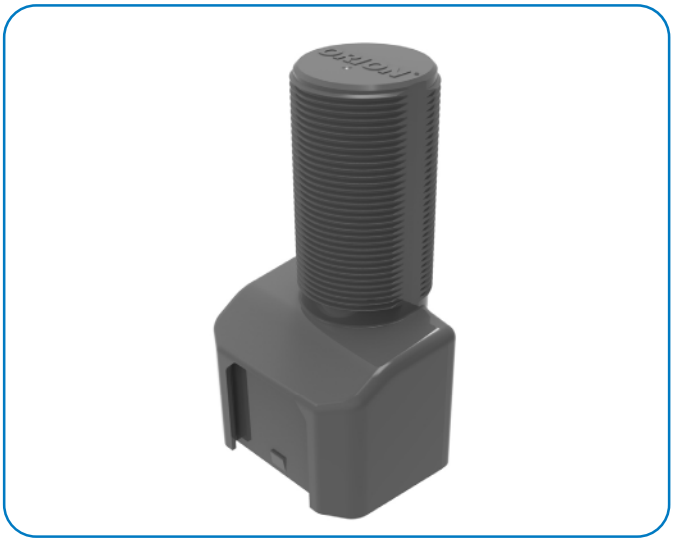
Activation: All ORION Cellular LTE endpoints are shipped in an inactive, non-transmitting state. The endpoints offer a Smart Activation feature. After installation, the endpoint begins broadcasting data when the encoder senses the first usage of water. No field programming or special tools are required. Alternatively, the Badger Meter IR Communication Device can be used to activate the endpoint and verify the encoder connection.

Successful endpoint function can be confirmed through a web app demonstrating that communication has been verified to both the encoder and the network.

Broadcast Mode: The endpoint broadcasts fixed network reading data through the secure existing cellular network within the service area. The endpoint also transmits a mobile message to support troubleshooting in the field.

Data Storage: The endpoint stores 42 days of 15-minute data.

Output Message: The endpoint broadcasts its unique serial number, meter reading data, and applicable status indicators. Each message is securely transported to the BEACON AMA software via Virtual Private Network (VPN) using Advanced Encryption Standard (AES) 256.



APPLICATION

Configurations: The endpoint is a multi-purpose endpoint that can be deployed in indoor, outdoor and pit applications. The electronics and battery assembly are fully encapsulated in epoxy for environmental integrity. The endpoint is available with a connector assembly for ease of installation.

Meter Compatibility: When attached to a Badger Meter High Resolution Encoder, the endpoint is compatible with all current Badger Meter Recordall® Disc, Turbo Series, Compound Series, Combo Series and Fire Service meters and assemblies, and with E-Series® Ultrasonic, E-Series® Ultrasonic Plus, and ModMAG® electromagnetic flow meters.

Encoder Compatibility: ORION Cellular LTE endpoints are suitable for use with Badger Meter High Resolution Encoders as well as the following Badger Meter approved three-wire encoder registers that have a manufacture date within 10 years of the current date as long as the encoder has three wires connected to it and is programmed into the three-wire output mode for AMR/AMI: Honeywell® (Elster) ScanCoder® encoder with Sensus® protocol module and evoQ4 meter (encoder output); Master Meter® Octave® Ultrasonic meter encoder output; Metron-Farnier Hawkeye; Mueller Systems 420 Solid State Register (SSR) LCD; and Sensus iPerl®.

SPECIFICATIONS

Dimensions	5.125 in. (130 mm) (H) 1.75 in. (44 mm) Diameter at top 2.625 in. (W) x 2.875 in. (D) at base 67 mm (W) x 73 mm (D) at base
Broadcast Network	LTE cellular network, with fallback to 3G where LTE is unavailable. Mobile backup frequency is FCC-regulated 902…928 MHz frequency hopping modulation
Operating Temperature Range • Storage, Meter Reading and Mobile Backup • Cellular Communications	 –40…60° C (–40…140° F) –20…60° C (–4…140° F)
Humidity	0%…100% condensing
Battery	One (1) lithium thionyl chloride D cell (nonreplaceable)

Construction: All ORION Cellular endpoints are housed in an engineered polymer enclosure with an ORION RF board, battery and antenna. To ensure long-term performance, the enclosure is fully potted to withstand harsh environments and to protect the electronics in flooded or submerged pit applications.

Wire Connections: ORION Cellular endpoints are available with in-line connectors (Twist Tight® or Nicor®) for easy installation and connection to compatible encoders/meters. The endpoints are also available with flying leads for field splice connections. Other wire connection configurations may be available upon request.

FEATURES

Communication Type	Two-way
Application Type	Control/Monitor
Reading Interval Type	15-minute
Encoder Compatibility	Absolute
Fixed Network Reading	✓
Premise Leak Detection	✓
Cut-Wire Indication	✓
Reverse Flow Indication	✓
No Usage Indication	✓
Encoder Error	✓
Low Battery Indication	✓
Remote Programming	✓
Remote Clock Synchronization	✓
Firmware Upgrades	✓

License Requirements: ORION Cellular LTE endpoints comply with Part 15, Part 22, Part 24, and Part 27 of the FCC Rules. No license is required by the utility to operate an ORION meter reading system. This device complies with Industry Canada license-exempt RSS standard(s).

Transportation: WARNING: The operation of transmitters and receivers on airlines is strictly prohibited by the Federal Aviation Administration. As such, the shipping of radios and endpoints via air is prohibited. Please follow all Badger Meter return and/or shipping procedures to prevent exposure to liability.

Warning: To reduce the possibility of electrical fire and shock hazards, never connect the cable from the endpoint to any electrical supply source. The endpoint cable provides SELV low voltage limited energy power to the load and should only be connected to passive elements of a water meter register.

Caution: The endpoint batteries are *not* replaceable. Users should make no attempt to replace the batteries.
Changes or modifications to the equipment that are not expressly approved by Badger Meter could void the user's authority to operate the equipment.

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WELCOME TO BEACON® AMA

Billing Integration Implementation

WELCOME TO BEACON AMA

Thank you for choosing Badger Meter to be part of your water management solution. Our BEACON® Advanced Metering Analytics (AMA) Solution brings a whole new level of utility-optimizing information to light while empowering your end users and streamlining your processes.

The following reflects an overview of what you can expect as your BEACON AMA implementation progresses.

Shaded areas indicate action items you and your team need to complete.

1. **Billing Interface**

   First things first, since you will be utilizing a billing interface, notify your billing vendor you will require an interface with BEACON AMA and their software.

   NOTE: **Please contact your billing vendor right away. You need to have the agreement in place with your billing vendor before we can proceed with our interface analysis.** Your billing vendor may charge a fee for their services, and you are responsible for any fees they may assess. Direct your billing vendor to *https://helpbeaconama.net/data-exchange/* for more information about the file format requirements and interface approval process.

2. **Onboarding Communication**

   Within a few days of order acknowledgment, the person identified as the Primary Admin (PAD) / portfolio Owner on the BEACON Onboarding Questionnaire (BOQ) will receive an email invitation to setup his/her BEACON login credentials.

   NOTE: To ensure the invitation is not blocked by your organization's spam filters, please whitelist the following:

   - noreply@eyeonwater.com
   - noreply@beaconama.net
   - alerts-noreply@beaconama.net
   - reports-noreply@beaconama.net
   - beaconama.ca (Canadian deployments only)

   This login invitation is valid for 48 hours. Should the invitation expire before you are able to setup your credentials please contact *BEACONOnboarding@badgermeter.com* to request a new invitation.

3. **First Login**

   When you first login to BEACON you may notice a lack of data. This is because your billing interface has not been approved and implemented yet. Although information may be available in BEACON, your portfolio is not fully configured or active and training will not be scheduled until the interface is complete

   NOTE: Feel free to login and browse around to familiarize yourself with the user interface. Your trainer will go over the basic BEACON features and functionality as part of your training session.

4. **Information Collection and Verification**

   The utility-specific information provided in the BOQ submitted with your order is used to verify your unique system specifications. Our Onboarding Coordinator may reach out to you to seek additional information or clarification before initiating communication with your billing vendor. A Badger Meter Interface Analyst (Analyst) will be assigned at this time.

   NOTE: If you have not contacted your billing vendor (Step 1) to establish an agreement for them to perform interface-related functions on their end, please do so immediately to reduce delays in the overall billing interface evaluation and approval process.

5. **Billing Vendor Interface Kickoff Communication**
   Once our BOQ review is complete and all questions have been answered, our Onboarding Coordinator will send an email to you, your billing vendor contact and your Analyst letting the group know Badger Meter has the information needed to begin work on your billing interface. This communication serves as a kickoff in a series of interface-related communications with the group.

6. **BEACON Import Test File Evaluation and Approval**
   Your Analyst will reach out to your billing vendor to request a test import file for evaluation. Your Analyst will conduct a review of the file received, then document any corrections that may be required. This information will be communicated to you and your billing vendor for correction.

   NOTE: This is the part of the process where you need to be highly involved to resolve any data issues identified in the import test file. Issues may include validating register resolutions, verifying correct addresses and establishing a valid format for the various data fields. Your Analyst will be helping you and your billing vendor throughout this process.

7. **BEACON Export Test File Evaluation and Approval**

   Once the BEACON import file is ready to go, your Analyst will provide your billing vendor with a test export file from BEACON to ensure the billing vendor can process the billing data. When your billing vendor approves the file, the interface analysis is complete. Your Analyst will provide notification to you, your billing vendor, and the trainer assigned to your deployment that the interface is approved and training may now be scheduled.

8. **Training**

   After the test file approval notification you will be contacted by your trainer to discuss the next steps. Your trainer will collect any additional information, confirm receipt of any reading hardware you may have ordered, and schedule your training session.

   Once your training is complete, you will be ready to enjoy the benefits BEACON has to offer. As a cloud-based platform, new BEACON features and functionalities will be available to you upon release simply by logging into your portfolio.

   Visit *https://helpbeaconama.net/training-2/* to learn more about supplemental training opportunities which are available to allow you to maximize your investment in a BEACON solution.

BEACON AMA Mobile Solutions with Windows® 10 Meter Reading Devices

If you are deploying a BEACON AMA Mobile Solution all compatible Windows 10 devices you will be using for mobile meter reading will require setup and configuration before they can be used with the BEACON AMA Mobile Read Module suite of applications (ORION® Mobile Read, ORION Endpoint Utility and Field Director). Please download and follow the instructions provided in the *Windows 10 Hardware Setup Quick Start Guide, UTL-QS-03133-EN* prior to powering up your devices to ensure appropriate selections are made during initial hardware boot and configuration.

Once you have completed the hardware setup for each device, please download *ORION® Mobile Read and Endpoint Utility Windows® 10 Device Setup, BEA-QG-03313-EN-01* and follow the instructions for installing Google® Chrome® on each device. Your Badger Meter authorized trainer will assist you with the remaining setup (software installation, COM port configuration) at the time your trainer contacts you to schedule your BEACON Mobile Solution training.

Thank you once again for being a valued Badger Meter customer. Should you have any questions about the process outlined in the document, please contact your account manager or *BEACONOnboarding@badgermeter.com*.

ACCOUNT MANAGER

NAME	
EMAIL	
PHONE	

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Clear Form

Badger Meter

BEACON® AMA Onboarding

Billing Vendor Integration & Deployment Best Practices

ONBOARDING OVERVIEW

BEACON AMA onboarding is the entire process a Utility goes through from the time an order is placed until users are trained and deriving value from BEACON AMA. A key part of the onboarding process is integration with the Utility's billing vendor, which can be time consuming and delay implementation of the Utility's BEACON AMA Solution if not properly executed.

This document is intended to help the Utility understand the overall process and responsibilities to help ensure a successful onboarding experience.

Best Practices When Deploying a BEACON® AMA Solution

Use the checklist below to get your BEACON AMA deployment going, and keep it on track.

- ☐ Identify a project champion who best understands and promotes the Utility's operational vision for your BEACON AMA Solution
- ☐ Establish a project budget
- ☐ Obtain a quote for the BEACON AMA Solution
- ☐ Contact your billing vendor to obtain a quote for a BEACON AMA Data Exchange interface
- ☐ Obtain project approval
- ☐ Issue a PO to Badger Meter for the BEACON AMA Solution and include completed *BEACON AMA Onboarding Questionnaire* (BEA-FM-03070-EN)
- ☐ Issue a PO to your billing vendor for the Data Exchange billing integration
- ☐ Participate in the Onboarding and Interface Integration kickoff meeting and take an active part in driving the project schedule dates
- ☐ Install endpoints and capture installation data, as applicable
- ☐ Stay **actively** engaged with your billing vendor and Badger Meter during the integration process
- ☐ Enter and export test data file(s) as requested
- ☐ Enter and clean up customer data as required
- ☐ Actively participate in the BEACON AMA online or onsite training and ensure appropriate Utility personnel attend training
- ☐ Use your BEACON AMA system and explore the features and functions!
- ☐ Attend BEACON AMA supplemental online training opportunities. Multiple no charge, online courses are available each month to keep users up to date on new features and give you an opportunity to engage with other users to maximize your investment in your BEACON AMA Solution. Visit *https://www.badgermeter.com/training/* to view available online courses and to register.

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BEA-QG-02995-EN-03 (January 2020)

QUICK GUIDE

BEACON® Advanced Metering Analytics

With ORION® Network as a Service (NaaS)

OVERVIEW

The BEACON® Advanced Metering Analytics (AMA) Solution with ORION® Network as a Service (NaaS) presents a simple, yet powerful solution to bring a new level of utility optimizing information to light.

The solution combines our intuitive BEACON AMA Software as a Service (SaaS) with a NaaS approach using proven ORION Cellular endpoints to deliver greater visibility and control over utility management.

Built-in infrastructure management services and a system design that keeps you in step with technology advancements, allows you to do what you do best—manage your water utility. Plus, built-in consumer engagement tools help enhance customer service, increase satisfaction and reduce costs.

SOFTWARE APPLICATIONS

BEACON Advanced Metering Analytics (AMA)

With tools beyond meter reading and network management, BEACON AMA software offers targeted Advanced Metering Analytics. BEACON AMA software puts interval meter data to work to increase efficiency in day-to-day utility operations and address demands for actionable intelligence.

- **Problem solver** – User intuitive data tools place the power of water consumption data at your fingertips, allowing you to rapidly respond to customer inquiries and quickly resolve—and even eliminate—many billing issues.
- **Customized design** – A customizable dashboard delivers information configured to user security access level in a format matched to the utility's individual requirements, providing data management integrity, security and control.
- **Works with you** – Integration with utility systems—billing, work order, inventory, Customer Relationship Management (CRM) and Geographic Information Systems (GIS)—streamlines and improves utility operations without disrupting the current utility billing interface file transfer process.
- **Find out fast** – Alert conditions can be set to monitor and notify users of system exceptions, including continuous flow, for faster leak detection.
- **Innovation at your service** – Secure, hosted platform with automatic software upgrades ensures the latest technology and features are always available.

EyeOnWater®

The BEACON AMA software suite includes informative consumer outreach tools to improve customer service consisting of the EyeOnWater consumer engagement website, smartphone mobile apps, and email or SMS text alerts, providing easy access to personal consumption data and alerts to potential leaks. With these tools, water consumers are able to view their usage activity, and gain greater understanding and control of what they use and the value you provide.

HARDWARE

ORION NaaS is powered by the proven ORION system for interval data capture and two-way communication. The solution employs cellular endpoints which, as they leverage the public cellular network and require no proprietary gateways to operate, dramatically reduce infrastructure requirements compared to a traditional fixed network. This speeds installations and simplifies expansion as a system evolves.

- **High resolution data** – ORION Cellular endpoints are programmed to automatically broadcast 15-minute meter reading and event data to the BEACON software up to four (4) times per day. The high resolution data helps identify potential customer-side leaks and other anomalies in water use, and provides the utility with a potent tool to enhance its customer service.
- **Two-way communication** – BEACON AMA software communicates with ORION Cellular endpoints to accomplish a number of system tasks, including requesting additional information from the endpoint and synchronizing the internal endpoint clock. If needed, the ORION two-way system architecture sends upgrades to the endpoint firmware over the air via the network, utilizing the powerful BEACON AMA software suite.
- **Data integrity** – Each message from the ORION Cellular endpoint is securely transported to the BEACON AMA software only via private network and never over the public internet.

SECURITY

BEACON AMA is ISO 27001 certified and SOC 2 examined for security, availability and confidentiality.

TECHNICAL SUPPORT AND TRAINING

Configured for the utility, safe and secure BEACON AMA SaaS provides utilities with regular software updates, long-term support and maintenance. Comprehensive BEACON AMA training courses are available for online or on-site delivery at the time of system deployment. To maintain best practices, a library of online resources and options for group web-based training and support are also available. Once deployed, our technical support specialists can be contacted by phone, email and web to provide ongoing, customer-friendly support. Customized one-on-one training is available (fee applies) to further enhance user expertise.

Additionally, Badger Meter offers extended customized training to further enhance user expertise.

TECHNICAL REQUIREMENTS

BEACON AMA

Developed as a hosted software platform, BEACON AMA is a cloud-based application accessed through a standard web browser. Internet access is required. User logins provide secure access.

BEACON AMA supported web browsers include the latest and next previous major releases of Google® Chrome, Microsoft® Edge, Mozilla® Firefox®, Microsoft® Internet Explorer® (IE 11 only); and Apple® Safari®.

EyeOnWater Consumer Engagement

The EyeOnWater consumer engagement website is a cloud-based application accessed through a standard web browser. Internet access is required. Water consumer user logins provide secure access to their information.

Supported web browsers include the latest and next previous major releases of Google® Chrome, Microsoft® Edge, Mozilla® Firefox®, Microsoft® Internet Explorer® (IE 11 only); and Apple® Safari®.

EyeOnWater smartphone applications require Android 6.0 or iOS 9.1 or later, and can be downloaded from Google Play or the Apple Store.

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Badger Meter

HR-E High Resolution Encoder

DESCRIPTION

Applications: The High Resolution Encoder (HR-E) is designed for use with all current Recordall® Disc, Turbo, Compound, Combo and Fire Series meters and assemblies. The HR-E provides connectivity with Badger Meter ORION® and GALAXY® AMR/AMI endpoints, BadgerTouch® modules and other AMR/AMI technology solutions approved by Badger Meter.

Electronic Resolution: Encoder output from the HR-E includes eight-dial resolution to AMR/AMI endpoints and the option of four, five, six, seven or eight-dial resolution for touch applications. Refer to tables on the next page for details.

Mounting: The HR-E in its shroud assembly uses a bayonet mount compatible with all Recordall Disc, Turbo, Compound and Fire Series meters and assemblies. The bayonet mount allows positioning of the register in any of four orientations for visual reading convenience. The HR-E can be removed from the meter without disrupting water service.

Magnetic Drive: A direct-drive, high-strength magnetic coupling, through the meter body to the wetted magnet, provides reliable and dependable register coupling.

Local Indication: The HR-E face features an eight-dial mechanical odometer wheel stack and a flow finder with a calibrated test circle.

Tamper-Resistant Features: Unauthorized removal of the HR-E is inhibited by the option of a tamper detection seal wire screw, tamper-resistant TORX® seal screw, or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

Construction: The housing of the HR-E is constructed of a strengthened glass lens top and a corrosion-resistant metal bottom. Internal construction materials are thermoplastic for long life and high reliability. The encoder gearing is self-lubricating thermoplastic to minimize friction and provide long, reliable life. The shroud assembly is thermoplastic.

Temperature: The operating range of the HR-E is – 40…140° F (– 40…60° C). The water meter should not be subjected to temperatures below freezing.

Sealing: The HR-E encoder is permanently sealed to eliminate the intrusion of moisture, dirt or other contaminants. The HR-E achieves true water resistance due the unique adhesive technology used to seal the glass dome to the corrosion-resistant metal bottom. Due to this sealing process, the HR-E exceeds all applicable requirements of AWWA Standard C707. With leak rates less than 10-6 cc/sec, as tested by a helium mass spectrometer, the HR-E is suitable for installation in all environments, including meter pits subject to continuous submergence.

Electrical: The electronic circuitry is designed to provide immunity to electrical surges and transients per IEC1000-4-2, IEC1000-4-4. Operation of the HR-E is dependent on the wire length limitations of connected AMR/AMI equipment.

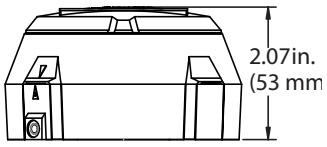
SPECIFICATIONS

Encoder Type	Straight reading, permanently sealed, magnetic drive
Unit of Measure	U.S. Gallons, Cubic Feet, Cubic Meters, clearly identified on encoder face
Number Wheels	Eight with 5/32 inch high numerals
Test Circle	360° circle with ten major increments, ten divisions each
Weight	10 ounces
Humidity	0…100% condensing when equipped with potted lead wire, 0…95% non-condensing with screw-terminal wire connections
Temperature	– 40…140° F (– 40…60° C)
Signal Output	Industry Standard ASCII Format
Visual Resolution	1/100th of Test Circle
Electronic Resolution	8-dial resolution for AMR/AMI; 4, 5, 6, 7 or 8-dial resolution for BadgerTouch
Signal Type	3-wire synchronous for AMR/AMI solutions (red=clock/power, black=ground, green=data) 2-wire asynchronous for Touch solutions
Power Source	External

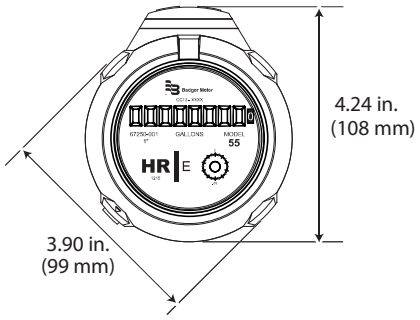
Operating Characteristics: The reading obtained by an AMR/AMI device is sensed directly from the position of the encoder's odometer using internal LED light paths to determine the exact position of each number wheel. This technology eliminates electromechanical contacts that could wear out, and provides greater long-term performance.

Wire Connections: The HR-E is available with an in-line connector for easy connection and installation to AMR/AMI endpoints. It is also available with a flying lead for a field splice connection or fully prewired to an AMR/AMI endpoint. A terminal screw version of the HR-E is also available. This version features a tamper-resistant cap over the three-wire terminals. The HR-E with terminal screws is designed for indoor installations in protected environments such as residential basements.

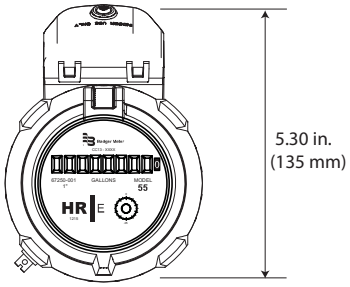
DIMENSIONAL DRAWINGS



Side view



With wire lead



With terminal screws

Top view

MEASUREMENT RESOLUTION

The minimum electronic resolution of the HR-E is as noted below (8-Dial Reading). To verify the correct resolution for your application, contact Badger Meter Customer Service.

Recordall Disc Series	Size (in.)	8-Dial Resolution (gal)	8-Dial Resolution (ft^3)	8-Dial Resolution (m^3)
M25/MLP	5/8	0.1	0.01	0.001
M25/MLP	3/4	0.1	0.01	0.001
M35	3/4	0.1	0.01	0.001
M40	1	0.1	0.01	0.001
M55	1	0.1	0.01	0.001
M70	1	0.1	0.01	0.001
M120	1-1/2	1	0.1	0.01
M170	2	1	0.1	0.01

Fire Service Series	8-Dial Resolution (gal)	8-Dial Resolution (ft^3)	8-Dial Resolution (m^3)
3 in.	1	0.1	0.01
4 in.	1	0.1	0.01
6 in.	10	1	0.1
8 in.	10	1	0.1
10 in.	10	1	0.1

Recordall Turbo Series	Size (in.)	8-Dial Resolution (gal)	8-Dial Resolution (ft^3)	8-Dial Resolution (m^3)
T160	1-1/2	1	0.1	0.01
T200	2	1	0.1	0.01
T450	3	1	0.1	0.01
T1000	4	1	0.1	0.01
T2000	6	10	1	0.1
T3500	8	10	1	0.1
T5500	10	10	1	0.1
T6200	12	100	10	0.1
T6600	16	100	10	1
T10000	20	100	100	1

Recordall Compound Series	Size (in.)	8-Dial Resolution (gal)	8-Dial Resolution (ft^3)	8-Dial Resolution (m^3)
High Side T200	2	1	0.1	0.01
Low Side M25	2	0.1	0.01	0.001
High Side T450	3	1	0.1	0.01
Low Side M25	3	0.1	0.01	0.001
High Side T1000	4	1	0.1	0.01
Low Side M35	4	0.1	0.01	0.001
High Side T2000	6	10	1	0.1
Low Side M35	6	0.1	0.01	0.001

Resolution stated as individual high and low readings.

Making Water Visible®

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Badger Meter | Absolute Digital Encoder

DESCRIPTION

Applications: The Absolute Digital Encoder (ADE®) is designed for use with all Recordall® Disc, Turbo, Compound and Fire Service meters to provide connectivity with ORION®, GALAXY, BadgerTouch® Itron ERT, and Badger Meter approved AMR/AMI technology solutions.

Electronic Resolution: Digital output from the ADE includes the option of either four, five or six dial resolution. Refer to tables on the next page for details.

Mounting: The ADE in its shroud assembly uses a bayonet mount compatible with all Recordall Disc, Turbo, Compound and Fire Series meters. The bayonet mount allows positioning of the register in any of four orientations for visual reading convenience. The ADE can be removed from the meter without disrupting water service.

Magnetic Drive: A direct-drive, high-strength magnetic coupling through the meter body to the wetted magnet provides reliable and dependable register coupling.

Local Indication: The ADE register face features a six-digit mechanical odometer wheel stack, a 360° test circle with sweep hand, and a flow finder to indicate leaks.

Tamper-Resistant Features: Unauthorized removal of the register or encoder is inhibited by the option of a tamper detection seal wire screw, resistant TORX® tamper-resistant seal screw, or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

Construction: The housing of the ADE is constructed of a strengthened glass lens top and a corrosion-resistant metal bottom. Internal construction materials are thermoplastic for long life and high reliability. The register gearing is self-lubricating thermoplastic to minimize friction and provide long, reliable life. The shroud assembly is thermoplastic.

Temperature: The operating range of the ADE is – 40…140° F (– 40…60° C). The water meter should not be subjected to temperatures below freezing.

Sealing: The ADE achieves true water resistance due to the adhesive technology used to seal the glass dome to the corrosion resistant metal bottom. Leak rates less than 10^{-6} cc/sec, as tested by a helium mass spectrometer, are comparable to a true hermetic seal. Due to this unique sealing process, the ADE exceeds all applicable requirements of AWWA Standard C707 regarding moisture intrusion.

Wire Connections: The ADE is available with either a wire lead, fully potted to prevent moisture intrusion at the connections, or with terminal screws. When provided with a wire lead, the ADE may be pre-wired at the factory to select Badger Meter-approved AMR/AMI endpoints, or may be furnished with a variety of lead wire lengths. Lead wire equipped ADE registers are suitable for installation in all environments, including continuously submerged water meter pits.

ADE-DS-00183-EN-02 (May 2013)

SPECIFICATIONS

Transmitter/Register	Straight reading, permanently sealed, magnetic drive
Unit of Measure	U.S. Gallons, Cubic Feet, Cubic Meters, clearly identified on register face
Number Wheels	Six with 3/16-inch high numerals
Test Circle	360° circle with ten major increments with ten divisions each
Weight	11 Ounces
Humidity	0% to 100% condensing when equipped with potted lead wire, 0% to 95% non-condensing with screw-terminal wire connections
Temperature	– 40…140° F (– 40…60° C)
Signal Output	Industry Standard ASCII Format
Visual Resolution	1/100th of Test Circle
Electronic Resolution	4-, 5- or 6-dial resolution
Signal Type	3-wire synchronous for AMR/AMI solutions 2-wire asynchronous for Touch solutions
Power Source	External

The terminal screw version ADE features a tamper-resistant cap over the three-wire terminals. ADE registers with terminal screws are for indoor installation in protected environments, such as residential basements.

Electrical: The electronic circuitry is designed to provide immunity to electrical surges and transients per IEC801-2, IEC801-4 Severity Level 4. Operation of the ADE is dependent on the wire length limitations of connected AMR equipment.

Operating Characteristics: The digital reading obtained by an AMR/AMI device is sensed directly from the position of the ADE register's odometer using internal LED light paths to determine the exact position of each number wheel. This technology eliminates electromechanical contacts that could wear out, and provides greater long-term performance.

Product Data Sheet

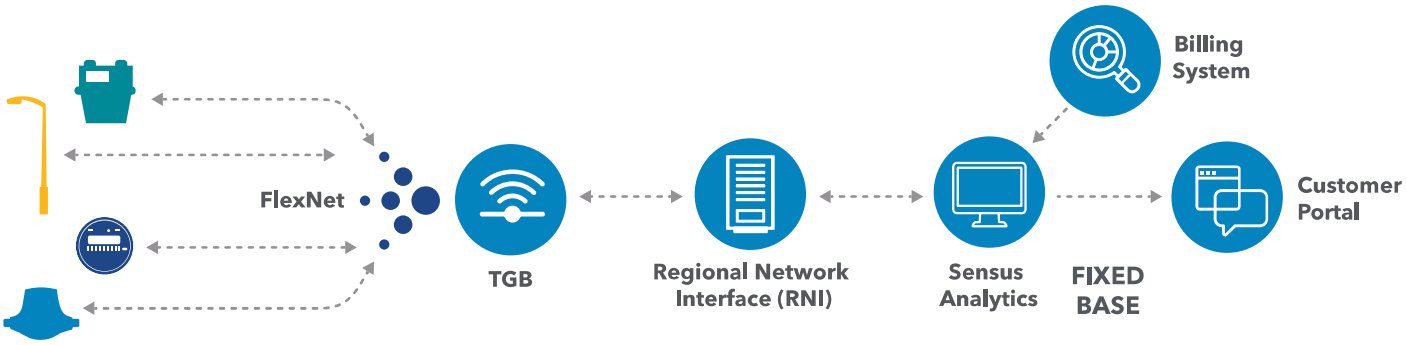
CUSTOMER SUCCESS | SOFTWARE

Critical data, seamless integration

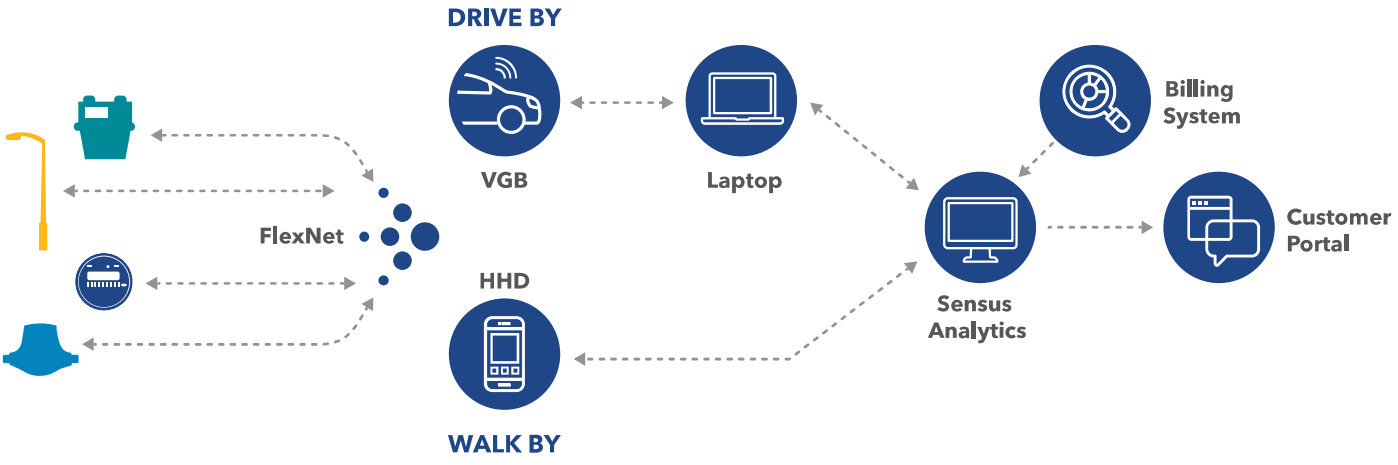
A superior network, intuitive software, incomparable results.

A utility's operations are only as good as its data. And data is only as reliable as the network. But data for data's sake…well, what's the point? At Sensus, our robust, secure network and easy-to-use software integrate with your CIS, billing systems and other data sources to provide actionable insights that improve safety, increase efficiency and boost your bottom line.

AMI



AMR



The FlexNet™ Communication Network

FlexNet is a point-to-multipoint and fixed-base communication network from Sensus that utilizes a private, FCC-licensed spectrum. As a fundamental part of an overall smart utility solution, FlexNet supplies the reliable two-way communication network needed to deliver data from meters and other infrastructure to utilities, deriving meaningful and actionable insights.

FlexNet is resilient, secure and future-proof.

- Reliable data.
- Fast transmission.
- Remote management.
- Support for scalability.
- Improved efficiencies.
- Low cost of ownership.

Sensus Analytics

Sensus Analytics makes your utility data clear, simple and actionable. A functionable and customizable suite of applications with user-friendly dashboards enables you to make informed decisions quickly and confidently. Our powerful data management tools aggregate information from your AMI, AMR and other sources, securely delivering insights through intuitive apps right to your desktop, tablet or smartphone. Role-based access allows service providers to share tailored information across the organization for improved productivity, visibility and decision-making.

Sensus Analytics helps drive the success of your business.

- Prepare and execute billing on meters.
- Support customer service.
- Maintain and manage meter performance and data.

Regional Network Interface™

Regional Network Interface (RNI) is a tool that comes with FlexNet to read, collect and deliver near-real-time data, providing a window into the field. Communicating with end points, RNI continuously gathers and processes network data, providing utility status updates and storing or sending data to CIS and billing systems. Priority alarms are delivered immediately, and onboard diagnostic tools optimize performance by monitoring and managing network health.

RNI is the nerve center of FlexNet, made up of customized hardware, software and database elements.

- Improves operational efficiency.
- Monitors system performance.
- Manages network security.
- Configures end points over the air.
- Enables reliable service, accurate billing and faster response.

Customer Portal

Customers want to be engaged and in control—and that means they want to be smart when it comes to utility usage. The Sensus Customer Portal works in conjunction with Sensus Analytics to improve customer service, enhance customer engagement and promote sustainability. This web-based, interactive application creates easy-to-read usage charts, graphs, billing estimates, tips and more, providing virtually everything a customer needs to correct current issues and make better-informed decisions about future usage.

- Customizable interface with 24/7 access.
- Greater customer control for reduced call volumes.
- Customer target-setting to manage bills and save resources.
- Email or text alerts on important account information.
- Home energy profiles, education and cost-saving tips.

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ASB-10005-01

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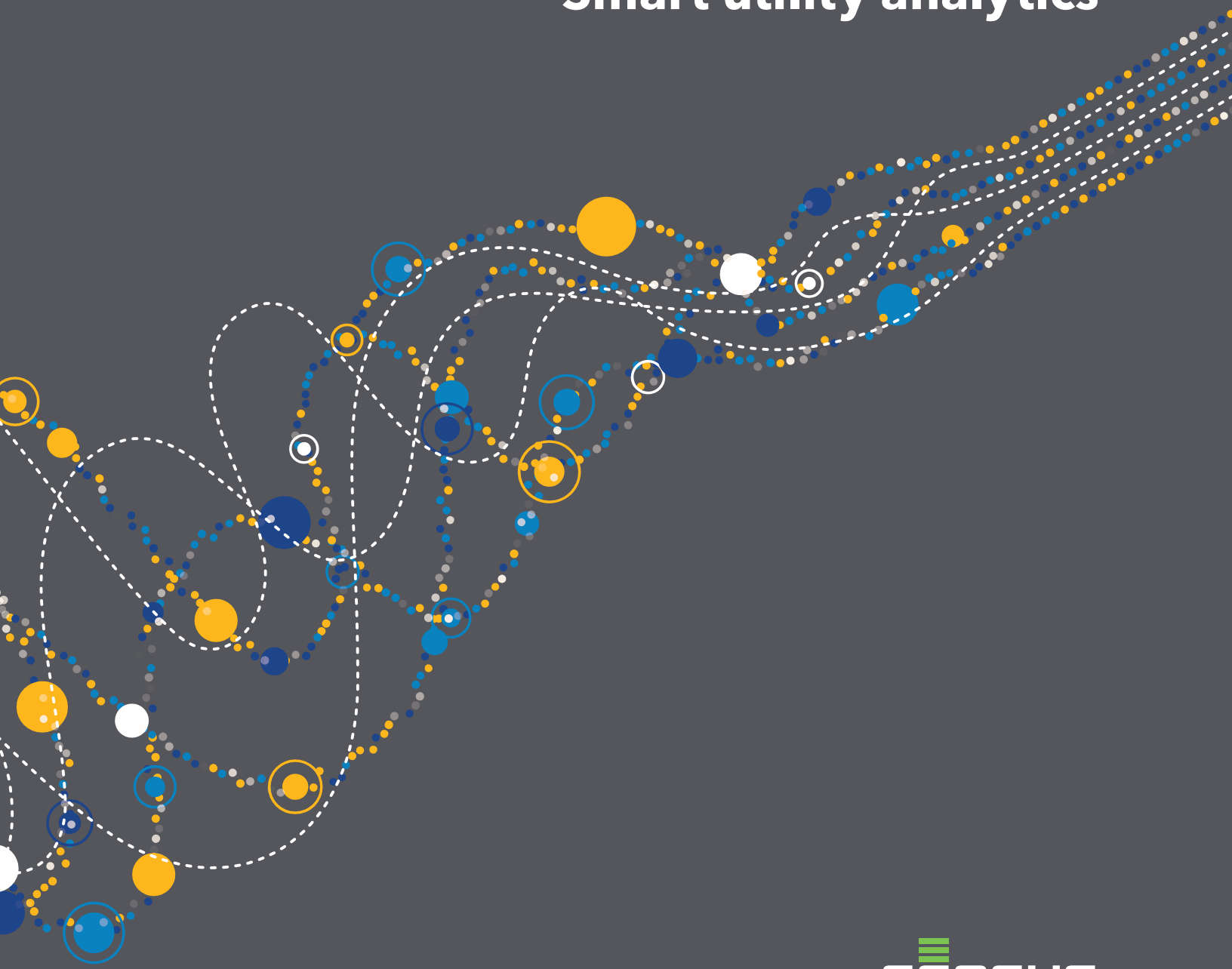
Nothing's out of reach.

CUSTOMER SUCCESS

Smart utility analytics



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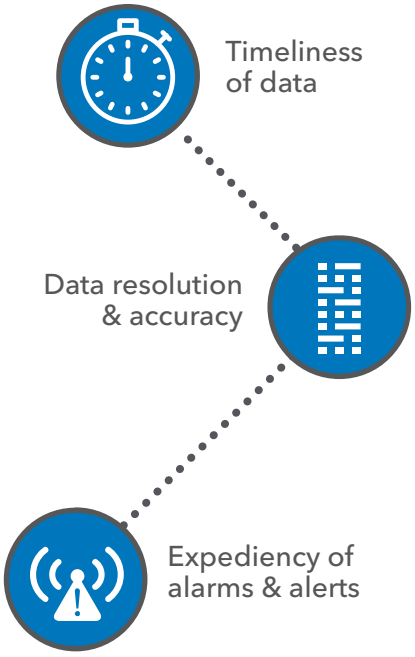
Top benefits of an analytics solution for smart utilities



"Big data" is a buzzword used across almost every industry to describe the massive amount of digital information collected in order to discover business or customer patterns, trends and connections. But data for data's sake doesn't provide much significance to the collector. Value is created by real-time processing and sorting of this information to deliver actionable insights.

As technology continues to transform the way essential resources are delivered, monitored and billed, utilities are growing increasingly smarter. Data collection from smart meters and sensors, transmitted across a smart communication network, provides an incredible opportunity to optimize operations, improve the customer experience and grow revenue. But the same "data dilemma" exists as in other industries: this smart data must be sorted for relevance and application—or all that technology-generated potential goes to waste.

Analytics software enables smart

Aggregating, sorting and dispensing utility data to generate actionable insights is the purpose of analytics software. According to Ryan Roberts, software product manager at Sensus, "As communication network technology provides the capacity to deliver real-time, two-way data, utilities can implement analytics software to harness the power of all this information, creating smart value that goes well beyond customer usage."

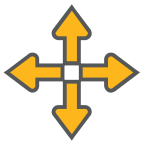
Because most utilities don't have a data scientist or statistician to analyze the incoming data, an analytics software solution should provide actionable data without the utility needing experts on staff—or the associated expenses. Analytics software provides value across the utility, from the meter shop to billing to customer service. According to Roberts, the top benefits fall into three main categories: data timeliness, resolution and accuracy of data, and alarm/alert expediency. "With an analytics solution in place, granular data is immediately available to make well-informed, timely decisions," Roberts says. "Plus, if something is going wrong, that information shows up on the customer's cellphone right away—not a day later."

Whether they're using gas, water or electricity, utility customers want to know usage data by the hour in order to have the ability to assess efficiencies, be notified of problems and plan for future needs. The entire business benefits, as meaningful data drives expansion planning, rate analysis and customer engagement. Plus, utilities can identify vulnerabilities in infrastructure or distribution design, implementing improvements before break-fix situations occur. "Some utilities have a single customer that generates 80% of their revenue," explains Roberts, "so it's imperative to see even slight pattern shifts. The smallest changes equate to a lot of money."

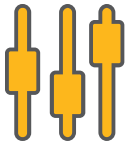
Five key factors to consider when choosing utility analytics software:

Flexibility

Interoperability



Scalability



Customization

Simplicity

Until about 15 years ago, obtaining utility data could be, well, dodgy. Whether due to human mistakes, mechanical errors or network insufficiencies, data corrections had to be made to ensure the data was usable. Typically, this entailed a meter data management (MDM) system. But today a network, especially a point-to-multipoint communication network, brings in much more accurate data. "Because coverage is better and the data is more accurate and timely, data management has to be more refined as well," says Roberts. When combined with the right network, analytics software significantly reduces operations costs. "A utility only needed MDM to fill information gaps when their network is not reliable and robust."

A key example is legacy VEE (Validation, Estimation and Editing). According to Roberts, "A utility can invest $1 million to $2 million each year to sustain a VEE that covers gaps in inaccuracy. Or it could spend the same amount of money on improved infrastructure and get 99.5% accurate reads. It's kind of a no-brainer."

Evaluating analytics software

When it comes to choosing from utility analytics software on the market today, there are five key factors to consider among vendors.

1. Flexibility: Utilities must be able to determine software functions to meet their unique needs by offering prescriptive and custom reports to view various data relationships based on areas, meters and more.

2. Interoperability: This is the ability to collect and process data from systems and sensors outside of meters. A perfect example is the implementation of stormwater sensors on dams to assess lake-level data.

3. Scalability: The solution should have the capacity to grow with utility complexity, customer increase, area expansion, etc., as well as scale with feature advancements and smart city applications.

4. Customization: The ideal solution offers just the right fit for the customer's requirements. The utility should be able to purchase just what the customer needs, no more.

5. Simplicity: Is the solution usable right out of the box? An analytics software solution should be user-friendly, easy to install and deployable with minimal expense.

"A city can have meters and sensors on everything and get data from all of them. But if that data is not being aggregated in a relevant way, it is not actionable. Actionable data is the key to a smart city. And analytics is the key to actionable data."

RYAN ROBERTS
Software product manager
Sensus

Making the case for analytics software

Municipalities and utilities need an analytics solution to optimize their incoming data. But how can a case be built to convince key stakeholders? "Simply put, it's a matter of looking back and then looking forward to present the facts," says Roberts. "When you assess issues that have already occurred, you can evaluate the ROI of having the right data, formatted the right way. The financial, safety and customer service impacts can be clearly presented based on what could have been."

Usage can be segregated by service, by user and by consumption. So when looking ahead to future decisions, utilities can customize reports for the necessary data to justify rate changes or tiered billing. The customer service team can have all the aggregated data at their fingertips, so when calls come in, they can point directly to a day—and hour—and immediately remedy the concern. The reports also provide the ability to be proactive with customers, which markedly improves customer satisfaction.

"Most communities are now crying out for smart city applications, and analytics software is the backbone for the success of smart," says Roberts. "A city can have meters and sensors on everything and get data from all of them. But if that data is not being aggregated in a relevant way, it is not actionable. Actionable data is the key to a smart city. And analytics is the key to actionable data." Because the right analytics solution can sort and report on data from across utilities and break down the typical silos, every aspect of a community's infrastructure can work together for a truly smart city.

Data trends for every utility

Big data is here to stay. And utilities must take advantage of the information that comes from processing their data in relevant ways. Customers—utilities and end-users—want to better manage their resources. So moving actionable data into their hands aligns with our current technology culture and consumer expectations. And it simply creates a better customer experience at all levels.

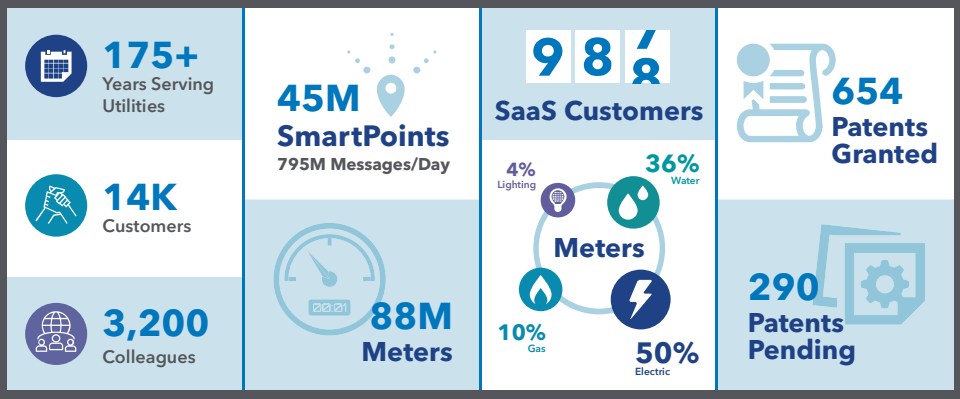
The other issue that is growing rapidly across utilities is compliance. "Government regulations are changing, and compliance is becoming mandatory," explains Roberts. "Utilities have to know their data in order to remain in line with federal and state directives."

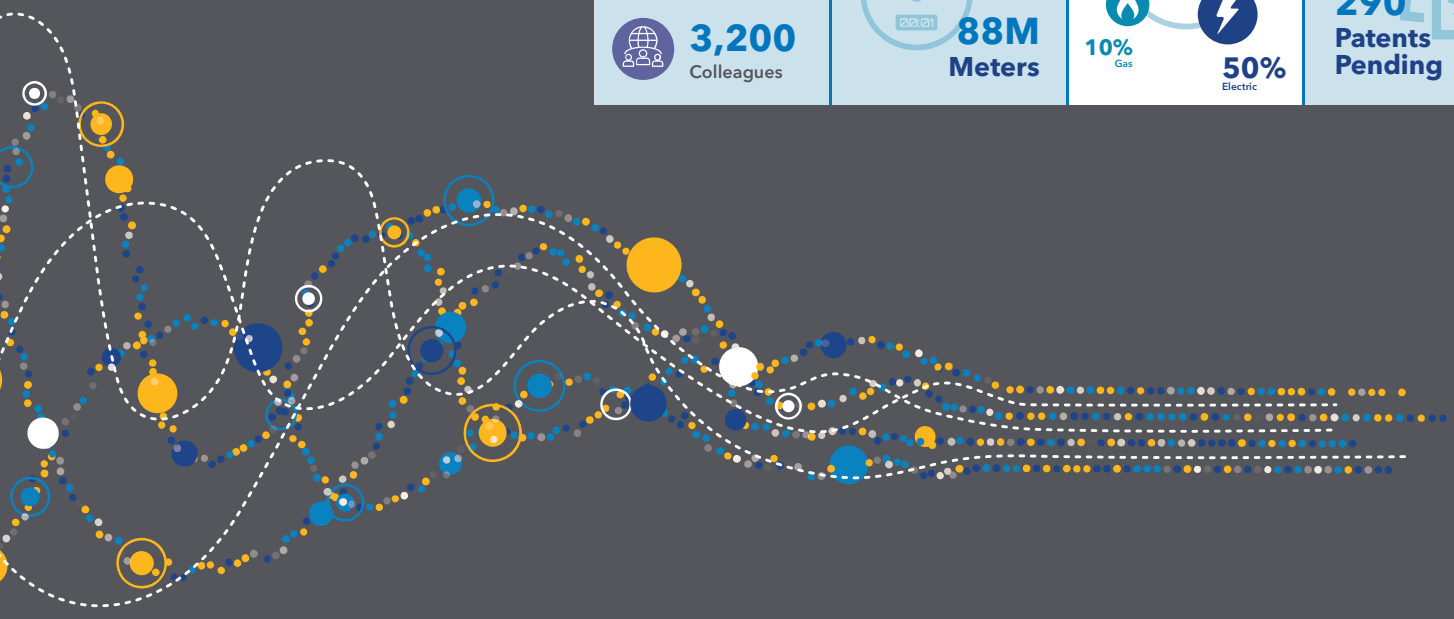
Finally, whether it involves the grid, water or gas, disaster preparation and planning is on the forefront of every municipality. Using data from a municipality's smart utility network, an analytics software solution is the ideal foundation for better asset utilization when crisis strikes—and for everyday efficiency and customer service.

About Sensus

Sensus, a Xylem brand, helps a wide range of public service providers–from utilities to cities to industrial complexes and campuses–do more with their infrastructure to improve quality of life in their communities. We enable our customers to reach farther through the application of technology and data-driven insights that deliver efficiency and responsiveness. We partner with them to anticipate and respond to evolving business needs with innovation in sensing and communications technologies, data analytics and services. Learn more at sensus.com and follow us on Facebook, LinkedIn and Twitter through @sensusglobal.

Sensus by the numbers





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Sensus Essential Analytics

Level the playing field with manageable data insights

Convert data to insight.

Water, gas and electric utilities know that analyzing the information is the best way to optimize your systems and make the most of your investment. Yet the key is sorting through all the data to reveal the right insights – insights to help improve everything from efficiency to customer service.

Sensus Essential Analytics provides the core business functionality you need to do just that. Part of our suite of intelligent infrastructure software, this bundle of applications equips you with user-friendly dashboards, so you can make informed decisions quickly and confidently. Our powerful data management tools aggregate information from your AMI, AMR and other sources. And these intuitive apps are delivered by a secure connection to the cloud right to your desktop, tablet or smart phone - just a click, tap or touch away - wherever and whenever you want.

Role-based access allows service providers to share information across the organization – from customer service and operations to accounting and rates - for improved productivity, visibility and decision-making.

Sensus Essential Analytics:

Data Store - a secure, cloud-based information warehouse that stores system and network data for the applications. Three years of storage is included

Report Access - a management tool that offers a menu of reports that instantly summarize the information you need to know right away

Device Access - a customer service tool that presents detailed usage history and trends, identifies anomalies and enables custom alert programming to track specific issues

Billing Access - a billing interface tool that previews and audits billing extracts for issues, enabling the utility to take corrective action, then generates final billing files for production

Meter Insight - a validation tool that provides a summary of incoming network meter data from and identifies issues to be addressed

Big data doesn't have to be a big deal.

We believe in making data easy to work with. That's why Sensus Analytics offers you the flexibility to purchase single applications or pre-bundled packages of our most popular apps to harness the power of big data for energy and water utilities.

Our cloud-based platform aggregates data from different information systems across your company into intuitive applications that are easy to use and quick to implement. That means less reliance on IT resources and lengthy training and more customer satisfaction, service reliability, quality and operational efficiency.

Here's how we do it:

App-based
Each purpose-built application accesses data from multiple systems and presents it in user-friendly dashboards

Flexible
Select a package of tools for billing and system management or single applications that help achieve key initiatives

Accessible
Our secure, cloud-based delivery platform puts your information within reach no matter where you are

Affordable
There's no need to purchase, install, update or maintain special software, licenses or hardware - or set aside valuable office space to house it

Fresh
Applications are continuously updated as information enters the system, so you can make decisions based on the latest data

Integratable
Sensus Analytics draws information from many systems through the cloud, so there's little time and cost required for standard systems integration

Scalable
Our Data Store and three years of included cloud-based storage enables you to add applications, or increase storage, quickly – often in hours

Visible
Role-based access allows information sharing across the organization – from customer service and operations to accounting and rates - for improved efficiency and cross-functional understanding

Ready to learn more?

Visit sensus.com/analytics.

About Sensus

Sensus, a Xylem brand, helps public service providers—from utilities to cities to industrial complexes and campuses—do more with their infrastructure to improve quality of life in their communities. We enable our customers to reach farther by responding to evolving business needs with innovation in sensing and communications technologies, data analytics and services. Learn more at **sensus.com**.

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FlexNet M400B2 Base Station

Compact Point-to-Multipoint Base Station

The Sensus FlexNet® M400B2 Base Station offers a strategic communications option for public service providers with endpoints deployed in remote or densely populated areas.

The efficient transceiver can transmit and receive in a 200kHz band of spectrum. 200kHz enables more dedicated channels, resulting in higher network capacity, allowing more granular data and more channels of data. And the Sensus FlexNet communication network delivers double the transmit power of competitive systems over primary-use licensed spectrum – ensuring reliability for mission critical applications.

The tower-based architecture enables reliable communication of status and usage information with fewer access points than other network architectures. These compact, efficient base stations fit in space-constrained environments and require no air conditioning.

FEATURES

- GPS receiver for time synchronization
- Duplexer for single antenna
- IP-addressable power supply with hot-swap capability
- 8-hour battery backup
- Alarms and reporting capability
- Backhaul via Ethernet/IP
- Heated battery for cold weather environments
- Modular construction for easy serviceability

APPLICATIONS

- Two-way Advanced Meter Infrastructure (AMI)
- Distribution Automation (DA)
- Demand Response (DR)
- Home Area Networks (HAN)
- Sensus VantagePoint® Lighting Control

Licensed Radio Spectrum

In North America, FCC/IC protected primary-use spectrum avoids competition with other wireless services, interference from other radio devices and the risk of being taken over by emergency service providers.

Fewer Access Points

Our point-to-multipoint architecture directly connects base stations to endpoints over large geographic areas – greatly reducing the number of network backhaul connections as well as O&M costs.

Resilient Network Design

Sensus Base Stations continue to provide real time data during outages and emergencies because of eight hour plus battery backup – enabling better workforce management and faster service restoration.

Small Footprint

Flexible pole or wall-mounting options enable strategic deployment with a discreet appearance.

Industry Leading Security

Sensus has achieved GE/Wurldtech™ Achilles® communications certification for critical infrastructure security against cyber threats.

FlexNet® M400B2 Base Station

Compact Point-to-Multipoint Base Station

PROPERTIES

Receive bandwidth	200 KHz
Transceivers	Single
Spectrum	Licensed 900 MHz PCS/MAS
Duplexing	Single transmit Sixteen receivers - simultaneous/dedicated
Applications	Single
Expandability	No
Compatibility	SNMP
FlexNet	Requires RNI 3.x or newer

ENCLOSURES - OUTDOOR - POLE/WALL MOUNT

Height	22″ (55.9 cm)
Width x Depth	22″ (55.9 cm) x 10.5″ (26.7 cm)
Capacity	One transceiver
Temperature	-40° to +122° F (-40° to +50° C)
Voltage	120 VAC
Battery backup	8 hours
NEMA rating	4
Air conditioned	No

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SmartPoint 520M

Pit Set Module

The SmartPoint® 520M Pit Set Module is a radio transceiver that provides water utilities inbound and outbound access to water measurement and ancillary device diagnostics via radio signal. The SmartPoint 520M is designed for submersible, pit-set environments.

TouchCoupler Design

The SmartPoint 520M Module utilizes TouchCoupler, the patented Sensus inductive coupling communication platform, to interface with the encoded meter. With TouchCoupler, the SmartPoint 520M Module can connect to the meter using existing two wire AMR installations instead of requiring utilities to access the meter to install a new three-wire connection. This results in a fast, efficient and reliable connection at minimal cost.

Operation

With its migratable, two-way communication ability, the M-Series SmartPoint functions as a walk-by/drive-by endpoint, fixed-base endpoint, or combination of the two. This flexibility increases utility data collection capabilities and streamlines operations. The SmartPoint 520M Module receives input from the meter register and remotely sends data to a walk-by/drive-by or fixed-base collection device. The SmartPoint 520M Module easily migrates from walk-by/drive-by to fixed base by simply installing a Base Station.

In walk-by/drive-by mode, the SmartPoint 520M Module collects data and awaits an activation signal from the Vehicle Gateway Basestation (VGB) or Hand-Held Device (HHD). Upon signal receipt, it transmits readings, the meter identification number and any alarms.

As a fixed-base endpoint, the SmartPoint 520M Module interacts with one or more strategically placed Base Stations located in the utility service area. Top of the hour readings and other diagnostics are instantly forwarded to the Regional Network Interface (RNI)™ at time of transmission. The FlexNet® communication network provides unmatched reliability by using expansive tower receiver coverage of metering end points, data/message redundancy, failover backup provisions and operation on FCC primary use (unshared) RF spectrum.

Powerful Transmission, Flexible Platform

The SmartPoint® 520M Pit Set Module offers several advantages that control both deployment and lifetime operation costs. Its powerful, industry-leading two watt transmitter broadcasts over large distances and minimizes collection infrastructure. And after the SmartPoint is installed, its migratable, two-way system platform can be updated without requiring personnel to visit each meter and/or inconveniencing customers.

BENEFITS

- Easily receives input from either walk-by/drive-by or fixed-base collection device
- Controls both deployment and lifetime operation costs
- Compact installation that saves time, space and money - without reducing system performance
- Delivers a fast, efficient and reliable connection at minimal cost
- Minimizes new infrastructure investment
- Enables effective leak detection

SmartPoint 520M

Pit Set Module

Additional Smartpoint 520M Module Features

The SmartPoint 520M Module obtains hourly readings and can monitor continuous flow over a programmable period of time, alerting the utility to leak conditions. In addition, the SmartPoint stores up to 840 consumption intervals (35 days of hourly consumption), providing the utility with the ability to extract detailed usage profiles for consumer information and dispute resolution. The SmartPoint also incorporates a two-port design, allowing the utility to connect multiple registers and ancillary devices (such as acoustic monitoring) to a single SmartPoint. This results in a compact installation that saves time, space and money - without reducing system performance.

SPECIFICATIONS

Service	Pit set installation interfacing the utility meter to the Sensus FlexNet communication network. Unit requires 1.75" diameter hole in pit lid; fits pit lid thicknesses up to 1.75"
Physical characteristics	Width: 4.43" x Height: 5.09" x Depth: 3"
Weight	1.0 lbs/16.0 oz
Color	Black
Frequency range	900 – 950 MHz, 8000 channels X 6.25 kHz steps
Modulation	Proprietary Narrow Band
Memory	Non-Volatile
Power	Lithium Thionyl Chloride batteries
Approvals	US: FCC CFR 47: Part 24D, Part 101C, Part 15 Licensed operation Canada: Industry Canada (IC) RSS-134, RSS-119
Operating temperature	- 22° F to +185° F - 30° C to + 85° C
Options	Dual or single port availability; TouchCoupler only, wired only
Installation environment	100% condensing, water submersible
Compatibility	TouchCoupler and Wired Version: Sensus Encoder Registers, Badger ADE water registers, Master Meter AccuLinx, and Hersey Translator (approved TR/PL Lead) Wired Version Only: Elster Encoder (Sensus protocol), Neptune ARB VI (ProRead), Hersey Translator, Zenner PMN Nitro 01, McCrometer flowcom FC100-00M, and Kamstrup flowIQ 2100 Refer to the 510M/520M SmartPoint® Module Water Meter and Ancillaries Compatibility Quick Guide for the latest compatibility information.
Warranty	20 years – Based on six transmissions per day. Refer to Sensus G-500 for warranty.

xylem

Xylem.com | Sensus.com

SENSUS | 637 Davis Drive | Morrisville, NC 27560 | 800.638.3748

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510M/520M SmartPoint® Module

Water Meter and Ancillaries Compatibility Quick Guide

Sensus

Register Type	Model	Meter Type
ICE & ICE Opto	All meters that accept ICE & ICE Opto 3-wire.	Positive Displacement, Multi-jet, Compound, Turbine, Propeller, Fire Service
OMNI™	T2, C2, F2, R2	Floating Ball Technology
accuMAG™	accuMAG	Mag
iPERL®	iPERL	Mag
Permalog	Permalog+	Acoustic Technology
Sensus® Electronic Register+™ and E-Register	accuSTREAM, SR II	Positive Displacement
ally	ally	ally
Hydroverse	Hydroverse	Mag

Badger

Register Type	Model	Meter Type
ADE	All meters that accept ADE 3-wire and TouchCoupler support, Sensus Approved TR/PL lead, up to 8 wheels.	Disc, Turbine, Compound, Fire Service
HR-E LCD	All meters that accept HR-E LCD 3-wire, up to 8 wheels. Must be at least SmartPoint firmware version R1.2.1f or higher.	Disc, Turbo Series, Compound Series, Combo Series, Fire Service
E-SERIES 8 digits	All models with firmware version 1.36. 3-wire**	Ultrasonic

Neptune

Register Type	Model	Meter Type
Proread 4 wheel	All meters that accept Proread registers. 3-wire support	Positive Displacement, Turbine, Compound, Fire Service
E-coder with TouchCoupler 4 wheel	All meters with firmware version 01.02. Manufactured after 1/2016.	Positive Displacement, Turbine, Compound, Fire Service
Proread 6 wheel	All meters that accept Proread registers. 3-wire support	Positive Displacement, Turbine, Compound, Fire Service
E-coder 6 wheel	All meters that accept E-coder registers. 3-wire support (Proread protocol only)	Positive Displacement, Turbine, Compound, Fire Service
E-coder with TouchCoupler 6 wheel	All meters with firmware version 01.02. Manufactured after 1/2016.	Positive Displacement, Turbine, Compound, Fire Service
E-coder 8 wheel	All meters that accept E-coder registers. 3-wire support*	Positive Displacement, Turbine, Compound, Fire Service
E-coder with TouchCoupler 8 wheel	All meters with firmware version 01.02. Manufactured after 1/2016.	Positive Displacement, Turbine, Compound, Fire Service
ProCoder 8 wheel	All meters with firmware version 63.16. Manufactured after 7/2018. TouchCoupler and 3-wire**	Positive Displacement, Turbine, Compound, Fire Service

*SmartPoint firmware version 1.2 and above only
**SmartPoint firmware version 1.7 and above only

sensus
a xylem brand

Elster/Amco

Register Type	Model	Meter Type
Scancoder	All meters that accept Scancoder 3-wire support (Sensus protocol only).	Positive Displacement, Turbine, Multi-jet, Bulk combo, Fire service
InVision	All meters that accept InVision 3-wire support (Sensus protocol only).	Positive Displacement, Turbine, Multi-jet, Bulk combo, Fire service

Master Meter

Register Type	Model	Meter Type
AccuLinx V1.19	All meters that accept AccuLinx 3-wire and TouchCoupler, Sensus approved TR/PL lead.	Positive Displacement
Sonata 8 digits	3-wire and TouchCoupler, firmware version 5.01 or greater.**	Ultrasonic
Octave 8 digits	3-wire only.**	Ultrasonic

McCrometer

Register Type	Model	Meter Type
McCrometer flowcom FC100-00M 8 digits	3-wire reading. Firmware 2.4. Manufactured after 4/2015.	Propeller
ML255 battery powered register 8 digits	3-wire reading only. Firmware 5.09 or greater.**	Propeller
ML Series converter, AC powered 8 digits	3-wire reading only. Firmware 3.03 or greater.**	Propeller

Kamstrup

Register Type	Model	Meter Type
flowIQ 2100 4, 6 and 8 wheel	3-wire reading. Version C1.	Ultrasonic
flowIQ 2100 4, 6, and 8 wheel	3-wire and TouchCoupler version H1.**	Ultrasonic

Diehl

Register Type	Model	Meter Type
Hydrus 8 digits	3-wire support only.** Manufactured after 4/2018.	Ultrasonic

Zenner

Register Type	Model	Meter Type
PMN Nitro 01 4 wheel, 6 wheel	3-wire support only. Manufactured after 8/2015.	Multi-jet

Hersey/Mueller Systems

Register Type	Model	Meter Type
Translator	All meters that accept Translator 3-wire and TouchCoupler support, Sensus approved TR/PL lead.	Positive Displacement, Mag

*SmartPoint firmware version 1.2 and above only
**SmartPoint firmware version 1.7 and above only

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Recordall
RCDL | Mechanical Flow Meters

Recordall® Turbo Series Meters

Models 160 (1-1/2 in.), 200 (2 in.), 450 (3 in.), 1000 (4 in.), 2000 (6 in.), 3500 (8 in.), 5500 (10 in.) and 6200 (12 in.) NSF/ANSI/CAN Standards 61 and 372 Certified

DESCRIPTION

Recordall Turbo Series meters meet or exceed the most recent revision of AWWA Standard C701 Class II Standards and are available in a lead-free bronze alloy for sizes 1-1/2 in. through 10 in. and cast iron for 12 in. meters. Turbo Series meters comply with the lead-free provisions of the Safe Drinking Water Act. Sizes 1-1/2 in. through 12 in. meters are also certified to NSF/ANSI/CAN Standards 61 and 372 (Trade Designation: Turbo Series LL-NS) and carry the NSF-61 mark on the housing. All components of the lead-free alloy meter (housing, measuring element, seals and so on) comprise the certified system.

Models 160 through 6200 are designed for 1-1/2 in. through 12 in. applications. These meters feature:

- Direct coupled turbine based on an exclusive "floating rotor" design that reduces bearing friction—and associated wear and tear.
- Low pressure loss for improved system efficiency.
- Exceptional registration accuracy across low flow rate, normal operating flow rate and maximum continuous operation flow.
- Permanently sealed, tamper-resistant register or encoder.
- Integral strainer helps protect your system from damaging debris and related downtime. Integral strainer is standard on 1-1/2 in. meter, and optional on 2 in. through 4 in. meters.
- Meters and encoders are compatible with Badger Meter AMR/AMI meter reading systems and other approved reading technologies.

Applications: Recordall Turbo Series meters are designed for cold water, commercial and industrial applications where flows are consistent medium to high flows. Applications include hotels, apartment buildings, irrigations centers and manufacturing and processing plants. Turbo Series meters help reduce day-to-day maintenance costs while delivering accurate and efficient performance.

Operation & Performance: Direct magnetic drive is achieved when the magnet carrier is driven by a gear train coupled to the rotor. The gear train consists of two sets of gears connected by a vertical transmission shaft. One gear set is at the magnet carrier, the other is a worm gear set at the rotor shaft. When water flows into the Turbo Series meter measuring element, it contacts the multi-vaned rotor. The resulting rotor rotation is then transmitted by magnetic coupling to a sealed register or encoder. The direct magnetic drive is built to provides a reliable meter-to-registration coupling.

Tamper-Proof Features: Unauthorized removal of the register or encoder is inhibited by the option of a tamper detection seal wire screw, TORX® tamper-resistant seal screw or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

Construction: The Recordall Turbo Series meter is constructed in compliance with ANSI and AWWA C701 standards. It consists of the following basic components: meter housing, interchangeable, unitized measuring element and permanently sealed direct reading registers or encoders.

The measuring element consists of the transmission coupling, rotor, inlet and outlet straightening vanes with nose cones, and calibration ring assembly. The unique inlet and outlet straightening vanes minimize swirl from piping arrangements upstream as well as downstream.

A strainer is recommended to help ensure optimal flow conditioning and protection for the measuring element. The integral strainer is standard on the 1-1/2 in. meter and an available option on the 2 in. through 4 in. meters. The stainless steel strainer is built into the inlet end and includes a removable cover plate to permit easy access for routine cleaning. External strainers are available in sizes 2 in. through 12 in.

To simplify maintenance, the registers or encoders and measuring elements can be removed without removing the meter housing. Interchangeability of certain parts between meters also minimizes spare parts inventory investment.

Meter Installation: The meter is designed for installations where flow is in one direction only. Companion flanges for installation of meters on various pipe types and sizes are available in cast iron or NL bronze as an option. See the *Recordall Turbo Series Meters User Manual* available at *badgermeter.com* for specific instructions.

SPECIFICATIONS

Turbo Series Model	**160** 1-1/2 in. (40 mm)	**200** 2 in. (50 mm)	**450** 3 in. (80 mm)	**1000** 4 in. (100 mm)	**2000** 6 in. (150 mm)	**3500** 8 in. (200 mm)	**5500** 10 in. (250 mm)	**6200** 12 in. (300 mm)
Meter Flanges AWWA 125 Pound Class	Elliptical	Elliptical or Round	Round	Round	Round	Round	Round	Round AWWA 125 lb class
Typical Operating Range (100% ± 1.5%)	4…200 gpm (0.9…45.4 m^3/h)	4…310 gpm (0.9…70.4 m^3/h)	5…550 gpm (1.1…124.9 m^3/h)	10…1250 gpm (2.3…284 m^3/hr)	20…2500 gpm (4.5…568 m^3/h)	30…4500 gpm (6.8…1022 m^3/h)	50…7000 gpm (11.4…1590 m^3/h)	90…8800 gpm (20.5…1998 m^3/h)
Typical Low Flow (95% min.)	2.5 gpm (0.6 m^3/h)	2.5 gpm (0.6 m^3/h)	4 gpm (0.9 m^3/h)	6 gpm (1.4 m^3/h)	12 gpm (2.7 m^3/h)	20 gpm (4.5 m^3/h)	30 gpm (6.8 m^3/h)	65 gpm (14.8 m^3/h)
Max. Continuous Flow	160 gpm (36 m^3/h)	200 gpm (45.4 m^3/h)	450 gpm (102.2 m^3/h)	1000 gpm (227.1 m^3/h)	2000 gpm (454 m^3/h)	3500 gpm (795 m^3/h)	5500 gpm (1250 m^3/h)	6200 gpm (1408 m^3/h)
Maximum Intermittent Flow	200 gpm (45.4 m^3/h)	310 gpm (70.4 m^3/h)	550 gpm (124.9 m^3h)	1250 gpm (284 m^3h)	2500 gpm (568 m^3/h)	4500 gpm (1022 m^3/h)	7000 gpm (1590 m^3h)	8800 gpm (1988 m^3/h)
Pressure Loss at Max. Continuous Flow	3.8 psi (0.26 bar)	3.1 psi (0.21 bar)	1.8 psi (0.12 bar)	7.3 psi (0.50 bar)	4.8 psi (0.33 bar)	2.5 psi (0.17 bar)	1.6 psi (0.11 bar)	0.8 psi (0.05 bar)
Pressure Loss at Max. Continuous Flow: With Integral Strainer	9.9 psi (0.68 bar)	8.3 psi (0.57 bar)	5 psi (0.43 bar)	17.8 psi (1.2 bar)	—			
Max. Operating Pressure	150 psi (10 bar)							
Max. Operating Temperature	120° F (49° C)							
Integral Strainer	Optional on 2 in. through 4 in. meters. Built into inlet end. Removable cover plate permits access to strainer for cleaning.				—			
Optional External Strainer	—	Available for Models 200, 450, 1000, 2000, 3500, 5500 and 6200.						
NPT Test Port	Standard with integral strainer; optional for other models.				Optional for Models 2000 and 3500.		—	

MATERIALS

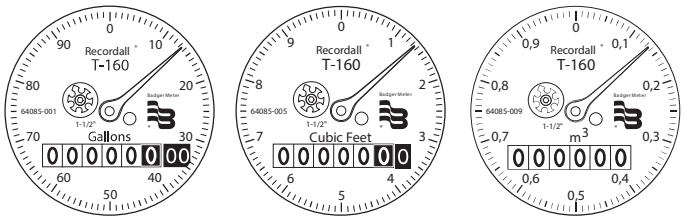
Meter Housing	Lead-free alloy (**EXCEPTION**: Model 6200 meter housing is blue epoxy-coated cast iron)
Turbo Head	Lead-free alloy
Nose Cone & Straightening Vanes	Thermoplastic
Rotor	Thermoplastic
Rotor Radial Bearings	Lubricated thermoplastic
Rotor Thruster Bearing	Sapphire jewels
Rotor Bearing Pivots	Passivated 316 stainless steel
Calibration Mechanism	Stainless steel & thermoplastic
Magnet	Ceramic
Trim	Stainless steel
Register Housing & Cover	Thermoplastic or bronze
Integral Strainer & Trim	Stainless steel

REGISTERS / ENCODERS

Standard—Sweep-Hand Registration

The standard register is a straight-reading, permanently sealed magnetic drive register. Dirt, moisture, tampering and lens fogging problems are eliminated. The register has a six-odometer wheel totalization display, 360° test circle with center sweep hand, and flow finder to detect leaks. Register gearing is made of self-lubricating engineered polymer, which minimizes friction and provides long life. The multi-position register simplifies meter installation and reading. The register capacity for the 1-1/2 in., 2 in., 3 in. and 4 in. meters is 100,000,000 gallons (10,000,000 ft^3, 1,000,000 m^3). The register capacity for the 6 in., 8 in., and 10 in. meters is 1,000,000,000 gallons (100,000,000 ft^3, 10,000,000 m^3). The high-flow register capacity for the 12 in. meter is 10,000,000,000 gallons (1,000,000,000 ft^3, 10,000,000 m^3).

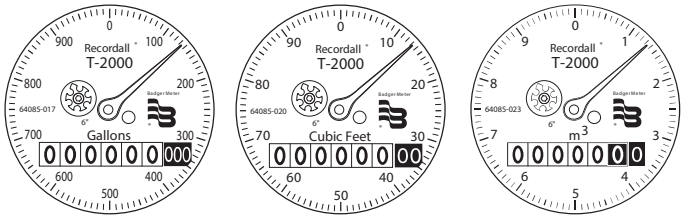
Registers for 1-1/2 in., 2 in., 3 in. and 4 in. Meters



Sweep Hand Revolution

Meter Model	Gallon	Cubic Feet	Cubic Meter
160	100	10	1
200	100	10	1
450	100	10	1
1000	100	10	1

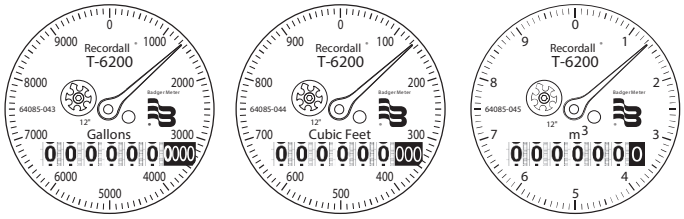
Registers for 6 in., 8 in. and 10 in. Meters



Sweep Hand Revolution

Meter Model	Gallon	Cubic Feet	Cubic Meter
2000	1000	100	10
3500	1000	100	10
5500	1000	100	10

Registers for 12 in. Meters



Sweep Hand Revolution

Meter Model	Gallon	Cubic Feet	Cubic Meter
6200	10000	1000	10

Optional—Encoders for AMR/AMI Reading Solutions

AMR/AMI solutions are available for all Recordall Disc Series meters. All reading options can be removed from the meter without disrupting water service. Badger Meter encoders provide years of reliable, accurate readings for a variety of applications and are also available pre-wired to Badger Meter approved AMR/AMI solutions. See details at *badgermeter.com*.

PHYSICAL DIMENSIONS OF METERS WITHOUT STRAINER

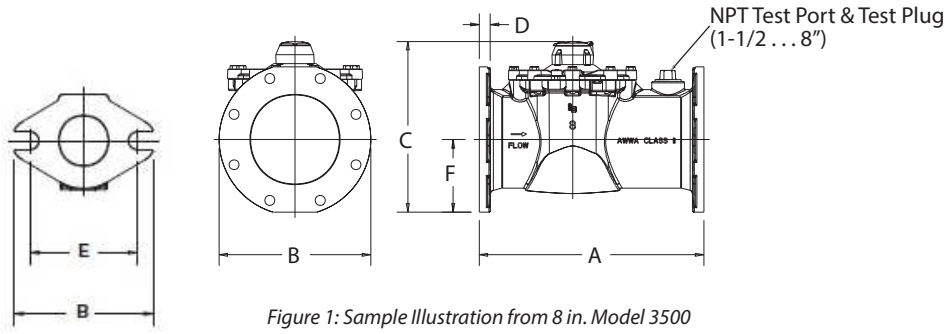


Figure 1: Sample Illustration from 8 in. Model 3500

Turbo Series Model	200	200	450	1000	2000	3500	5500	6200
Meter Flanges	2 in. Elliptical	2 in. Round	3 in. Round	4 in. Round	6 in. Round	8 in. Round	10 in. Round	12 in. Round
Meter & Pipe Size	2 in. (50 mm)	2 in. (50 mm)	3 in. (80 mm)	4 in. (100 mm)	6 in. (150 mm)	8 in. (200 mm)	10 in. (250 mm)	12 in. (300 mm)
Net Weight	14.9 lb (6.8 kg)	17.4 lb (7.9 kg)	31 lb (14.1 kg)	40 lb (18.1 kg)	77 lb (35 kg)	123 lb (55.7 kg)	210 lb (95.3 kg)	262 lb (118.8 kg)
Shipping Weight	16.4 lb (7.4 kg)	18.9 lb (8.6 kg)	34 lb (15.4 kg)	45 lb (20.4 kg)	89 lb (40.4 kg)	147 lb (66.6 kg)	235 lb (106.6 kg)	286 lb (129.7 kg)
Qty. of Bolts	2	4	4	8	8	8	12	12
NPT Test Port (optional)	1-1/2 in. (40 mm)	1-1/2 in. (40 mm)	2 in. (50 mm)	2 in. (50 mm)	2 in. (50 mm)	2 in. (50 mm)	—	—
Length (A)	10 in. (254 mm)	10 in. (254 mm)	12 in. (305 mm)	14 in. (356 mm)	18 in. (457 mm)	20 in. (508 mm)	26 in. (660.4 mm)	19-11/16 in. (500 mm)
Width (B)	5-27/32 in. (148 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)	9 in. (229 mm)	11 in. (280 mm)	13-1/2 in. (343 mm)	16 in. (406.4 mm)	19 in. (482 mm)
Height (C)	6-1/2 in. (165 mm)	7-3/32 in. (180 mm)	8-11/16 in. (220 mm)	9-21/32 in. (245 mm)	13-5/16 in. (338 mm)	15-3/16 in. (385 mm)	17-15/32 in. (443 mm)	19-11/16 in. (500 mm)
Flange (D)	25/32 in. (20 mm)	5/8 in. (16 mm)	3/4 in. (19 mm)	13/16 in. (21 mm)	7/8 in. (22 mm)	1 in. (25 mm)	1-1/16 in. (27 mm)	1.26 in. (32 mm)
Bolt Circle (E)	4-1/2 in. (114 mm)	4-3/4 in. (121 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)	9-1/2 in. (241 mm)	11-3/4 in. (298 mm)	14-1/4 in. (362 mm)	17 in. (432 mm)
Centerline (F)	2-1/16 in. (52 mm)	2-5/8 in. (67 mm)	3-11/32 in. (85 mm)	4-5/16 in. (109 mm)	5-1/4 in. (133 mm)	6-3/8 in. (162 mm)	7-7/8 in. (199.4 mm)	8-7/8 in. (226 mm)

PHYSICAL DIMENSIONS OF METERS WITH INTEGRAL STRAINER

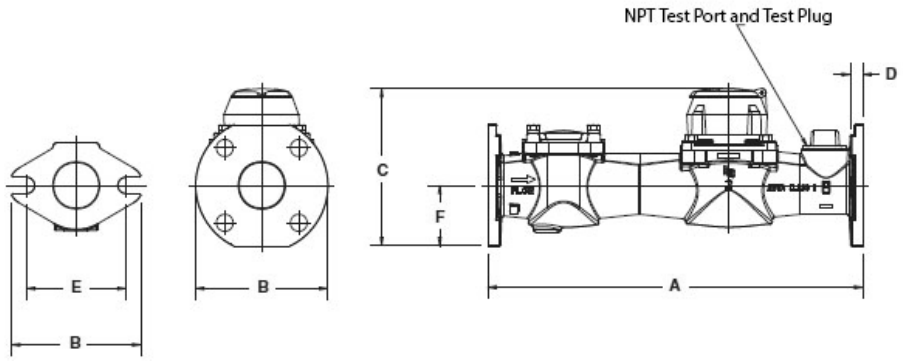
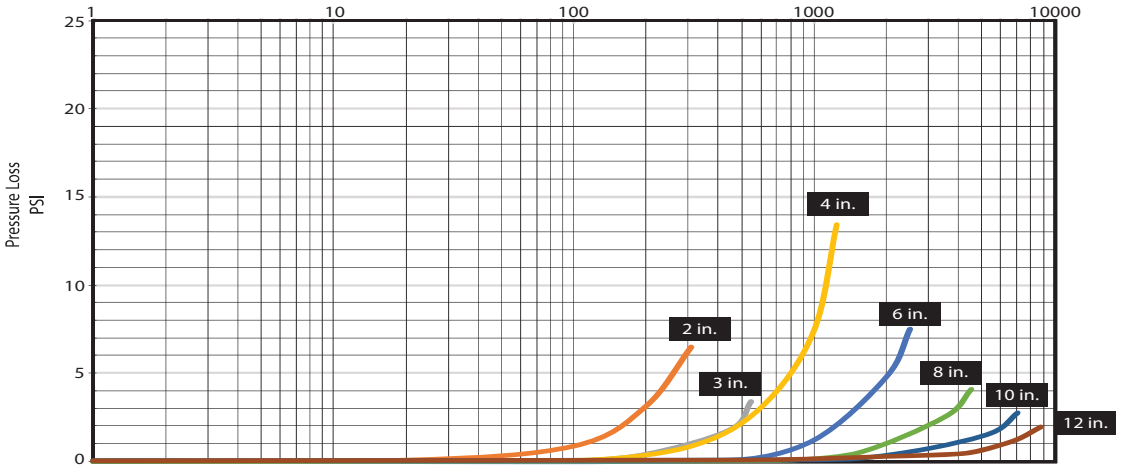


Figure 2: Physical dimensions

Turbo Series Model	160	200	200	450	1000
Meter Flanges	Elliptical	Elliptical	Round	Round	Round
Meter & Pipe Size	1-1/2 in. (40 mm)	2 in. (50 mm)	2 in. (50 mm)	3 in. (80 mm)	4 in. (100 mm)
Net Weight	14.3 lb (6.5 kg)	24 lb (11 kg)	26 lb (12 kg)	49 lb (22 kg)	60 lb (27.22 kg)
Shipping Weight	16.8 lb (7.6 kg)	28 lb (13 kg)	30 lb (14 kg)	55 lb (25 kg)	70 lb (31.75 kg)
Number of Bolts	2	2	4	4	8
NPT Test Port (Standard)	1 in. (25.4 mm)	1-1/2 in. (40 mm)	1-1/2 in. (40 mm)	2 in. (50 mm)	2 in. (50 mm)
Length (A)	13 in. (330 mm)	17 in. (432 mm)	17 in. (432 mm)	19 in. (483 mm)	23 in. (584 mm)
Width (B)	5-7/32 in. (133 mm)	5-27/32 in. (148 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)	9 in. (229 mm)
Height (C)	6-9/32 in. (159 mm)	6-1/2 in. (165 mm)	7-3/32 in. (180 mm)	8-15/16 in. (227 mm)	9-21/32 in. (245 mm)
Flange (D)	51/64 in. (20 mm)	27/32 in. (47 mm)	5/8 in. (16 mm)	27/32 in. (21 mm)	13/16 in. (21 mm)
Bolt Circle (E)	4 in. (102 mm)	4-1/2 in. (114 mm)	4-3/4 in. (121 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)
Centerline (F)	1-27/32 in. (47 mm)	2-1/16 in. (52 mm)	2-5/8 in. (67 mm)	3-19/32 in. (91 mm)	4-5/16 in. (109 mm)

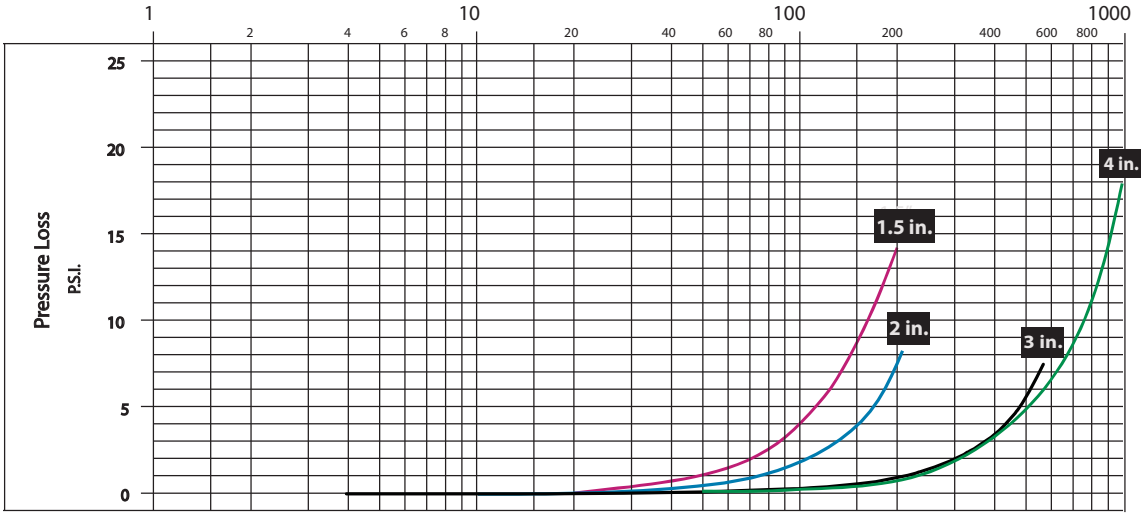
PRESSURE LOSS CHART FOR METERS WITHOUT STRAINER

Rate of flow in gallons per minute (gpm)



PRESSURE LOSS CHART FOR METERS WITH INTEGRAL STRAINER

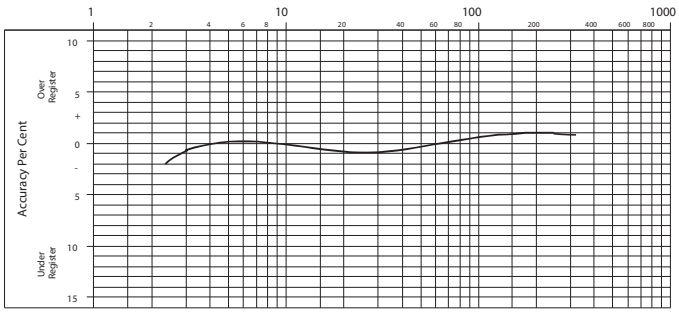
Rate of flow in gallons per minute (gpm)



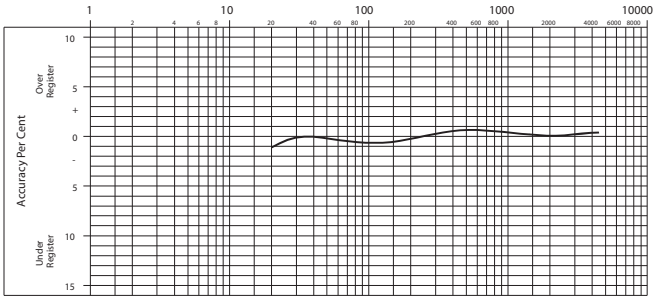
ACCURACY CHARTS FOR METERS WITHOUT STRAINER

Rate of flow in gallons per minute (gpm)

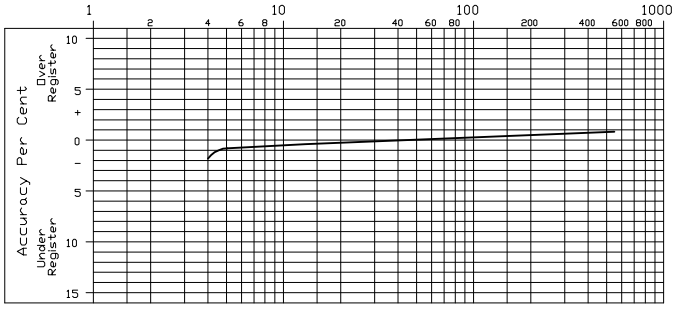
2 in. Meter



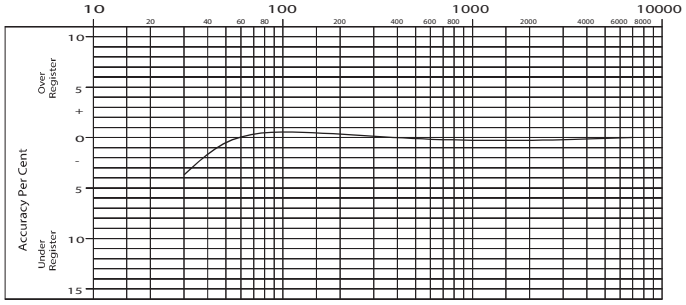
8 in. Meter



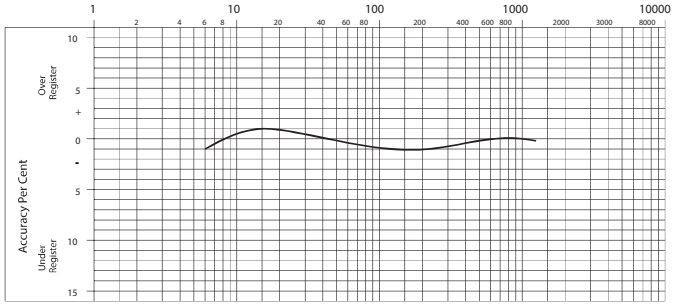
3 in. Meter



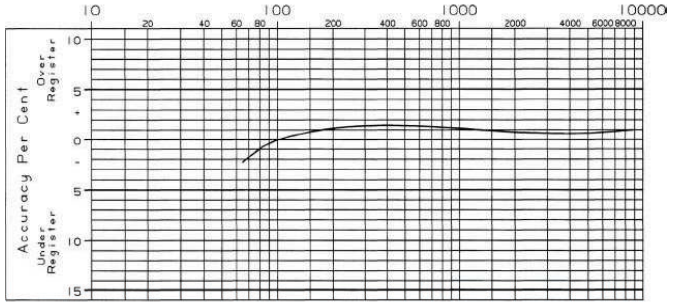
10 in. Meter



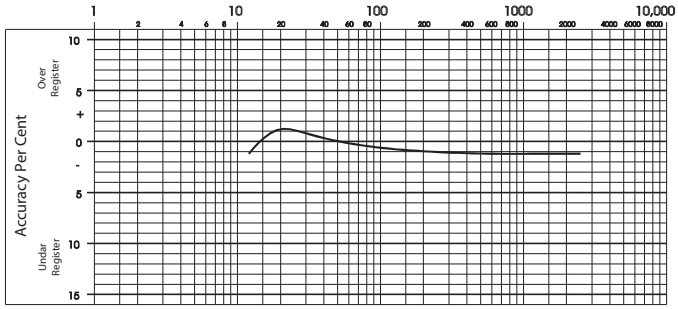
4 in. Meter



12 in. Meter



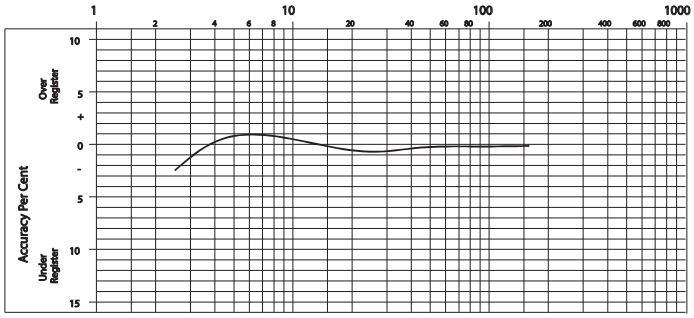
6 in. Meter



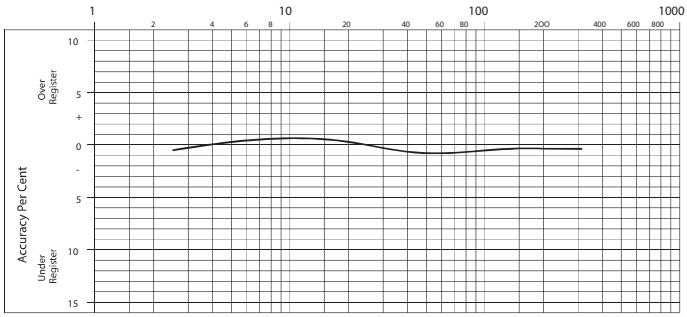
ACCURACY CHARTS FOR METERS WITH INTEGRAL STRAINER

Rate of flow in gallons per minute (gpm)

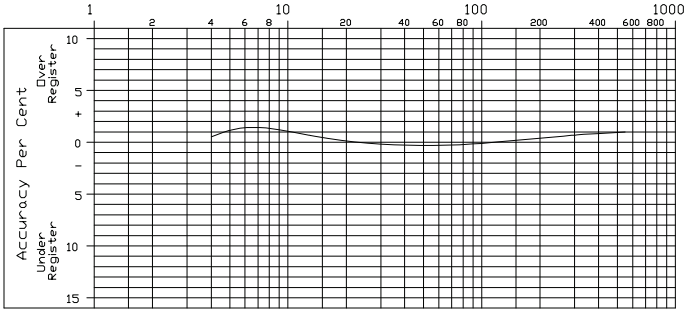
1-1/2 in. Meter



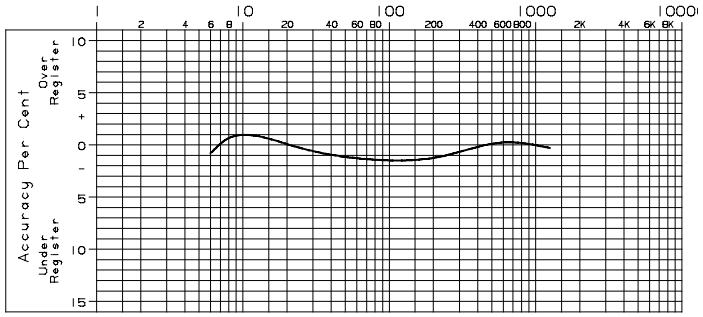
2 in. Meter



3 in. Meter



4 in. Meter



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Legacy Document Numbers: RTS-T-1-1/2. 3. 4. 6. 8. 10 and 12; RTS-T-I 1-1/2, 2, 3, and 4

Recordall®
RCDL | Mechanical Flow Meters

Recordall® Turbo Series Meter

Model 450 Fire Hydrant Meter 3 inch

DESCRIPTION

The Badger Meter Model 450 fire hydrant meter is designed for use in measuring cold water from a fire hydrant or other non-permanent installation where flow is in one direction.

Operation

Water flows into the meter's measuring element where flow readings are obtained by rotor revolutions transmitted by magnetic drive coupling through the meter's cover plate to the sealed register. Magnetic drive is achieved by a right angle worm drive, coupling the rotor to the vertical transmission spindle. A ceramic magnet on the spindle rotates around the vertical axis. Through the magnetic coupling, rotor rotation is transmitted to a follower magnet which transmits rotation to the register gearing.

Operating Performance

The Model 450 fire hydrant meters meet or exceed registration accuracy for the low flow rate, normal operating flow rate, and maximum continuous operation flow rate as specifically stated in AWWA Standard C701.

Construction

The Model 450 fire hydrant meter construction consists of three basic components: meter housing, measuring element, and permanently sealed register. The housing is light-weight heat treated aluminum alloy, compact and easy to handle. The measuring element consists of the transmission coupling, measuring element insert, rotor, straightening vane, and calibration vane assembly. The straightening vanes minimize swirl from piping arrangements upstream.

Magnetic Drive

Direct magnetic drive, through the use of high-strength magnets, provides positive, reliable and dependable register coupling.

Restriction Plate

A permanent orifice, positioned in the outlet side of the meter housing, limits the maximum flow of water through the meter. This is provided to protect the measuring element from overspeeding when the meter discharges to atmosphere.

Sealed Register

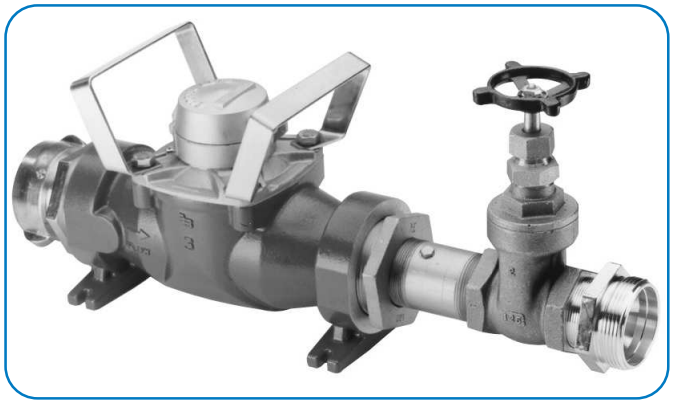
The standard register consists of a straight-reading odometer-type totalization display, 360° test circle with center sweep hand and flow finder to detect leaks. Register gearing consists of self-lubricating thermoplastic gears to minimize friction and provide long life. Permanently sealed; dirt, moisture, tampering and lens fogging problems are eliminated. Multi-position register simplifies meter installation and reading.

Tamper-Resistant Features

Removal of the register to obtain free water is prevented when the tamper detection seal wire screw or TORX® tamper-resistant seal screw is added to the meter. A tamper-resistant calibration plug seal provides protection from unauthorized personnel use.

Strainer

A compression fit double layer stainless steel strainer is installed in the inlet housing tube. The strainer insures optimum long-term field performance.



Maintenance

The Model 450 fire hydrant meters are designed and manufactured to provide long-term service with minimal maintenance. When maintenance is required, it can be performed easily either at the meter installation or at any other convenient location. As an alternative to repair by the utility, Badger Meter offers various maintenance and meter component exchange programs to fit the needs of the utility.

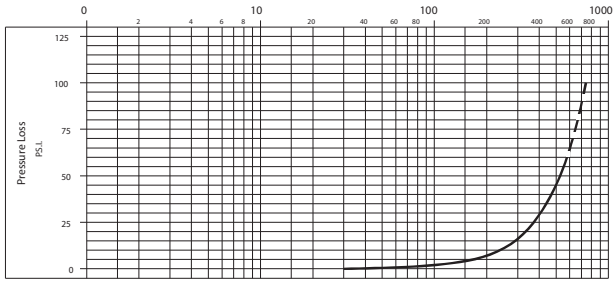
Hose Couplings

The meter is available with standard (2-1/2 in. – 7-1/2 NST) fire hose swivel couplings, unless otherwise specified. Complete thread specifications (listed on the back page of this document) must be furnished for special fire hose fittings.

Options: 2 in. or 2-1/2 in. gate valve, check valve.

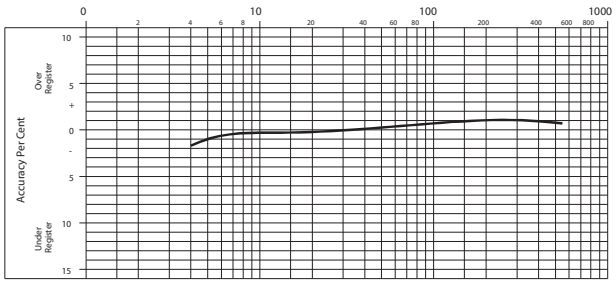
Pressure Loss Chart

Rate of flow in gallons per minute (gpm)



Accuracy Chart

Rate of flow in gallons per minute (gpm)



Badger Meter

RTS-DS-00546-EN-03 (September 2021)

Product Data Sheet

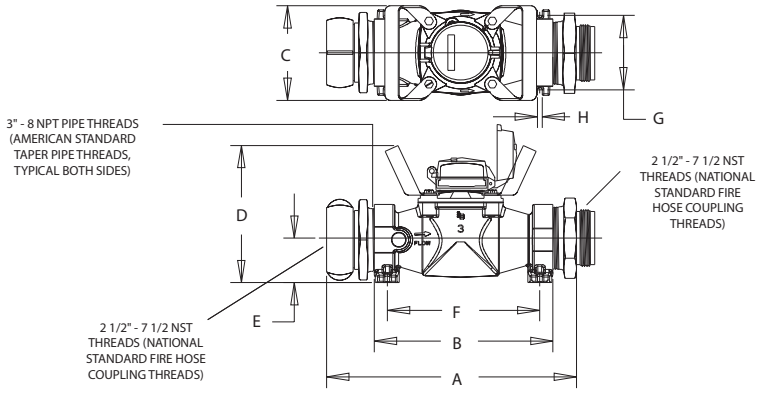
SPECIFICATIONS

Typical Operating Range (100%±1.5%)	5…660 gpm (1.1…150 m^3/hr)
Maximum Continuous Flow	500 gpm (102 m^3/hr)
Maximum Intermittant Flow	660 gpm (150 m^3/hr)
Typical Low Flow (Min. 95%)	4 gpm (0.9 m^3/hr)
Pressure Loss at Max. Continuous Operation	37 psi @ 450 gpm (2.55 bar @ 102 m^3/hr) (standard couplings with orifice and screen) **Note:** 27 psi @ 350 gpm
Maximum Operating Pressure	150 psi (10 bar)
Standard Hose Coupling	2-1/2 in. – 7-1/2 NST threads (78P – 3.4 mm) (National standard fire hose coupling thread)
Register	Straight-reading, permanently sealed magnetic drive standard.
Registration	100,000,000 gallons; 100 gallons/sweep hand revolution.
	10,000,000 cubic feet; 10 cubic ft/sweep hand revolution.
	1,000,000 m^3; 1 m^3/sweep hand revolution.
Flow Restriction (Orifice)	Limits flow through the meter to 660 gpm @ 85 psi (150 m^3/hr @ 59 bar) system pressure with standard couplings.

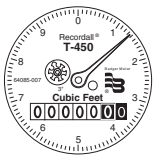
Materials

Housing	Heat treated aluminum alloy
Nose Cone and Straightening Vanes	Thermoplastic
Rotor	Thermoplastic
Rotor Radial Bearings	Lubricated thermoplastic
Rotor Thrust Bearings	Sapphire jewels
Rotor Bearing Pivots	Passivated 316 stainless steel
Calibration Mechanism	Stainless steel and thermoplastic
Magnet	Ceramic
Register Cover	Bronze
Options	2 in. gate valve, 2-1/2 in. gate valve, 2 in. check valve, bronze
Trim	Stainless steel
Inlet Screen	Stainless steel with Elastomer

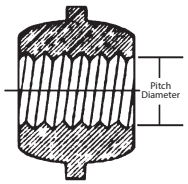
DIMENSIONS



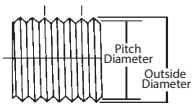
Meter & Pipe Size	Length w/coupl. A	Length w/o coupl. B	Width C	Height D	Ctrline E	F	G	H	Net Weight w/o Fittings	Net Weight w/Fittings	Net Weight w/Valve	Shipping Weight w/o Fittings	Shipping Weight w/Fittings	Shipping Weight w/Valve
3" (DN 80)	17 in. (432 mm)	12 in. (305 mm)	6-3/8 in. (162 mm)	9.0 in. (229 mm)	2-15/16 in. (73 mm)	10-1/4 in. (260 mm)	5 in. (127 mm)	11/32 in. (9 mm)	14.2 lb (6.44 kg)	20.6 lb (9.34 kg)	31.6 lb (14.33 kg)	17.2 lb (7.80 kg)	23.6 lb (10.7 kg)	34.6 lb (15.7 kg)



Specifications for Special Fire Hose Coupling Threads



Female Threads



Male Threads

Required Information

- Number of threads per inch and thread form, if other than American National Standard.
- Outside diameter of male threads.
- Pitch diameter of male threads.
- Pitch diameter of female threads.

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Legacy Document Number: RTS-T-3FH-EN

Recordall® Disc Meters

Lead-Free Bronze Alloy, Sizes 5/8, 5/8 x 3/4, 3/4 & 1 inch
NSF/ANSI Standards 61 and 372 Certified

Model 25—5/8 in., 5/8 × 3/4 in.

Model 35—3/4 in.

Model 55—1 in.

Model 70—1 in.

DESCRIPTION

The Recordall Disc Series meters meet or exceed the most recent revision of AWWA Standard C700 and are available in a lead-free bronze alloy. The meters comply with the lead-free provisions of the Safe Drinking Water Act, are certified to NSF/ANSI Standards 61 and 372 (Trade Designations: M25-LL, M35-LL, M55-LL, M70-LL) and carry the NSF-61 mark on the housing. All components of the lead-free bronze alloy meter (housing, measuring element, seals, and so on) comprise the certified system.

Applications: For use in measurement of potable cold water in residential, commercial and industrial services where flow is in one direction only.

Operation: Water flows through the meter's strainer and into the measuring chamber where it causes the disc to nutate. The disc, which moves freely, nutates on its own ball, guided by a thrust roller. A drive magnet transmits the motion of the disc to a follower magnet located within the permanently sealed register. The follower magnet is connected to the register gear train. The gear train reduces the disc nutations into volume totalization units displayed on the register or encoder face.

Operating Performance: The Recordall Disc Series meters meet or exceed registration accuracy for the low flow rates (95%), normal operating flow rates (100 ±1.5%), and maximum continuous operation flow rates as specifically stated in AWWA Standard C700.

Construction: Recordall Disc meter construction, which complies with ANSI/AWWA standard C700, consists of three basic components: meter housing, measuring chamber and permanently sealed register or encoder. The meter is available in a lead-free bronze alloy with externally threaded spuds. A corrosion-resistant engineered polymer material is used for the measuring chamber.

Magnetic Drive: Direct magnetic drive, through the use of high-strength magnets, provides positive, reliable and dependable register coupling for straight-reading or AMR/AMI meter reading options.

Tamper-Proof Features: Unauthorized removal of the register or encoder is inhibited by the option of a tamper detection seal wire screw, TORX® tamper-resistant seal screw or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

Maintenance: Badger Meter Recordall Disc Series meters are designed and manufactured to provide long-term service with minimal maintenance. When maintenance is required, it can be performed easily either at the meter installation or at any other convenient location.

To simplify maintenance, the register, measuring chamber, and strainer can be replaced without removing the meter housing from the installation. No change gears are required for accuracy calibration. Interchangeability of parts among like-sized meters and meter models also minimizes spare parts inventory investment. The built-in strainer has an effective straining area of twice the inlet size.

Connections: Tailpieces/Unions for installations of meters on various pipe types and sizes, including misaligned pipes, are available as an option.

Meter Spud and Connection Sizes

Model	Size Designation (in.)	×	"L" Laying Length (in.)	"B" Bore Dia. (in.)	Coupling Nut and Spud Thread (in.)	Tailpiece Pipe Thread (NPT) (in.)
25	5/8	×	7-1/2	5/8	3/4 (5/8)	1/2
	5/8 x 3/4	×	7-1/2	5/8, 3/4	1 (3/4)	3/4
35	3/4	×	7-1/2	3/4	1 (3/4)	3/4
	3/4	×	9	3/4	1 (3/4)	3/4
	3/4 x 1	×	9	3/4	1-1/4 (1)	1
55	1	×	10-3/4	1	1-1/4 (1)	1
70	1	×	10-3/4	1	1-1/4 (1)	1

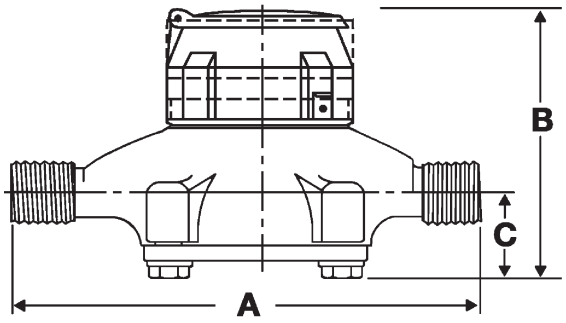
SPECIFICATIONS

	Model 25 (5/8 in. & 5/8 × 3/4 in.)	**Model 35 (3/4 in.)**	**Model 55 (1 in.)**	**Model 70 (1 in.)**
Typical Operating Range (100% ±1.5%)	0.5…25 gpm (0.11…5.7 m^3/hr)	0.75…35 gpm (0.17…7.9 m^3/hr)	1…55 gpm (0.23…12.5 m^3/hr)	1.25…70 gpm (0.28…16 m^3/hr)
Low Flow	0.25 gpm (0.057 m^3/hr) Min. 98.5%	0.375 gpm (0.085 m^3/hr) Min. 97%	0.5 gpm (0.11 m^3/hr) Min. 95%	0.75 gpm (0.17 m^3/hr) Min. 95%
Maximum Continuous Operation	15 gpm (3.4 m^3/hr)	25 gpm (5.7 m^3/hr)	40 gpm (9.1 m^3/hr)	50 gpm (11.3 m^3/hr)
Pressure Loss at Maximum Continuous Operation	**5/8 in. size**: 3.5 psi @ 15 gpm (0.24 bar @ 3.4 m^3/hr) **5/8 × 3/4 in. size**: 2.8 psi @ 15 gpm (0.19 bar @ 3.4 m^3/hr)	5 psi @ 25 gpm (0.37 bar @ 5.7 m^3/hr)	3.4 psi @ 40 gpm (0.23 bar @ 9.1 m^3/hr)	6.5 psi @ 50 gpm (0.45 bar @ 11.3 m^3/hr)
Maximum Operating Temperature	80° F (26° C)			
Maximum Operating Pressure	150 psi (10 bar)			
Measuring Element	Nutating disc, positive displacement			
Meter Connections	*Available in NL bronze and engineered polymer to fit spud thread bore diameter sizes:*			
	5/8 in. size: 5/8 in. (DN 15 mm) **5/8 × 3/4 in. size**: 3/4 in. (DN 15 mm)	3/4 in. (DN 20 mm)	1 in. (DN 25 mm)	1 in. (DN 25 mm)

MATERIALS

	Model 25 (5/8 in. & 5/8 × 3/4 in.)	**Model 35 (3/4 in.)**	**Model 55 (1 in.)**	**Model 70 (1 in.)**
Meter Housing	Lead-free bronze alloy			
Housing Bottom Plates	Cast iron, lead-free bronze alloy, engineered polymer	Cast iron, lead-free bronze alloy		
Measuring Chamber	Engineered polymer			
Disc	Engineered polymer			
Trim	Stainless steel			
Strainer	Engineered polymer			
Disc Spindle	Stainless steel	Stainless steel	Engineered polymer	Stainless steel
Magnet	Ceramic	Ceramic	Ceramic	Ceramic
Magnet Spindle	Engineered polymer	Stainless steel	Engineered polymer	Stainless steel
Register Lid and Shroud	Engineered polymer, bronze			

DIMENSIONS



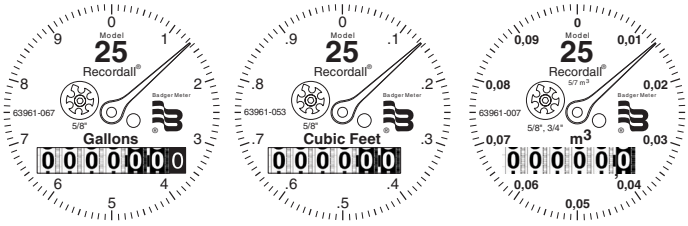
Meter Size	Model	A Laying Length	B Height Reg.	C Centerline Base	Width	Approx. Shipping Weight
5/8 in. (15 mm)	25	7-1/2 in. (190 mm)	4-15/16 in. (125 mm)	1-11/16 in. (42 mm)	4-1/4 in. (108 mm)	4-1/2 lb (2 kg)
5/8 in. × 3/4 in. (15 mm)		7-1/2 in. (190 mm)	4-15/16 in. (125 mm)	1-11/16 in. (42 mm)	4-1/4 in. (108 mm)	4-1/2 lb (2 kg)
3/4 in. (20 mm)	35	7-1/2 in. (190 mm)	5-1/4 in. (133 mm)	1-5/8 in. (41 mm)	5 in. (127 mm)	5-1/2 lb (2.5 kg)
3/4 in. (20 mm)		9 in. (229 mm)	5-1/4 in. (133 mm)	1-5/8 in. (41 mm)	5 in. (127 mm)	5-3/4 lb (2.6 kg)
3/4 in. × 1 in. (20 mm)		9 in. (229 mm)	5-1/4 in. (133 mm)	1-5/8 in. (41 mm)	5 in. (127 mm)	6 lb (2.7 kg)
1 in. (25 mm)	55	10-3/4 in. (273 mm)	6 in. (152 mm)	2-1/32 in. (52 mm)	6-1/4 in. (159 mm)	8-3/4 lb (3.9 kg)
1 in. (25 mm)	70	10-3/4 in. (273 mm)	6-1/2 in. (165 mm)	2-5/16 in. (59 mm)	7-3/4 in. (197 mm)	11-1/2 lb (5.2 kg)

REGISTERS / ENCODERS

Standard—Sweep-Hand Registration

The standard register is a straight-reading, permanently sealed magnetic drive register. Dirt, moisture, tampering and lens fogging problems are eliminated. The register has a six-odometer wheel totalization display, 360° test circle with center sweep hand, and flow finder to detect leaks. Register gearing is made of self-lubricating engineered polymer, which minimizes friction and provides long life. The multi-position register simplifies meter installation and reading. The register capacity is 10,000,000 gallons (1,000,000 ft^3, 100,000 m^3).

A Model 25 register is used in the following example:



Model	Gallon	Cubic Feet	Cubic Meter
25 (5/8 in.)	10	1	0.1/0.01
25 (5/8 × 3/4 in.)	10	1	0.1/0.01
35	10	1	0.1
55	10	1	0.1
70	10	1	0.1

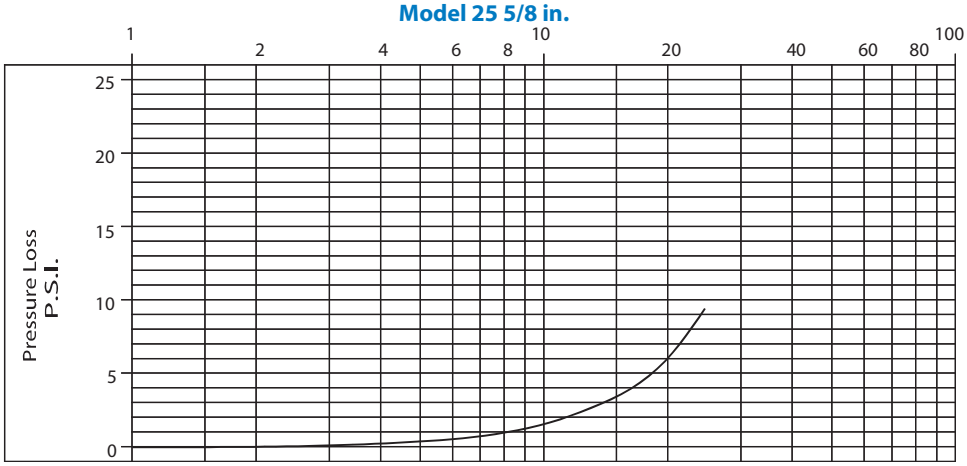
Optional—Encoders for AMR/AMI Reading Solutions

AMR/AMI solutions are available for all Recordall Disc Series meters. All reading options can be removed from the meter without disrupting water service. Badger Meter encoders provide years of reliable, accurate readings for a variety of applications. See details at ***www.badgermeter.com***.

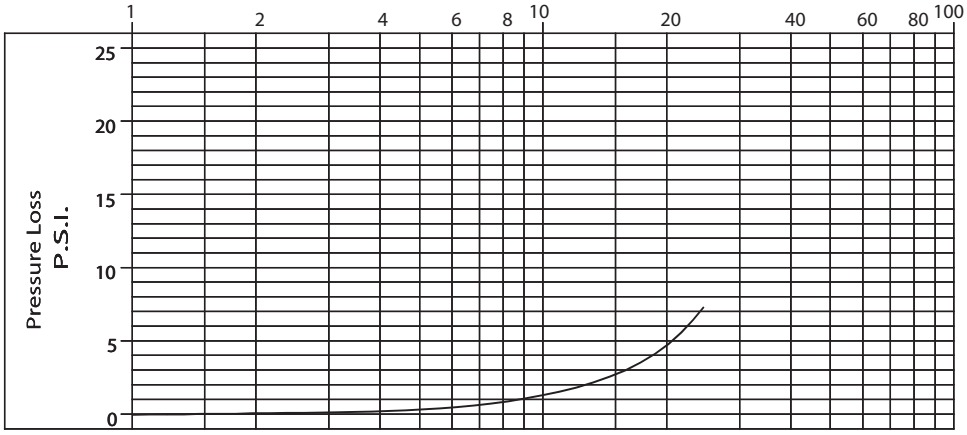
PRESSURE LOSS CHARTS

Rate of Flow in Gallons per Minute

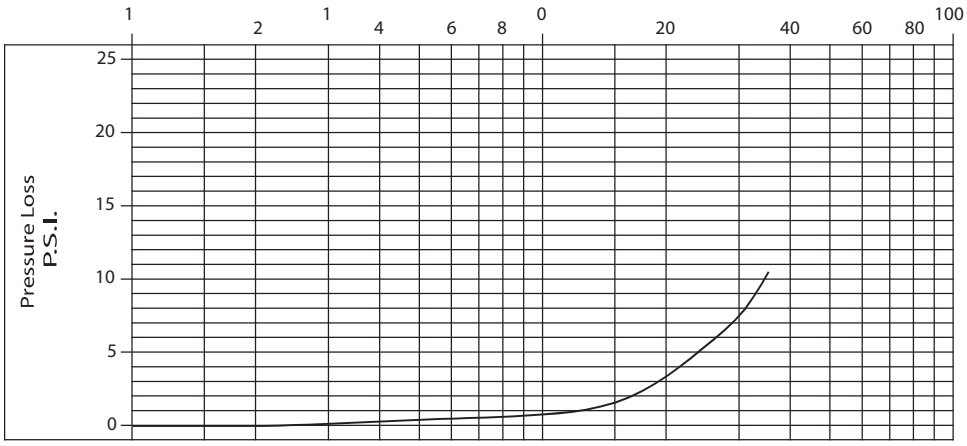
Model 25 5/8 in.



Model 25 5/8 × 3/4 in.



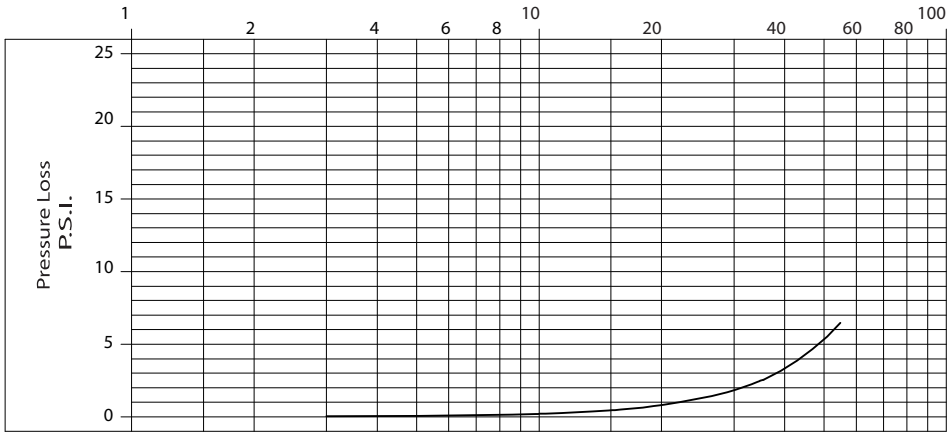
Model 35 3/4 in.



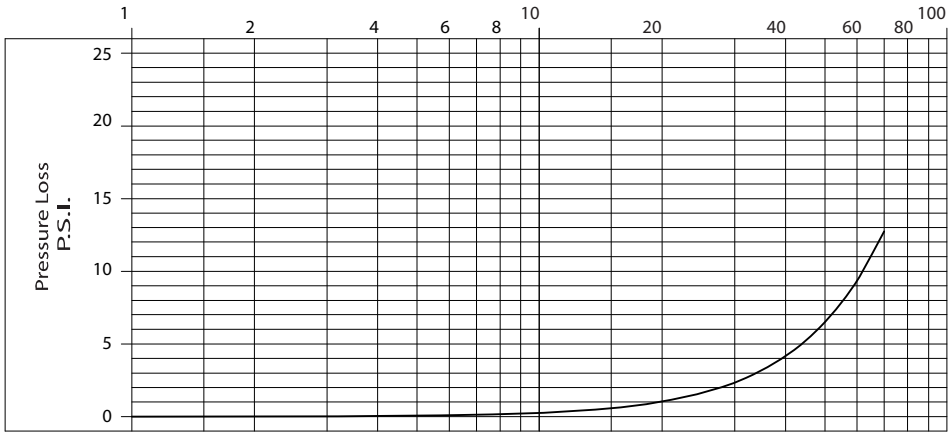
PRESSURE LOSS CHARTS (CONTINUED)

Rate of Flow in Gallons per Minute

Model 55 1 in.

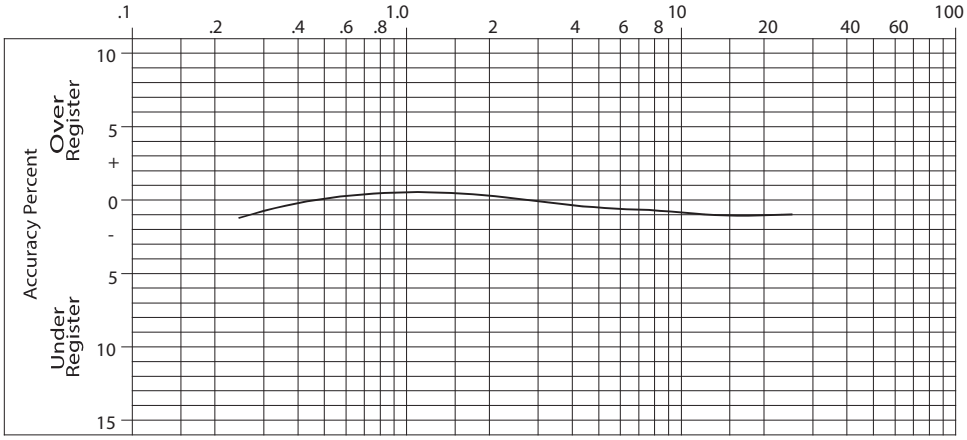


Model 70 1 in.

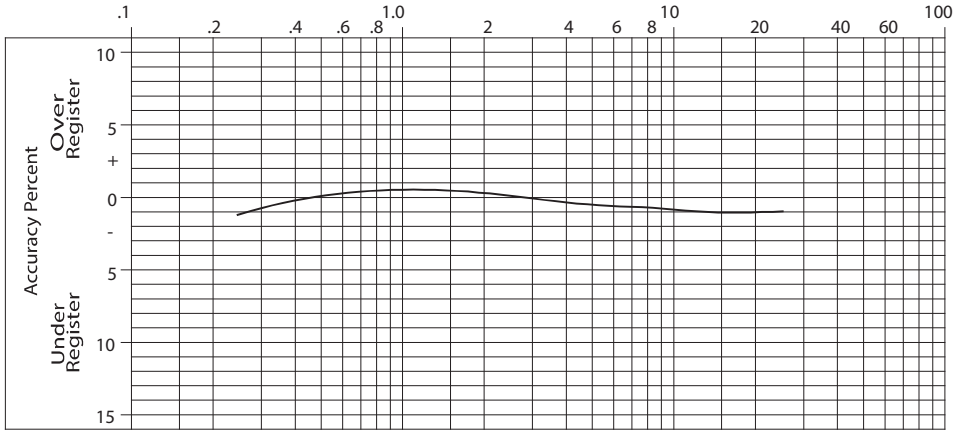


ACCURACY CHARTS

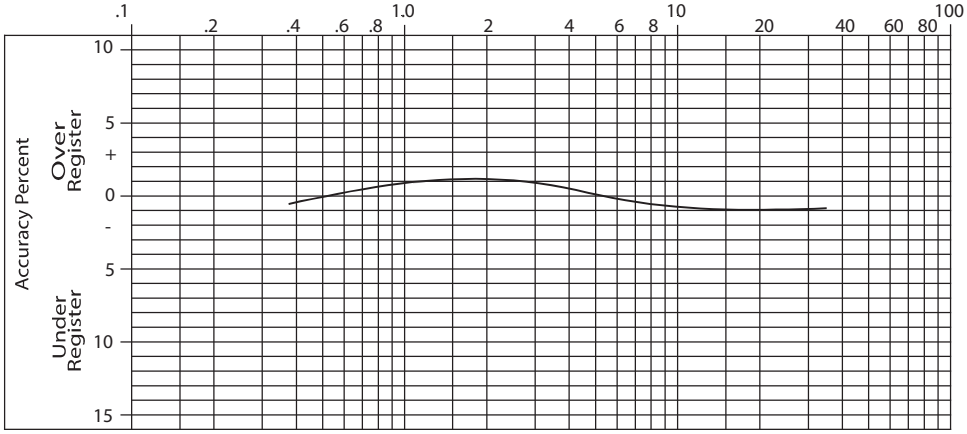
Model 25 5/8 in.



Model 25 5/8 × 3/4 in.

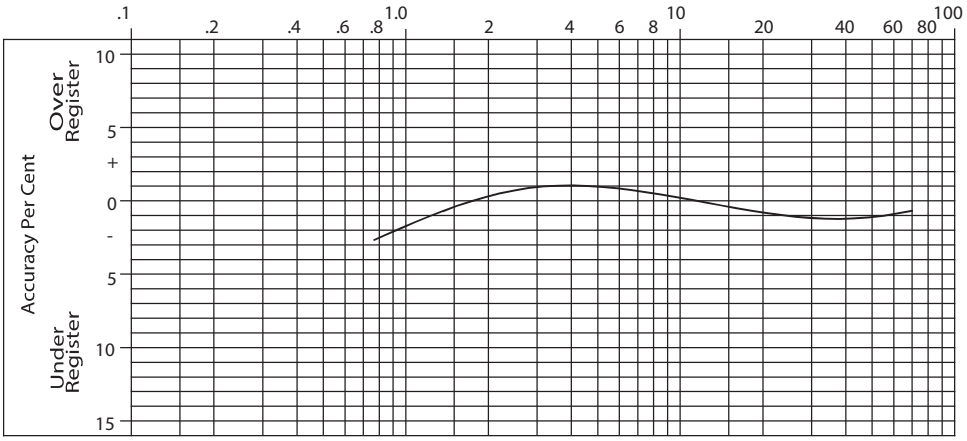


Model 35 3/4 in.

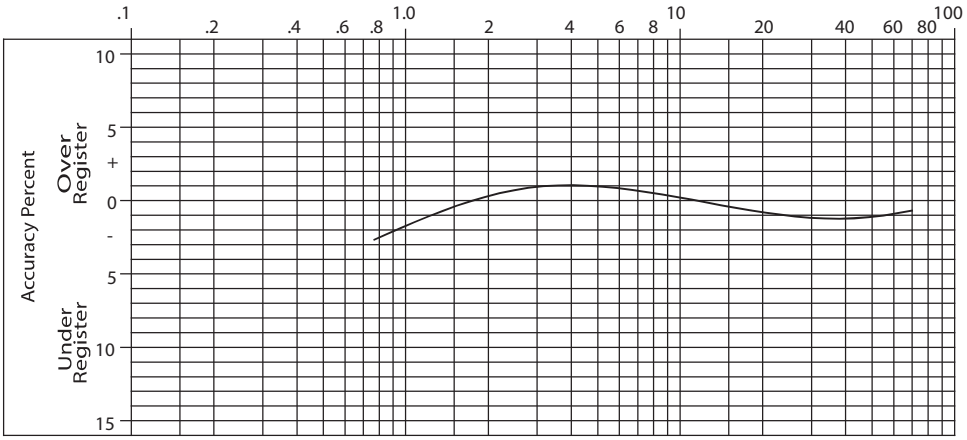


ACCURACY CHARTS (CONTINUED)

Model 55 1 in.



Model 70 1 in.



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www.badgermeter.com

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Legacy Document Numbers: RDM-DS-00062, 63, 64, 65, 66, and 74

Recordall®
RCDL | Mechanical Flow Meters

Recordall® Compound Series Meter

Lead-Free Bronze Alloy, Sizes 2, 3, 4 & 6 inch
NSF/ANSI/CAN Standards 61 and 372 Certified

DESCRIPTION

The Recordall® Compound Series meters meet or exceed the most recent revision of AWWA Standard C702 and are available in a lead-free bronze alloy. The Compound Series meters comply with the lead-free provisions of the Safe Drinking Water Act, are certified to NSF/ANSI/CAN Standards 61 and 372 (Trade Designation: LL-NS) and carry the NSF-61 mark on the housing. All components of the lead-free bronze alloy meter (housing, measuring element, seals, and so on) comprise the certified system.

Badger Meter Recordall Compound Series meters combine two metering technologies in one innovative package. A positive displacement chamber measures low flow, while a turbine chamber records high flow.

Offered in four sizes, the Compound Series meter features:

- Patented design that eliminates the need for a trigger valve and maintains crossover accuracy
- Permanently sealed, tamper-resistant register or encoder
- Meters and encoders that are compatible with Badger Meter AMR/AMI systems and other approved reading technologies

Badger Meter ORION® and GALAXY® AMR/AMI meter reading systems are available for all Compound Series meters. Itron® ERT reading systems are also available. All register options are removable from the meter without disrupting water service.

TAMPER-PROOF FEATURES

Unauthorized removal of the register or encoder is inhibited by the use of an optional tamper detection seal wire screw, TORX® tamper-resistant seal screw or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

APPLICATIONS

Use the Recordall Compound meter for measuring potable cold water in commercial and industrial applications where flow is in one direction only. The meter is an ideal choice for facilities that experience rapid and wide fluctuations in water demand, such as hospitals, universities, residential complexes and manufacturing or processing facilities.

OPERATION

At low flow rates, the Compound Series meter diverts water up through a bypass to the disc chamber. Leaving the chamber's outlet port, water flows beyond the turbine element and main valve. As the flow rate increases, a pressure differential is created that opens the main valve. The water then flows straight through the turbine chamber. In addition, a portion still flows through the disc chamber before exiting the meter.

Rotor and disc movements are transmitted by magnetic drive couplings to individual register odometers. The direct magnetic drive provides a positive, reliable and dependable register coupling for straight-reading or remote reading options. The self-lubricating thermoplastic register gearing is designed to minimize friction and provide long life.

OPERATING PERFORMANCE

The Recordall Compound Series meets or exceeds registration accuracy for low, normal operating, maximum continuous operation, and changeover flow rates as specified in AWWA Standard C702.

CONSTRUCTION

The Recordall Compound Series meter's construction complies with ANSI and AWWA C702 standards. It consists of three basic components: meter housing, interchangeable measuring elements, and sealed direct reading registers. The measuring element consists of the disc measuring chamber, turbine head assembly, and high flow valve assembly. To simplify maintenance, the registers and measuring elements can be removed without removing the meter housing from the line.

METER INSTALLATION

The meter is designed for installations where flow is in one direction only. A separate strainer is required to ensure optimum flow conditioning and protection of the measuring element. Companion flanges for installation of meters on various pipe types and sizes are available in cast iron or NL bronze as an option.

Badger Meter

RCS-DS-00078-EN-09 (March 2022)

Product Data Sheet

REGISTERS / ENCODERS

Standard—Sweep-Hand Registration

The standard register is a straight-reading, permanently sealed magnetic drive register. Dirt, moisture, tampering and lens fogging problems are eliminated. The register has a six-odometer wheel totalization display, 360° test circle with center sweep hand, and flow finder to detect leaks. Register gearing is made of self-lubricating engineered polymer, which minimizes friction and provides long life. The multi-position register simplifies meter installation and reading. The register capacity is 100,000,000 gallons (10,000,000 ft^3, 1,000,000 m^3).

Optional—Encoders for AMR/AMI Reading Solutions

AMR/AMI solutions are available for all Recordall Compound Series meters. All reading options can be removed from the meter without disrupting water service. Badger Meter encoders provide years of reliable, accurate readings for a variety of applications and are also available pre-wired to Badger Meter approved AMR/AMI solutions. See details at *www.badgermeter.com*.

SPECIFICATIONS

Compound Series Model	2 in. (50 mm)	3 in. (80 mm)	4 in. (100 mm)	6 in. (150 mm)
Meter Flanges, Class 150	2 in. elliptical or round	3 in. round	4 in. round	6 in. round
	(50 mm)	(80 mm)	(100 mm)	(150 mm)
Typical Operating Range (100% ± 1.5%)	0.5…200 gpm (0.1…45 m^3/h)	0.5…450 gpm (0.1…102 m^3/h)	0.75…1000 gpm (0.17…227 m^3/h)	0.75…2000 gpm (0.17…454.4 m^3/h)
Low Flow Registration (95% minimum)	0.25 gpm (0.06 m^3/h)	0.25 gpm (0.06 m^3/h)	0.375 gpm (0.09 m^3/h)	0.375 gpm (0.09 m^3/h)
Maximum Continuous Flow	170 gpm (38.3 m^3/h)	400 gpm (90.3 m^3/h)	800 gpm (181.6 m^3/h)	1500 gpm (340.5 m^3/h)
Pressure Loss at Maximum Continuous Flow	5.4 psi at 170 gpm	6.0 psi at 400 gpm	11.0 psi at 800 gpm	9.3 psi at 1500 gpm
	(0.38 bar at 38.3 m^3/h)	(0.41 bar at 90.3 m^3/h)	(0.75 bar at 181.6 m^3/h)	(0.64 bar at 340.5 m^3/h)
Crossover Flow Rate, Typical	12 gpm (2.73 m^3/h)	12 gpm (2.73 m^3/h)	20 gpm (4.54 m^3/h)	30 gpm (6.81 m^3/h)
Pressure Loss at Crossover	3.5 psi (0.24 bar)	4.0 psi (0.28 bar)	4.0 psi (0.28 bar)	5.0 psi (0.35 bar)
Minimum Crossover Accuracy	97%	97%	97%	95%
Maximum Operating Pressure	150 psi (10 bar)			
Maximum Operating Temperature	105° F (41° C)			
NPT Test Port	1-1/2 in.		2 in.	

Materials

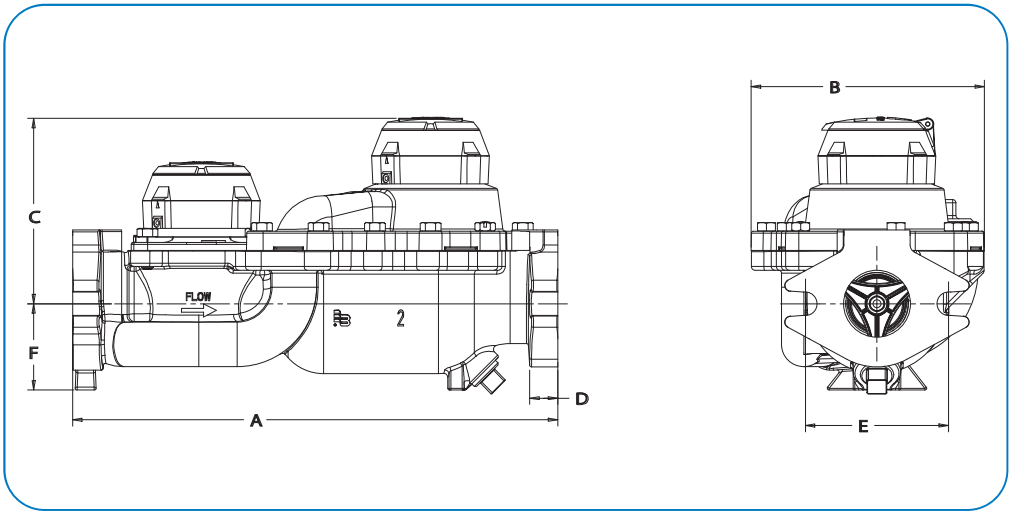
Meter Housing & Cover	Lead-free bronze alloy
Turbo Cast Head	Lead-free bronze alloy
Nose Cone & Straightening Vanes	Thermoplastic
Rotor	Thermoplastic
Rotor Radial Bearings	Lubricated thermoplastic
Rotor Thrust Bearing	Sapphire jewels
Rotor Bearing Pivots	Passivated 316 stainless steel
Calibration Mechanism	Stainless steel & thermoplastic
Measuring Chamber & Disc	Thermoplastic
High Flow Valve	Stainless steel & thermoplastic
Magnets	Ceramic
Register Lens	Glass
Register Housing & Cover	Thermoplastic or bronze
Trim	Stainless steel
Drain Plug (3/4 in.)	Stainless steel or lead-free bronze alloy
Test Plug	Stainless steel or lead-free bronze alloy

PHYSICAL DIMENSIONS

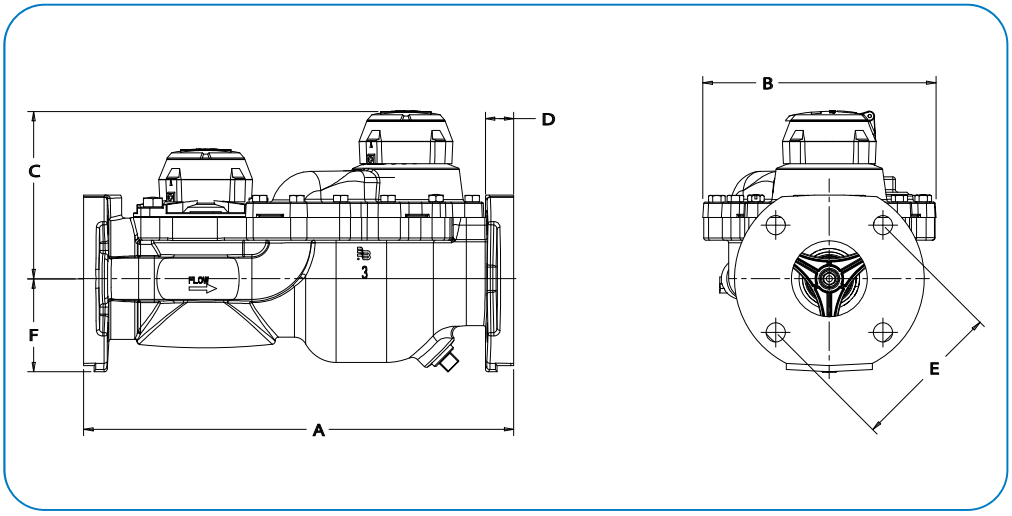
Compound Series Model	2 in. Elliptical (50 mm)	2 in. Round (50 mm)	3 in. (80 mm)	4 in. (100 mm)	6 in. (150 mm)
Meter & Pipe Size	2 in. (50 mm)		3 in. (80 mm)	4 in. (100 mm)	6 in. (150 mm)
Net Weight	45 lb (20 kg)		51 lb (23 kg)	85 lb (38 kg)	152 lb (69 kg)
Shipping Weight	63 lb (29 kg)		79 lb (36 kg)	120 lb (54 kg)	200 lb (90 kg)
Length (A)	15-1/4 in. * (387 mm)		17 in. (432 mm)	20 in. (508 mm)**	24 in. (610 mm)
Width (B)	7-3/8 in. (187 mm)		8-1/2 in. (216 mm)	9-1/8 in. (232 mm)	12-3/8 in. (314 mm)
Height (C)	5-7/8 in. (149 mm)		6-5/8 in. (168 mm)	7-1/4 in. (184 mm)	8-7/8 in. (225 mm)
Flange (D)	5/8 in. (16 mm)		3/4 in. (19 mm)	7/8 in. (22 mm)	15/16 in. (24 mm)
Bolt Circle (E)	4-1/2 in. (114 mm)	4-3/4 in. (121 mm)	6 in. (152 mm)	7-1/2 in. (191 mm)	9-1/2 in. (241 mm)
Centerline (C) to Base (F)	2-3/4 in. (70 mm)		3-5/8 in. (92 mm)	4-1/4 in. (108 mm)	5-3/8 in. (137 mm)
Number of Bolts	2	4	4	8	8

* Adapter available to increase total length to 17 in. (432 mm).
**Adapter available to increase total length to 24 in. (610 mm).

Elliptical Flange (2 in. Only)



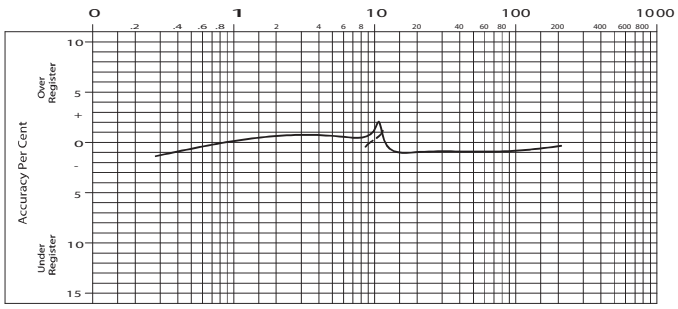
Round Flange



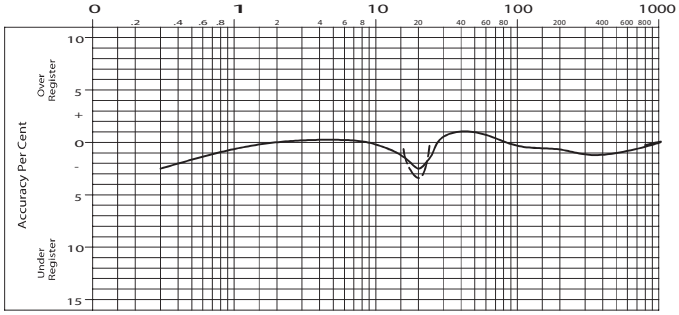
ACCURACY CHARTS

Rate of flow in gallons per minute (gpm). Dashed line on each chart (— — —) represents crossover flow accuracy.

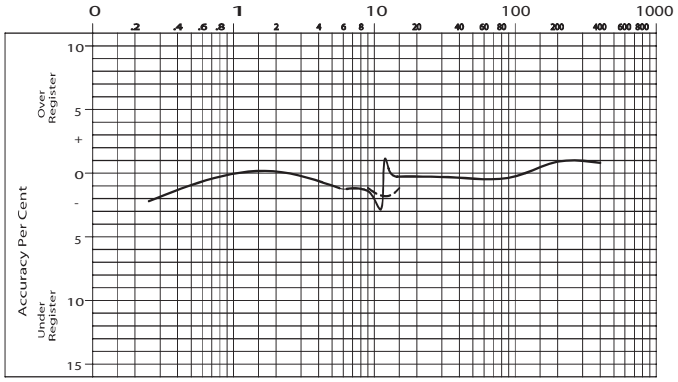
2 in. COMPOUND SERIES METER



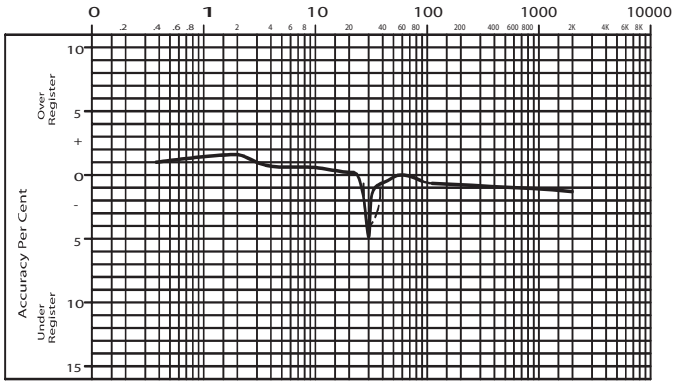
4 in. COMPOUND SERIES METER



3 in. COMPOUND SERIES METER

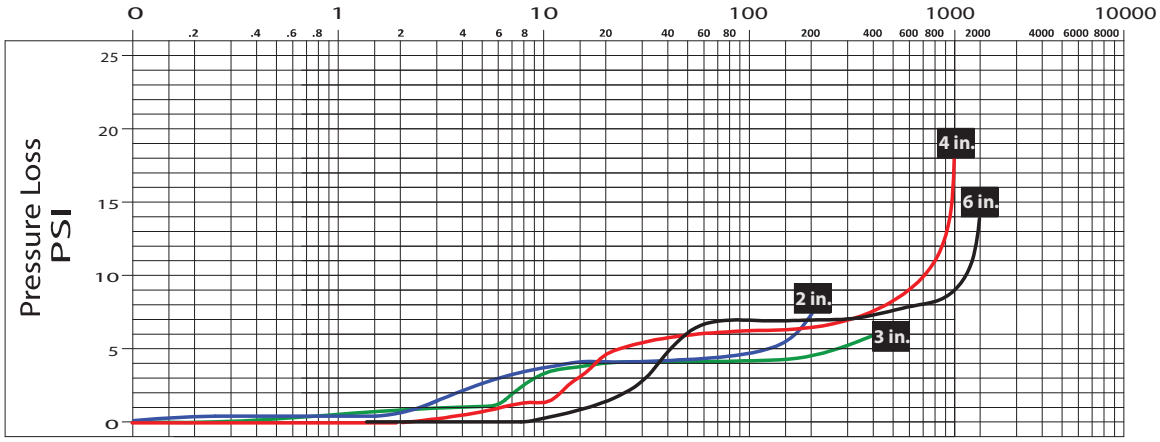


6 in. COMPOUND SERIES METER



PRESSURE LOSS CHART

Rate of flow in gallons per minute (gpm)



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ORION® Cellular Water Endpoints

DESCRIPTION

ORION® Cellular water endpoints are innovative, two-way endpoints for smart water applications. The endpoints utilize existing IoT (Internet of Things) cellular infrastructure to efficiently and securely deliver meter reading data to the utility in a Network as a Service (NaaS) approach. Leveraging existing cellular infrastructure, the NaaS solution offers all the performance benefits of AMI, while eliminating network-related maintenance and technology concerns and enhancing deployment flexibility.

Cellular endpoints are members of the time-tested ORION family of products from Badger Meter, designed for maximum flexibility. Since 2002, the ORION product family has provided comprehensive Advanced Metering Analytics (AMA) for interval meter reading and data capture using both one-way and two-way communications.

FUNCTIONALITY

Operation: ORION Cellular water endpoints communicate with the encoder and capture 15-minute interval read data and meter status information. The endpoints then automatically broadcast the information, including endpoint status information, via the cellular network to BEACON® Software as a Service (SaaS). ORION NaaS is powered by the proven ORION system for interval data capture and two-way communication. The solution employs cellular endpoints which, as they leverage the public cellular network and require no proprietary gateways to operate, dramatically reduce infrastructure requirements compared to a traditional fixed network. This speeds installations and simplifies expansion as a system evolves.

The endpoints are designed to call in four times each workday and feature a configurable schedule that enables utility customers to select call-in times that best support their processes.

Activation: ORION Cellular water endpoints are shipped in an inactive, non-transmitting state. The Badger Meter IR Communication Device can be used to activate the endpoints and verify the encoder connection. Successful endpoint function can be confirmed through a web app demonstrating that communication has been verified to both the encoder and the network.

Alternatively, the endpoints offer a Smart Activation feature. After installation, the endpoints begin broadcasting data when the encoder senses the first usage of water. No field programming or special tools are required.

Broadcast Mode: ORION Cellular water endpoints broadcast fixed network reading data through the secure cellular network within the service area.

Specific configurations also transmit a radio frequency (RF) message to facilitate troubleshooting in the field. See *"Configurations" on page 2.*

Data Storage: The endpoints store 42 days of 15-minute data.

ORION Cellular C endpoint (pictured)

Output Message: ORION Cellular water endpoints broadcast a unique serial number, meter reading data, and applicable status indicators. As an advanced data security measure, each message is securely transported to BEACON SaaS only via private network and never over the public internet.

APPLICATION

Configurations: ORION Cellular water endpoints are multi-purpose endpoints that can be deployed in indoor, outdoor and pit (non-metal pit lid) applications. The electronics and battery assembly are fully encapsulated in epoxy for environmental integrity. The endpoint is available with a connector assembly for ease of installation.

Meter Compatibility: When attached to a Badger Meter High Resolution Encoder, the ORION Cellular water endpoint is compatible with all current Badger Meter Recordall® Disc, Turbo Series, Compound Series, Combo Series and Fire Service meters and assemblies, and with E-Series G2® Ultrasonic, E-Series® Ultrasonic, E-Series® Ultrasonic Plus, and ModMAG® electromagnetic flow meters.

Encoder Compatibility: The ORION Cellular water endpoint is suitable for use with a Badger Meter High Resolution Encoder as well as the following Badger Meter approved three-wire encoder registers that have a manufacture date within 10 years of the current date as long as the encoder has three wires connected to it and is programmed into the three-wire output mode for AMR/AMI: Honeywell® (Elster) ScanCoder® encoder with Sensus® protocol module and evoQ4 meter (encoder output); Master Meter® Octave® Ultrasonic meter encoder output; Metron-Farnier Hawkeye; Mueller Systems 420 Solid State Register (SSR) LCD; Neptune® ProRead, E-Coder®, ARB-V®, and ProCoder; and Sensus iPerl®.

SPECIFICATIONS

Dimensions	5.125 in. (130 mm) (H) 1.75 in. (44 mm) Diameter at top 2.625 in. (W) x 2.875 in. (D) at base (67 mm (W) x 73 mm (D) at base)
Broadcast Network	LTE-M cellular network (primary communication technology)
	NB-IoT (secondary communication technology for certain variants)
RF Message for Troubleshooting	Where available (see table below) frequency is FCC-regulated 902…928 MHz frequency hopping modulation
Operating Temperature Range	
• Storage, Meter Reading and RF Message (for troubleshooting)	–40…60° C (–40…140° F)
• Cellular Communications	–20…60° C (–4…140° F)
Humidity	0%…100% condensing
Battery	One (1) lithium thionyl chloride D cell (nonreplaceable)

Construction: All ORION Cellular water endpoints are housed in an engineered polymer enclosure with an ORION RF board, battery and antenna. For long-term performance, the enclosure is fully potted to withstand harsh environments and to protect the electronics in flooded or submerged pit applications.

Wire Connections: ORION Cellular water endpoints are available with in-line connectors (Twist Tight® or Nicor®) for easy installation and connection to compatible encoders/meters. The endpoints are also available with flying leads for field splice connections. Other wire connection configurations may be available upon request.

FEATURES

Smart City Ready	Future-proof technology
Communication Type	Two-way
Application Type	Control/Monitor
Endpoint Communication	Configurable call-in schedule, up to four times each workday
Reading Interval Type	15-minute
Encoder Compatibility	Absolute
Fixed Network Reading	✓
Cut-Wire Indication	✓
Encoder Error	✓
Low Battery Indication	✓
Remote Clock Synchronization	✓
Firmware Upgrades	✓

CONFIGURATIONS

Endpoint	Notes
ORION Cellular C	Includes RF and IR messages for troubleshooting
ORION Cellular CS	Secondary carrier; includes RF and IR messages for troubleshooting
ORION Cellular LTE-M	Includes RF and IR messages for troubleshooting
ORION Cellular LTE-MS	Secondary carrier; includes RF and IR messages for troubleshooting
ORION Cellular HLA	Includes IR message for troubleshooting

NOTE: For the ORION Cellular LTE-MP endpoint, see the *ORION Cellular LTE-MP Endpoint product data sheet*, available at *www.badgermeter.com*.

License Requirements: ORION Cellular water endpoints comply with Part 15, Part 22, Part 24, and Part 27 of the FCC Rules. No license is required by the utility to operate an ORION meter reading system. This device complies with Industry Canada license-exempt RSS standard(s).

Transportation: **WARNING**: The operation of transmitters and receivers on airlines is strictly prohibited by the Federal Aviation Administration. As such, the shipping of radios and endpoints via air is prohibited. Please follow all Badger Meter return and/or shipping procedures to prevent exposure to liability.

Warning: To reduce the possibility of electrical fire and shock hazards, never connect the cable from the endpoint to any electrical supply source. The endpoint cable provides SELV low voltage limited energy power to the load and should only be connected to passive elements of a water meter register.

Caution: Endpoint batteries are *not* replaceable. Users should make no attempt to replace the batteries.
Changes or modifications to the equipment that are not expressly approved by Badger Meter could void the user's authority to operate the equipment.

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www.badgermeter.com

ORION® Water Endpoints

Cellular LTE Endpoint

DESCRIPTION

The ORION® Cellular endpoint is an innovative, two-way water endpoint that utilizes existing cellular infrastructure to efficiently and securely deliver meter reading data to the utility via the reliable cellular network.

The Cellular endpoint is a member of the time-tested ORION family of products from Badger Meter, designed for maximum flexibility. Since 2002, the ORION product family has provided comprehensive Advanced Metering Analytics (AMA) for interval meter reading and data capture using both one-way and two-way communications.

FUNCTIONALITY

Operation: The endpoint communicates with the encoder and captures 15-minute interval read data and meter status information. On a regular schedule (up to twice per day) the endpoint then automatically broadcasts the information, including endpoint status information, via the cellular network to the BEACON® AMA software.

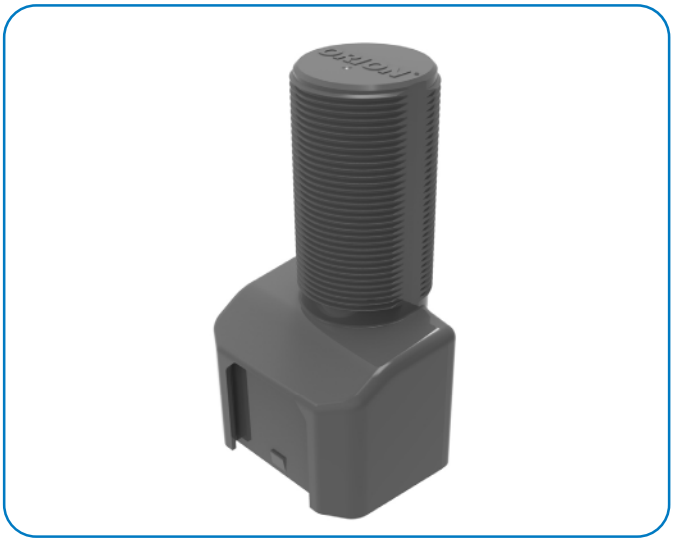
Activation: All ORION Cellular LTE endpoints are shipped in an inactive, non-transmitting state. The endpoints offer a Smart Activation feature. After installation, the endpoint begins broadcasting data when the encoder senses the first usage of water. No field programming or special tools are required. Alternatively, the Badger Meter IR Communication Device can be used to activate the endpoint and verify the encoder connection.

Successful endpoint function can be confirmed through a web app demonstrating that communication has been verified to both the encoder and the network.

Broadcast Mode: The endpoint broadcasts fixed network reading data through the secure existing cellular network within the service area. The endpoint also transmits a mobile message to support troubleshooting in the field.

Data Storage: The endpoint stores 42 days of 15-minute data.

Output Message: The endpoint broadcasts its unique serial number, meter reading data, and applicable status indicators. Each message is securely transported to the BEACON AMA software via Virtual Private Network (VPN) using Advanced Encryption Standard (AES) 256.



APPLICATION

Configurations: The endpoint is a multi-purpose endpoint that can be deployed in indoor, outdoor and pit applications. The electronics and battery assembly are fully encapsulated in epoxy for environmental integrity. The endpoint is available with a connector assembly for ease of installation.

Meter Compatibility: When attached to a Badger Meter High Resolution Encoder, the endpoint is compatible with all current Badger Meter Recordall® Disc, Turbo Series, Compound Series, Combo Series and Fire Service meters and assemblies, and with E-Series® Ultrasonic, E-Series® Ultrasonic Plus, and ModMAG® electromagnetic flow meters.

Encoder Compatibility: ORION Cellular LTE endpoints are suitable for use with Badger Meter High Resolution Encoders as well as the following Badger Meter approved three-wire encoder registers that have a manufacture date within 10 years of the current date as long as the encoder has three wires connected to it and is programmed into the three-wire output mode for AMR/AMI: Honeywell® (Elster) ScanCoder® encoder with Sensus® protocol module and evoQ4 meter (encoder output); Master Meter® Octave® Ultrasonic meter encoder output; Metron-Farnier Hawkeye; Mueller Systems 420 Solid State Register (SSR) LCD; and Sensus iPerl®.

SPECIFICATIONS

Dimensions	5.125 in. (130 mm) (H) 1.75 in. (44 mm) Diameter at top 2.625 in. (W) x 2.875 in. (D) at base 67 mm (W) x 73 mm (D) at base
Broadcast Network	LTE cellular network, with fallback to 3G where LTE is unavailable. Mobile backup frequency is FCC-regulated 902…928 MHz frequency hopping modulation
Operating Temperature Range • Storage, Meter Reading and Mobile Backup • Cellular Communications	 –40…60° C (–40…140° F) –20…60° C (–4…140° F)
Humidity	0%…100% condensing
Battery	One (1) lithium thionyl chloride D cell (nonreplaceable)

Construction: All ORION Cellular endpoints are housed in an engineered polymer enclosure with an ORION RF board, battery and antenna. To ensure long-term performance, the enclosure is fully potted to withstand harsh environments and to protect the electronics in flooded or submerged pit applications.

Wire Connections: ORION Cellular endpoints are available with in-line connectors (Twist Tight® or Nicor®) for easy installation and connection to compatible encoders/meters. The endpoints are also available with flying leads for field splice connections. Other wire connection configurations may be available upon request.

FEATURES

Communication Type	Two-way
Application Type	Control/Monitor
Reading Interval Type	15-minute
Encoder Compatibility	Absolute
Fixed Network Reading	✓
Premise Leak Detection	✓
Cut-Wire Indication	✓
Reverse Flow Indication	✓
No Usage Indication	✓
Encoder Error	✓
Low Battery Indication	✓
Remote Programming	✓
Remote Clock Synchronization	✓
Firmware Upgrades	✓

License Requirements: ORION Cellular LTE endpoints comply with Part 15, Part 22, Part 24, and Part 27 of the FCC Rules. No license is required by the utility to operate an ORION meter reading system. This device complies with Industry Canada license-exempt RSS standard(s).

Transportation: WARNING: The operation of transmitters and receivers on airlines is strictly prohibited by the Federal Aviation Administration. As such, the shipping of radios and endpoints via air is prohibited. Please follow all Badger Meter return and/or shipping procedures to prevent exposure to liability.

Warning: To reduce the possibility of electrical fire and shock hazards, never connect the cable from the endpoint to any electrical supply source. The endpoint cable provides SELV low voltage limited energy power to the load and should only be connected to passive elements of a water meter register.

Caution: The endpoint batteries are *not* replaceable. Users should make no attempt to replace the batteries.
Changes or modifications to the equipment that are not expressly approved by Badger Meter could void the user's authority to operate the equipment.

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WELCOME TO BEACON® AMA

Billing Integration Implementation

WELCOME TO BEACON AMA

Thank you for choosing Badger Meter to be part of your water management solution. Our BEACON® Advanced Metering Analytics (AMA) Solution brings a whole new level of utility-optimizing information to light while empowering your end users and streamlining your processes.

The following reflects an overview of what you can expect as your BEACON AMA implementation progresses.

Shaded areas indicate action items you and your team need to complete.

1. **Billing Interface**

   First things first, since you will be utilizing a billing interface, notify your billing vendor you will require an interface with BEACON AMA and their software.

   NOTE: **Please contact your billing vendor right away. You need to have the agreement in place with your billing vendor before we can proceed with our interface analysis.** Your billing vendor may charge a fee for their services, and you are responsible for any fees they may assess. Direct your billing vendor to *https://helpbeaconama.net/data-exchange/* for more information about the file format requirements and interface approval process.

2. **Onboarding Communication**

   Within a few days of order acknowledgment, the person identified as the Primary Admin (PAD) / portfolio Owner on the BEACON Onboarding Questionnaire (BOQ) will receive an email invitation to setup his/her BEACON login credentials.

   NOTE: To ensure the invitation is not blocked by your organization's spam filters, please whitelist the following:

   - noreply@eyeonwater.com
   - noreply@beaconama.net
   - alerts-noreply@beaconama.net
   - reports-noreply@beaconama.net
   - beaconama.ca (Canadian deployments only)

   This login invitation is valid for 48 hours. Should the invitation expire before you are able to setup your credentials please contact *BEACONOnboarding@badgermeter.com* to request a new invitation.

3. **First Login**

   When you first login to BEACON you may notice a lack of data. This is because your billing interface has not been approved and implemented yet. Although information may be available in BEACON, your portfolio is not fully configured or active and training will not be scheduled until the interface is complete

   NOTE: Feel free to login and browse around to familiarize yourself with the user interface. Your trainer will go over the basic BEACON features and functionality as part of your training session.

4. **Information Collection and Verification**

   The utility-specific information provided in the BOQ submitted with your order is used to verify your unique system specifications. Our Onboarding Coordinator may reach out to you to seek additional information or clarification before initiating communication with your billing vendor. A Badger Meter Interface Analyst (Analyst) will be assigned at this time.

   NOTE: If you have not contacted your billing vendor (Step 1) to establish an agreement for them to perform interface-related functions on their end, please do so immediately to reduce delays in the overall billing interface evaluation and approval process.

5. **Billing Vendor Interface Kickoff Communication**
   Once our BOQ review is complete and all questions have been answered, our Onboarding Coordinator will send an email to you, your billing vendor contact and your Analyst letting the group know Badger Meter has the information needed to begin work on your billing interface. This communication serves as a kickoff in a series of interface-related communications with the group.

6. **BEACON Import Test File Evaluation and Approval**
   Your Analyst will reach out to your billing vendor to request a test import file for evaluation. Your Analyst will conduct a review of the file received, then document any corrections that may be required. This information will be communicated to you and your billing vendor for correction.

   NOTE: This is the part of the process where you need to be highly involved to resolve any data issues identified in the import test file. Issues may include validating register resolutions, verifying correct addresses and establishing a valid format for the various data fields. Your Analyst will be helping you and your billing vendor throughout this process.

7. **BEACON Export Test File Evaluation and Approval**

   Once the BEACON import file is ready to go, your Analyst will provide your billing vendor with a test export file from BEACON to ensure the billing vendor can process the billing data. When your billing vendor approves the file, the interface analysis is complete. Your Analyst will provide notification to you, your billing vendor, and the trainer assigned to your deployment that the interface is approved and training may now be scheduled.

8. **Training**

   After the test file approval notification you will be contacted by your trainer to discuss the next steps. Your trainer will collect any additional information, confirm receipt of any reading hardware you may have ordered, and schedule your training session.

   Once your training is complete, you will be ready to enjoy the benefits BEACON has to offer. As a cloud-based platform, new BEACON features and functionalities will be available to you upon release simply by logging into your portfolio.

   Visit *https://helpbeaconama.net/training-2/* to learn more about supplemental training opportunities which are available to allow you to maximize your investment in a BEACON solution.

BEACON AMA Mobile Solutions with Windows® 10 Meter Reading Devices

If you are deploying a BEACON AMA Mobile Solution all compatible Windows 10 devices you will be using for mobile meter reading will require setup and configuration before they can be used with the BEACON AMA Mobile Read Module suite of applications (ORION® Mobile Read, ORION Endpoint Utility and Field Director). Please download and follow the instructions provided in the *Windows 10 Hardware Setup Quick Start Guide, UTL-QS-03133-EN* prior to powering up your devices to ensure appropriate selections are made during initial hardware boot and configuration.

Once you have completed the hardware setup for each device, please download *ORION® Mobile Read and Endpoint Utility Windows® 10 Device Setup, BEA-QG-03313-EN-01* and follow the instructions for installing Google® Chrome® on each device. Your Badger Meter authorized trainer will assist you with the remaining setup (software installation, COM port configuration) at the time your trainer contacts you to schedule your BEACON Mobile Solution training.

Thank you once again for being a valued Badger Meter customer. Should you have any questions about the process outlined in the document, please contact your account manager or *BEACONOnboarding@badgermeter.com*.

ACCOUNT MANAGER

NAME	
EMAIL	
PHONE	

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Clear Form

Badger Meter

BEACON® AMA Onboarding

Billing Vendor Integration & Deployment Best Practices

ONBOARDING OVERVIEW

BEACON AMA onboarding is the entire process a Utility goes through from the time an order is placed until users are trained and deriving value from BEACON AMA. A key part of the onboarding process is integration with the Utility's billing vendor, which can be time consuming and delay implementation of the Utility's BEACON AMA Solution if not properly executed.

This document is intended to help the Utility understand the overall process and responsibilities to help ensure a successful onboarding experience.

Best Practices When Deploying a BEACON® AMA Solution

Use the checklist below to get your BEACON AMA deployment going, and keep it on track.

- ☐ Identify a project champion who best understands and promotes the Utility's operational vision for your BEACON AMA Solution
- ☐ Establish a project budget
- ☐ Obtain a quote for the BEACON AMA Solution
- ☐ Contact your billing vendor to obtain a quote for a BEACON AMA Data Exchange interface
- ☐ Obtain project approval
- ☐ Issue a PO to Badger Meter for the BEACON AMA Solution and include completed *BEACON AMA Onboarding Questionnaire* (BEA-FM-03070-EN)
- ☐ Issue a PO to your billing vendor for the Data Exchange billing integration
- ☐ Participate in the Onboarding and Interface Integration kickoff meeting and take an active part in driving the project schedule dates
- ☐ Install endpoints and capture installation data, as applicable
- ☐ Stay **actively** engaged with your billing vendor and Badger Meter during the integration process
- ☐ Enter and export test data file(s) as requested
- ☐ Enter and clean up customer data as required
- ☐ Actively participate in the BEACON AMA online or onsite training and ensure appropriate Utility personnel attend training
- ☐ Use your BEACON AMA system and explore the features and functions!
- ☐ Attend BEACON AMA supplemental online training opportunities. Multiple no charge, online courses are available each month to keep users up to date on new features and give you an opportunity to engage with other users to maximize your investment in your BEACON AMA Solution. Visit *https://www.badgermeter.com/training/* to view available online courses and to register.

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BEA-QG-02995-EN-03 (January 2020)

QUICK GUIDE

BEACON® Advanced Metering Analytics

With ORION® Network as a Service (NaaS)

OVERVIEW

The BEACON® Advanced Metering Analytics (AMA) Solution with ORION® Network as a Service (NaaS) presents a simple, yet powerful solution to bring a new level of utility optimizing information to light.

The solution combines our intuitive BEACON AMA Software as a Service (SaaS) with a NaaS approach using proven ORION Cellular endpoints to deliver greater visibility and control over utility management.

Built-in infrastructure management services and a system design that keeps you in step with technology advancements, allows you to do what you do best—manage your water utility. Plus, built-in consumer engagement tools help enhance customer service, increase satisfaction and reduce costs.

SOFTWARE APPLICATIONS

BEACON Advanced Metering Analytics (AMA)

With tools beyond meter reading and network management, BEACON AMA software offers targeted Advanced Metering Analytics. BEACON AMA software puts interval meter data to work to increase efficiency in day-to-day utility operations and address demands for actionable intelligence.

- **Problem solver** – User intuitive data tools place the power of water consumption data at your fingertips, allowing you to rapidly respond to customer inquiries and quickly resolve—and even eliminate—many billing issues.
- **Customized design** – A customizable dashboard delivers information configured to user security access level in a format matched to the utility's individual requirements, providing data management integrity, security and control.
- **Works with you** – Integration with utility systems—billing, work order, inventory, Customer Relationship Management (CRM) and Geographic Information Systems (GIS)—streamlines and improves utility operations without disrupting the current utility billing interface file transfer process.
- **Find out fast** – Alert conditions can be set to monitor and notify users of system exceptions, including continuous flow, for faster leak detection.
- **Innovation at your service** – Secure, hosted platform with automatic software upgrades ensures the latest technology and features are always available.

EyeOnWater®

The BEACON AMA software suite includes informative consumer outreach tools to improve customer service consisting of the EyeOnWater consumer engagement website, smartphone mobile apps, and email or SMS text alerts, providing easy access to personal consumption data and alerts to potential leaks. With these tools, water consumers are able to view their usage activity, and gain greater understanding and control of what they use and the value you provide.

HARDWARE

ORION NaaS is powered by the proven ORION system for interval data capture and two-way communication. The solution employs cellular endpoints which, as they leverage the public cellular network and require no proprietary gateways to operate, dramatically reduce infrastructure requirements compared to a traditional fixed network. This speeds installations and simplifies expansion as a system evolves.

- **High resolution data** – ORION Cellular endpoints are programmed to automatically broadcast 15-minute meter reading and event data to the BEACON software up to four (4) times per day. The high resolution data helps identify potential customer-side leaks and other anomalies in water use, and provides the utility with a potent tool to enhance its customer service.
- **Two-way communication** – BEACON AMA software communicates with ORION Cellular endpoints to accomplish a number of system tasks, including requesting additional information from the endpoint and synchronizing the internal endpoint clock. If needed, the ORION two-way system architecture sends upgrades to the endpoint firmware over the air via the network, utilizing the powerful BEACON AMA software suite.
- **Data integrity** – Each message from the ORION Cellular endpoint is securely transported to the BEACON AMA software only via private network and never over the public internet.

SECURITY

BEACON AMA is ISO 27001 certified and SOC 2 examined for security, availability and confidentiality.

TECHNICAL SUPPORT AND TRAINING

Configured for the utility, safe and secure BEACON AMA SaaS provides utilities with regular software updates, long-term support and maintenance. Comprehensive BEACON AMA training courses are available for online or on-site delivery at the time of system deployment. To maintain best practices, a library of online resources and options for group web-based training and support are also available. Once deployed, our technical support specialists can be contacted by phone, email and web to provide ongoing, customer-friendly support. Customized one-on-one training is available (fee applies) to further enhance user expertise.

Additionally, Badger Meter offers extended customized training to further enhance user expertise.

TECHNICAL REQUIREMENTS

BEACON AMA

Developed as a hosted software platform, BEACON AMA is a cloud-based application accessed through a standard web browser. Internet access is required. User logins provide secure access.

BEACON AMA supported web browsers include the latest and next previous major releases of Google® Chrome, Microsoft® Edge, Mozilla® Firefox®, Microsoft® Internet Explorer® (IE 11 only); and Apple® Safari®.

EyeOnWater Consumer Engagement

The EyeOnWater consumer engagement website is a cloud-based application accessed through a standard web browser. Internet access is required. Water consumer user logins provide secure access to their information.

Supported web browsers include the latest and next previous major releases of Google® Chrome, Microsoft® Edge, Mozilla® Firefox®, Microsoft® Internet Explorer® (IE 11 only); and Apple® Safari®.

EyeOnWater smartphone applications require Android 6.0 or iOS 9.1 or later, and can be downloaded from Google Play or the Apple Store.

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Badger Meter

HR-E High Resolution Encoder

DESCRIPTION

Applications: The High Resolution Encoder (HR-E) is designed for use with all current Recordall® Disc, Turbo, Compound, Combo and Fire Series meters and assemblies. The HR-E provides connectivity with Badger Meter ORION® and GALAXY® AMR/AMI endpoints, BadgerTouch® modules and other AMR/AMI technology solutions approved by Badger Meter.

Electronic Resolution: Encoder output from the HR-E includes eight-dial resolution to AMR/AMI endpoints and the option of four, five, six, seven or eight-dial resolution for touch applications. Refer to tables on the next page for details.

Mounting: The HR-E in its shroud assembly uses a bayonet mount compatible with all Recordall Disc, Turbo, Compound and Fire Series meters and assemblies. The bayonet mount allows positioning of the register in any of four orientations for visual reading convenience. The HR-E can be removed from the meter without disrupting water service.

Magnetic Drive: A direct-drive, high-strength magnetic coupling, through the meter body to the wetted magnet, provides reliable and dependable register coupling.

Local Indication: The HR-E face features an eight-dial mechanical odometer wheel stack and a flow finder with a calibrated test circle.

Tamper-Resistant Features: Unauthorized removal of the HR-E is inhibited by the option of a tamper detection seal wire screw, tamper-resistant TORX® seal screw, or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

Construction: The housing of the HR-E is constructed of a strengthened glass lens top and a corrosion-resistant metal bottom. Internal construction materials are thermoplastic for long life and high reliability. The encoder gearing is self-lubricating thermoplastic to minimize friction and provide long, reliable life. The shroud assembly is thermoplastic.

Temperature: The operating range of the HR-E is – 40…140° F (– 40…60° C). The water meter should not be subjected to temperatures below freezing.

Sealing: The HR-E encoder is permanently sealed to eliminate the intrusion of moisture, dirt or other contaminants. The HR-E achieves true water resistance due the unique adhesive technology used to seal the glass dome to the corrosion-resistant metal bottom. Due to this sealing process, the HR-E exceeds all applicable requirements of AWWA Standard C707. With leak rates less than 10-6 cc/sec, as tested by a helium mass spectrometer, the HR-E is suitable for installation in all environments, including meter pits subject to continuous submergence.

Electrical: The electronic circuitry is designed to provide immunity to electrical surges and transients per IEC1000-4-2, IEC1000-4-4. Operation of the HR-E is dependent on the wire length limitations of connected AMR/AMI equipment.

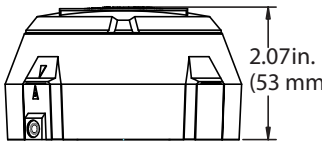
SPECIFICATIONS

Encoder Type	Straight reading, permanently sealed, magnetic drive
Unit of Measure	U.S. Gallons, Cubic Feet, Cubic Meters, clearly identified on encoder face
Number Wheels	Eight with 5/32 inch high numerals
Test Circle	360° circle with ten major increments, ten divisions each
Weight	10 ounces
Humidity	0…100% condensing when equipped with potted lead wire, 0…95% non-condensing with screw-terminal wire connections
Temperature	– 40…140° F (– 40…60° C)
Signal Output	Industry Standard ASCII Format
Visual Resolution	1/100th of Test Circle
Electronic Resolution	8-dial resolution for AMR/AMI; 4, 5, 6, 7 or 8-dial resolution for BadgerTouch
Signal Type	3-wire synchronous for AMR/AMI solutions (red=clock/power, black=ground, green=data) 2-wire asynchronous for Touch solutions
Power Source	External

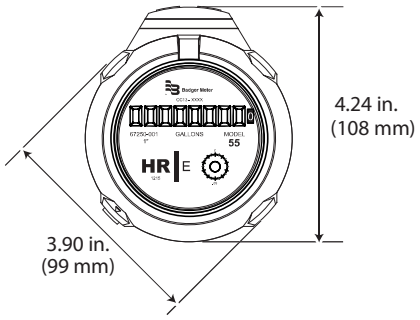
Operating Characteristics: The reading obtained by an AMR/AMI device is sensed directly from the position of the encoder's odometer using internal LED light paths to determine the exact position of each number wheel. This technology eliminates electromechanical contacts that could wear out, and provides greater long-term performance.

Wire Connections: The HR-E is available with an in-line connector for easy connection and installation to AMR/AMI endpoints. It is also available with a flying lead for a field splice connection or fully prewired to an AMR/AMI endpoint. A terminal screw version of the HR-E is also available. This version features a tamper-resistant cap over the three-wire terminals. The HR-E with terminal screws is designed for indoor installations in protected environments such as residential basements.

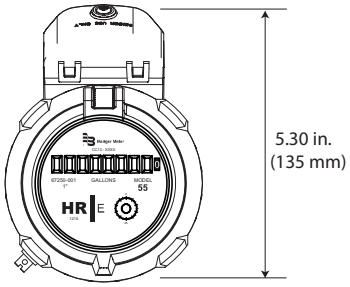
DIMENSIONAL DRAWINGS



Side view



With wire lead



With terminal screws

Top view

MEASUREMENT RESOLUTION

The minimum electronic resolution of the HR-E is as noted below (8-Dial Reading). To verify the correct resolution for your application, contact Badger Meter Customer Service.

Recordall Disc Series	Size (in.)	8-Dial Resolution (gal)	8-Dial Resolution (ft^3)	8-Dial Resolution (m^3)
M25/MLP	5/8	0.1	0.01	0.001
M25/MLP	3/4	0.1	0.01	0.001
M35	3/4	0.1	0.01	0.001
M40	1	0.1	0.01	0.001
M55	1	0.1	0.01	0.001
M70	1	0.1	0.01	0.001
M120	1-1/2	1	0.1	0.01
M170	2	1	0.1	0.01

Fire Service Series	8-Dial Resolution (gal)	8-Dial Resolution (ft^3)	8-Dial Resolution (m^3)
3 in.	1	0.1	0.01
4 in.	1	0.1	0.01
6 in.	10	1	0.1
8 in.	10	1	0.1
10 in.	10	1	0.1

Recordall Turbo Series	Size (in.)	8-Dial Resolution (gal)	8-Dial Resolution (ft^3)	8-Dial Resolution (m^3)
T160	1-1/2	1	0.1	0.01
T200	2	1	0.1	0.01
T450	3	1	0.1	0.01
T1000	4	1	0.1	0.01
T2000	6	10	1	0.1
T3500	8	10	1	0.1
T5500	10	10	1	0.1
T6200	12	100	10	0.1
T6600	16	100	10	1
T10000	20	100	100	1

Recordall Compound Series	Size (in.)	8-Dial Resolution (gal)	8-Dial Resolution (ft^3)	8-Dial Resolution (m^3)
High Side T200	2	1	0.1	0.01
Low Side M25	2	0.1	0.01	0.001
High Side T450	3	1	0.1	0.01
Low Side M25	3	0.1	0.01	0.001
High Side T1000	4	1	0.1	0.01
Low Side M35	4	0.1	0.01	0.001
High Side T2000	6	10	1	0.1
Low Side M35	6	0.1	0.01	0.001

Resolution stated as individual high and low readings.

Making Water Visible®

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Badger Meter | Absolute Digital Encoder

DESCRIPTION

Applications: The Absolute Digital Encoder (ADE®) is designed for use with all Recordall® Disc, Turbo, Compound and Fire Service meters to provide connectivity with ORION®, GALAXY, BadgerTouch® Itron ERT, and Badger Meter approved AMR/AMI technology solutions.

Electronic Resolution: Digital output from the ADE includes the option of either four, five or six dial resolution. Refer to tables on the next page for details.

Mounting: The ADE in its shroud assembly uses a bayonet mount compatible with all Recordall Disc, Turbo, Compound and Fire Series meters. The bayonet mount allows positioning of the register in any of four orientations for visual reading convenience. The ADE can be removed from the meter without disrupting water service.

Magnetic Drive: A direct-drive, high-strength magnetic coupling through the meter body to the wetted magnet provides reliable and dependable register coupling.

Local Indication: The ADE register face features a six-digit mechanical odometer wheel stack, a 360° test circle with sweep hand, and a flow finder to indicate leaks.

Tamper-Resistant Features: Unauthorized removal of the register or encoder is inhibited by the option of a tamper detection seal wire screw, resistant TORX® tamper-resistant seal screw, or the proprietary tamper-resistant keyed seal screw. Each can be installed at the meter site or at the factory.

Construction: The housing of the ADE is constructed of a strengthened glass lens top and a corrosion-resistant metal bottom. Internal construction materials are thermoplastic for long life and high reliability. The register gearing is self-lubricating thermoplastic to minimize friction and provide long, reliable life. The shroud assembly is thermoplastic.

Temperature: The operating range of the ADE is – 40…140° F (– 40…60° C). The water meter should not be subjected to temperatures below freezing.

Sealing: The ADE achieves true water resistance due to the adhesive technology used to seal the glass dome to the corrosion resistant metal bottom. Leak rates less than 10^{-6} cc/sec, as tested by a helium mass spectrometer, are comparable to a true hermetic seal. Due to this unique sealing process, the ADE exceeds all applicable requirements of AWWA Standard C707 regarding moisture intrusion.

Wire Connections: The ADE is available with either a wire lead, fully potted to prevent moisture intrusion at the connections, or with terminal screws. When provided with a wire lead, the ADE may be pre-wired at the factory to select Badger Meter-approved AMR/AMI endpoints, or may be furnished with a variety of lead wire lengths. Lead wire equipped ADE registers are suitable for installation in all environments, including continuously submerged water meter pits.

ADE-DS-00183-EN-02 (May 2013)

SPECIFICATIONS

Transmitter/Register	Straight reading, permanently sealed, magnetic drive
Unit of Measure	U.S. Gallons, Cubic Feet, Cubic Meters, clearly identified on register face
Number Wheels	Six with 3/16-inch high numerals
Test Circle	360° circle with ten major increments with ten divisions each
Weight	11 Ounces
Humidity	0% to 100% condensing when equipped with potted lead wire, 0% to 95% non-condensing with screw-terminal wire connections
Temperature	– 40…140° F (– 40…60° C)
Signal Output	Industry Standard ASCII Format
Visual Resolution	1/100th of Test Circle
Electronic Resolution	4-, 5- or 6-dial resolution
Signal Type	3-wire synchronous for AMR/AMI solutions 2-wire asynchronous for Touch solutions
Power Source	External

The terminal screw version ADE features a tamper-resistant cap over the three-wire terminals. ADE registers with terminal screws are for indoor installation in protected environments, such as residential basements.

Electrical: The electronic circuitry is designed to provide immunity to electrical surges and transients per IEC801-2, IEC801-4 Severity Level 4. Operation of the ADE is dependent on the wire length limitations of connected AMR equipment.

Operating Characteristics: The digital reading obtained by an AMR/AMI device is sensed directly from the position of the ADE register's odometer using internal LED light paths to determine the exact position of each number wheel. This technology eliminates electromechanical contacts that could wear out, and provides greater long-term performance.

Product Data Sheet

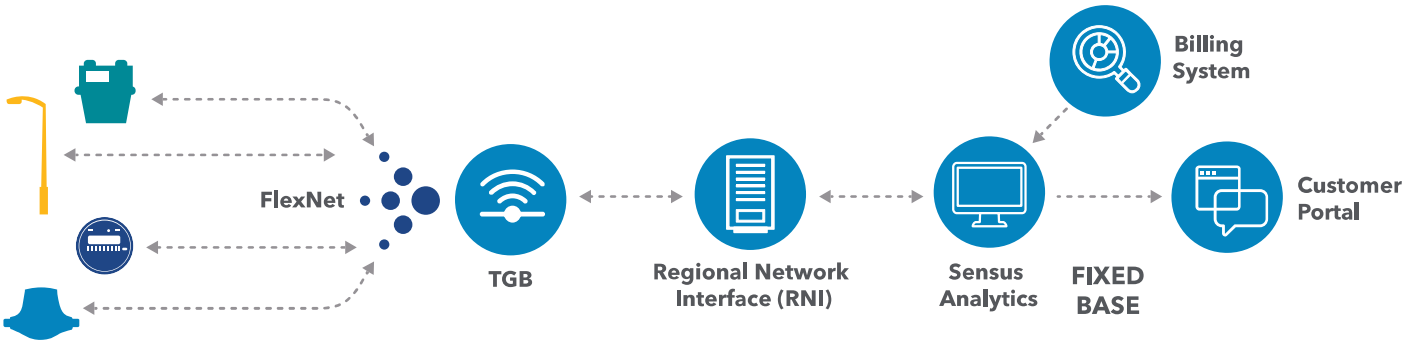
CUSTOMER SUCCESS | SOFTWARE

Critical data, seamless integration

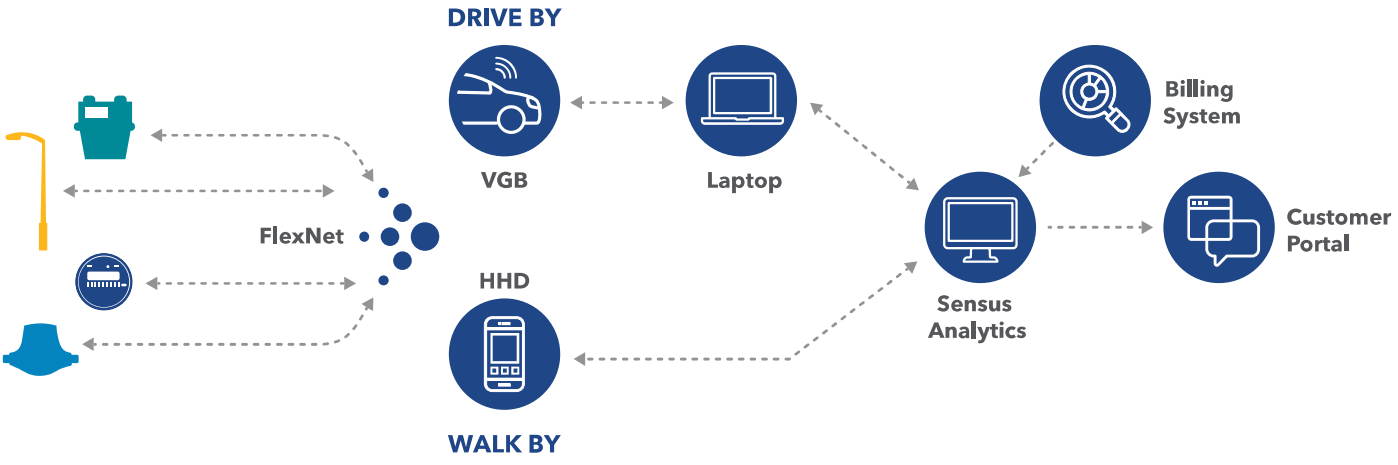
A superior network, intuitive software, incomparable results.

A utility's operations are only as good as its data. And data is only as reliable as the network. But data for data's sake…well, what's the point? At Sensus, our robust, secure network and easy-to-use software integrate with your CIS, billing systems and other data sources to provide actionable insights that improve safety, increase efficiency and boost your bottom line.

AMI



AMR



The FlexNet™ Communication Network

FlexNet is a point-to-multipoint and fixed-base communication network from Sensus that utilizes a private, FCC-licensed spectrum. As a fundamental part of an overall smart utility solution, FlexNet supplies the reliable two-way communication network needed to deliver data from meters and other infrastructure to utilities, deriving meaningful and actionable insights.

FlexNet is resilient, secure and future-proof.

- Reliable data.
- Fast transmission.
- Remote management.
- Support for scalability.
- Improved efficiencies.
- Low cost of ownership.

Sensus Analytics

Sensus Analytics makes your utility data clear, simple and actionable. A functionable and customizable suite of applications with user-friendly dashboards enables you to make informed decisions quickly and confidently. Our powerful data management tools aggregate information from your AMI, AMR and other sources, securely delivering insights through intuitive apps right to your desktop, tablet or smartphone. Role-based access allows service providers to share tailored information across the organization for improved productivity, visibility and decision-making.

Sensus Analytics helps drive the success of your business.

- Prepare and execute billing on meters.
- Support customer service.
- Maintain and manage meter performance and data.

Regional Network Interface™

Regional Network Interface (RNI) is a tool that comes with FlexNet to read, collect and deliver near-real-time data, providing a window into the field. Communicating with end points, RNI continuously gathers and processes network data, providing utility status updates and storing or sending data to CIS and billing systems. Priority alarms are delivered immediately, and onboard diagnostic tools optimize performance by monitoring and managing network health.

RNI is the nerve center of FlexNet, made up of customized hardware, software and database elements.

- Improves operational efficiency.
- Monitors system performance.
- Manages network security.
- Configures end points over the air.
- Enables reliable service, accurate billing and faster response.

Customer Portal

Customers want to be engaged and in control—and that means they want to be smart when it comes to utility usage. The Sensus Customer Portal works in conjunction with Sensus Analytics to improve customer service, enhance customer engagement and promote sustainability. This web-based, interactive application creates easy-to-read usage charts, graphs, billing estimates, tips and more, providing virtually everything a customer needs to correct current issues and make better-informed decisions about future usage.

- Customizable interface with 24/7 access.
- Greater customer control for reduced call volumes.
- Customer target-setting to manage bills and save resources.
- Email or text alerts on important account information.
- Home energy profiles, education and cost-saving tips.

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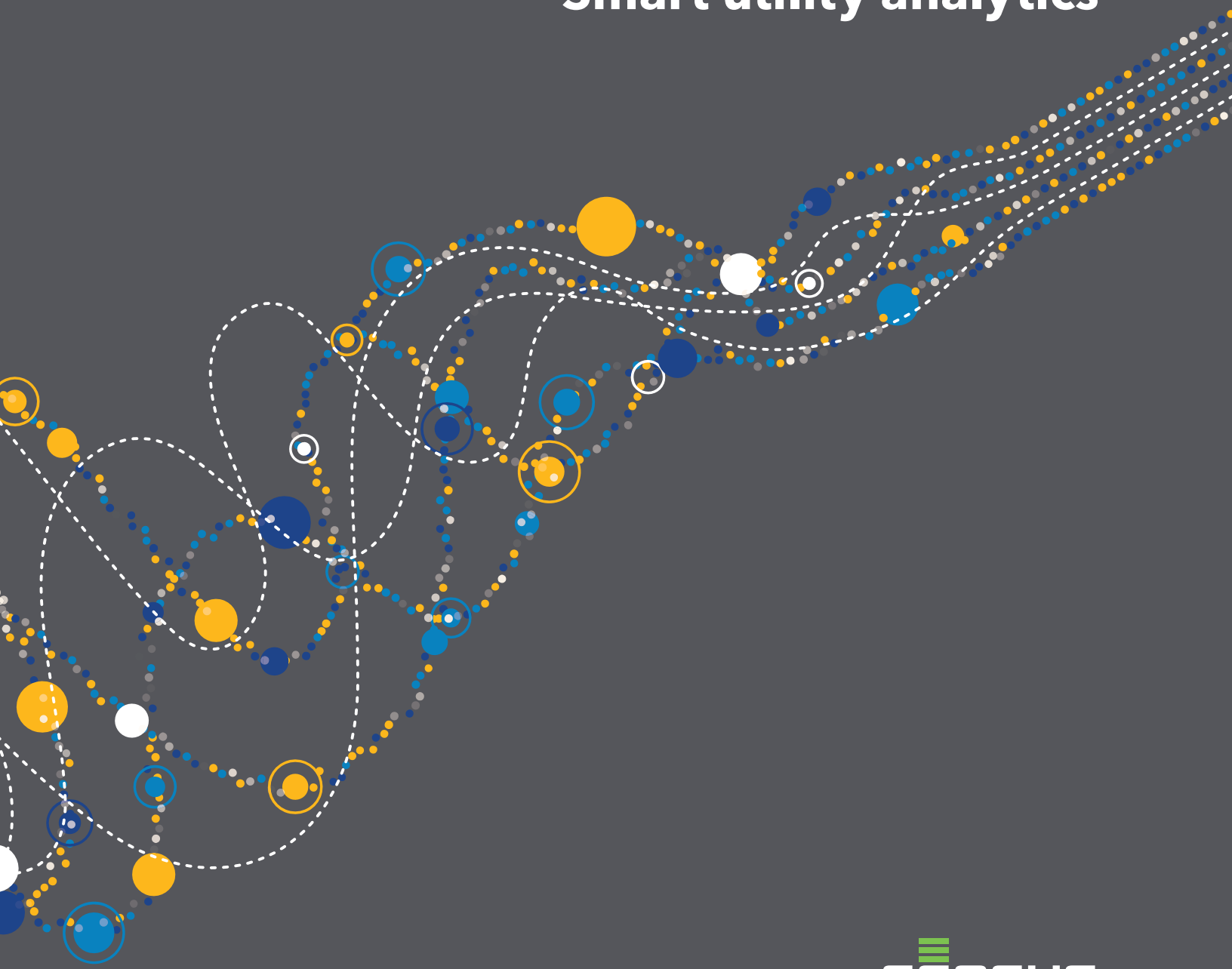
Nothing's out of reach.

CUSTOMER SUCCESS

Smart utility analytics



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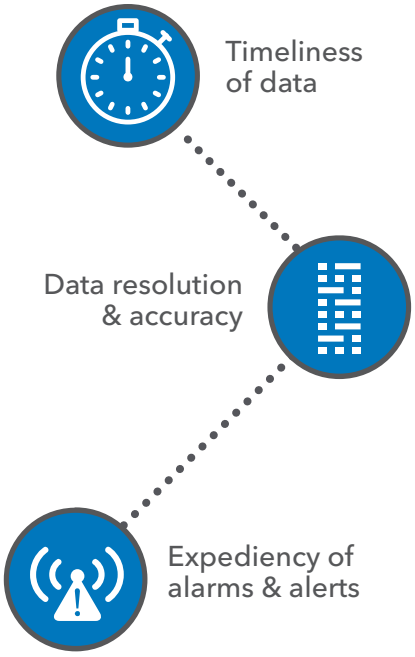
Top benefits of an analytics solution for smart utilities



"Big data" is a buzzword used across almost every industry to describe the massive amount of digital information collected in order to discover business or customer patterns, trends and connections. But data for data's sake doesn't provide much significance to the collector. Value is created by real-time processing and sorting of this information to deliver actionable insights.

As technology continues to transform the way essential resources are delivered, monitored and billed, utilities are growing increasingly smarter. Data collection from smart meters and sensors, transmitted across a smart communication network, provides an incredible opportunity to optimize operations, improve the customer experience and grow revenue. But the same "data dilemma" exists as in other industries: this smart data must be sorted for relevance and application—or all that technology-generated potential goes to waste.

Analytics software enables smart

Aggregating, sorting and dispensing utility data to generate actionable insights is the purpose of analytics software. According to Ryan Roberts, software product manager at Sensus, "As communication network technology provides the capacity to deliver real-time, two-way data, utilities can implement analytics software to harness the power of all this information, creating smart value that goes well beyond customer usage."

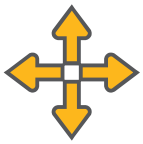
Because most utilities don't have a data scientist or statistician to analyze the incoming data, an analytics software solution should provide actionable data without the utility needing experts on staff—or the associated expenses. Analytics software provides value across the utility, from the meter shop to billing to customer service. According to Roberts, the top benefits fall into three main categories: data timeliness, resolution and accuracy of data, and alarm/alert expediency. "With an analytics solution in place, granular data is immediately available to make well-informed, timely decisions," Roberts says. "Plus, if something is going wrong, that information shows up on the customer's cellphone right away—not a day later."

Whether they're using gas, water or electricity, utility customers want to know usage data by the hour in order to have the ability to assess efficiencies, be notified of problems and plan for future needs. The entire business benefits, as meaningful data drives expansion planning, rate analysis and customer engagement. Plus, utilities can identify vulnerabilities in infrastructure or distribution design, implementing improvements before break-fix situations occur. "Some utilities have a single customer that generates 80% of their revenue," explains Roberts, "so it's imperative to see even slight pattern shifts. The smallest changes equate to a lot of money."

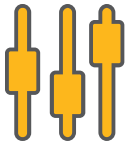
Five key factors to consider when choosing utility analytics software:

Flexibility

Interoperability



Scalability



Customization

Simplicity

Until about 15 years ago, obtaining utility data could be, well, dodgy. Whether due to human mistakes, mechanical errors or network insufficiencies, data corrections had to be made to ensure the data was usable. Typically, this entailed a meter data management (MDM) system. But today a network, especially a point-to-multipoint communication network, brings in much more accurate data. "Because coverage is better and the data is more accurate and timely, data management has to be more refined as well," says Roberts. When combined with the right network, analytics software significantly reduces operations costs. "A utility only needed MDM to fill information gaps when their network is not reliable and robust."

A key example is legacy VEE (Validation, Estimation and Editing). According to Roberts, "A utility can invest $1 million to $2 million each year to sustain a VEE that covers gaps in inaccuracy. Or it could spend the same amount of money on improved infrastructure and get 99.5% accurate reads. It's kind of a no-brainer."

Evaluating analytics software

When it comes to choosing from utility analytics software on the market today, there are five key factors to consider among vendors.

1. Flexibility: Utilities must be able to determine software functions to meet their unique needs by offering prescriptive and custom reports to view various data relationships based on areas, meters and more.

2. Interoperability: This is the ability to collect and process data from systems and sensors outside of meters. A perfect example is the implementation of stormwater sensors on dams to assess lake-level data.

3. Scalability: The solution should have the capacity to grow with utility complexity, customer increase, area expansion, etc., as well as scale with feature advancements and smart city applications.

4. Customization: The ideal solution offers just the right fit for the customer's requirements. The utility should be able to purchase just what the customer needs, no more.

5. Simplicity: Is the solution usable right out of the box? An analytics software solution should be user-friendly, easy to install and deployable with minimal expense.

"A city can have meters and sensors on everything and get data from all of them. But if that data is not being aggregated in a relevant way, it is not actionable. Actionable data is the key to a smart city. And analytics is the key to actionable data."

RYAN ROBERTS
Software product manager
Sensus

Making the case for analytics software

Municipalities and utilities need an analytics solution to optimize their incoming data. But how can a case be built to convince key stakeholders? "Simply put, it's a matter of looking back and then looking forward to present the facts," says Roberts. "When you assess issues that have already occurred, you can evaluate the ROI of having the right data, formatted the right way. The financial, safety and customer service impacts can be clearly presented based on what could have been."

Usage can be segregated by service, by user and by consumption. So when looking ahead to future decisions, utilities can customize reports for the necessary data to justify rate changes or tiered billing. The customer service team can have all the aggregated data at their fingertips, so when calls come in, they can point directly to a day—and hour—and immediately remedy the concern. The reports also provide the ability to be proactive with customers, which markedly improves customer satisfaction.

"Most communities are now crying out for smart city applications, and analytics software is the backbone for the success of smart," says Roberts. "A city can have meters and sensors on everything and get data from all of them. But if that data is not being aggregated in a relevant way, it is not actionable. Actionable data is the key to a smart city. And analytics is the key to actionable data." Because the right analytics solution can sort and report on data from across utilities and break down the typical silos, every aspect of a community's infrastructure can work together for a truly smart city.

Data trends for every utility

Big data is here to stay. And utilities must take advantage of the information that comes from processing their data in relevant ways. Customers—utilities and end-users—want to better manage their resources. So moving actionable data into their hands aligns with our current technology culture and consumer expectations. And it simply creates a better customer experience at all levels.

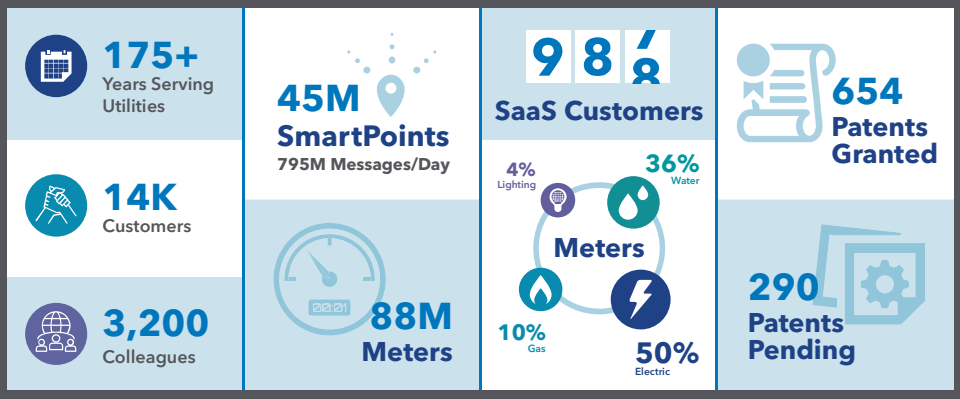
The other issue that is growing rapidly across utilities is compliance. "Government regulations are changing, and compliance is becoming mandatory," explains Roberts. "Utilities have to know their data in order to remain in line with federal and state directives."

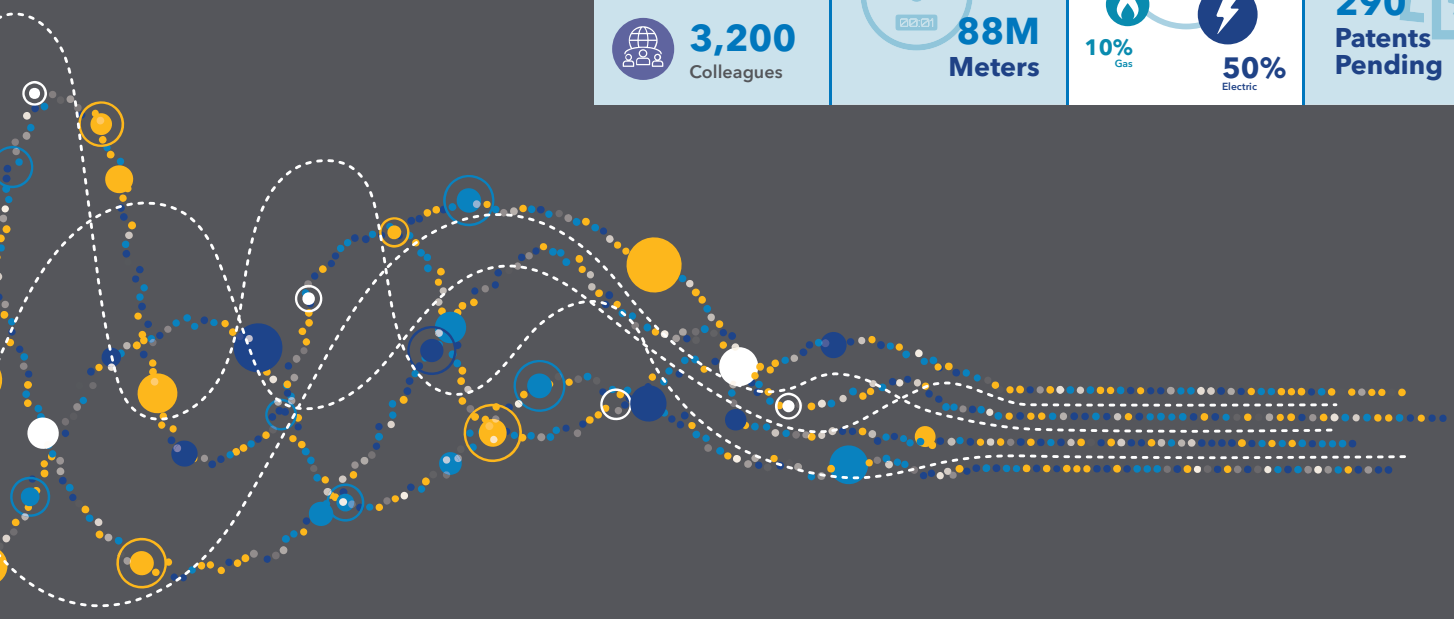
Finally, whether it involves the grid, water or gas, disaster preparation and planning is on the forefront of every municipality. Using data from a municipality's smart utility network, an analytics software solution is the ideal foundation for better asset utilization when crisis strikes—and for everyday efficiency and customer service.

About Sensus

Sensus, a Xylem brand, helps a wide range of public service providers–from utilities to cities to industrial complexes and campuses–do more with their infrastructure to improve quality of life in their communities. We enable our customers to reach farther through the application of technology and data-driven insights that deliver efficiency and responsiveness. We partner with them to anticipate and respond to evolving business needs with innovation in sensing and communications technologies, data analytics and services. Learn more at sensus.com and follow us on Facebook, LinkedIn and Twitter through @sensusglobal.

Sensus by the numbers





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Sensus Essential Analytics

Level the playing field with manageable data insights

Convert data to insight.

Water, gas and electric utilities know that analyzing the information is the best way to optimize your systems and make the most of your investment. Yet the key is sorting through all the data to reveal the right insights – insights to help improve everything from efficiency to customer service.

Sensus Essential Analytics provides the core business functionality you need to do just that. Part of our suite of intelligent infrastructure software, this bundle of applications equips you with user-friendly dashboards, so you can make informed decisions quickly and confidently. Our powerful data management tools aggregate information from your AMI, AMR and other sources. And these intuitive apps are delivered by a secure connection to the cloud right to your desktop, tablet or smart phone - just a click, tap or touch away - wherever and whenever you want.

Role-based access allows service providers to share information across the organization – from customer service and operations to accounting and rates - for improved productivity, visibility and decision-making.

Sensus Essential Analytics:

Data Store - a secure, cloud-based information warehouse that stores system and network data for the applications. Three years of storage is included

Report Access - a management tool that offers a menu of reports that instantly summarize the information you need to know right away

Device Access - a customer service tool that presents detailed usage history and trends, identifies anomalies and enables custom alert programming to track specific issues

Billing Access - a billing interface tool that previews and audits billing extracts for issues, enabling the utility to take corrective action, then generates final billing files for production

Meter Insight - a validation tool that provides a summary of incoming network meter data from and identifies issues to be addressed

Big data doesn't have to be a big deal.

We believe in making data easy to work with. That's why Sensus Analytics offers you the flexibility to purchase single applications or pre-bundled packages of our most popular apps to harness the power of big data for energy and water utilities.

Our cloud-based platform aggregates data from different information systems across your company into intuitive applications that are easy to use and quick to implement. That means less reliance on IT resources and lengthy training and more customer satisfaction, service reliability, quality and operational efficiency.

Here's how we do it:

App-based
Each purpose-built application accesses data from multiple systems and presents it in user-friendly dashboards

Flexible
Select a package of tools for billing and system management or single applications that help achieve key initiatives

Accessible
Our secure, cloud-based delivery platform puts your information within reach no matter where you are

Affordable
There's no need to purchase, install, update or maintain special software, licenses or hardware - or set aside valuable office space to house it

Fresh
Applications are continuously updated as information enters the system, so you can make decisions based on the latest data

Integratable
Sensus Analytics draws information from many systems through the cloud, so there's little time and cost required for standard systems integration

Scalable
Our Data Store and three years of included cloud-based storage enables you to add applications, or increase storage, quickly – often in hours

Visible
Role-based access allows information sharing across the organization – from customer service and operations to accounting and rates - for improved efficiency and cross-functional understanding

Ready to learn more?

Visit sensus.com/analytics.

About Sensus

Sensus, a Xylem brand, helps public service providers—from utilities to cities to industrial complexes and campuses—do more with their infrastructure to improve quality of life in their communities. We enable our customers to reach farther by responding to evolving business needs with innovation in sensing and communications technologies, data analytics and services. Learn more at **sensus.com**.

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FlexNet M400B2 Base Station

Compact Point-to-Multipoint Base Station

The Sensus FlexNet® M400B2 Base Station offers a strategic communications option for public service providers with endpoints deployed in remote or densely populated areas.

The efficient transceiver can transmit and receive in a 200kHz band of spectrum. 200kHz enables more dedicated channels, resulting in higher network capacity, allowing more granular data and more channels of data. And the Sensus FlexNet communication network delivers double the transmit power of competitive systems over primary-use licensed spectrum – ensuring reliability for mission critical applications.

The tower-based architecture enables reliable communication of status and usage information with fewer access points than other network architectures. These compact, efficient base stations fit in space-constrained environments and require no air conditioning.

FEATURES

- GPS receiver for time synchronization
- Duplexer for single antenna
- IP-addressable power supply with hot-swap capability
- 8-hour battery backup
- Alarms and reporting capability
- Backhaul via Ethernet/IP
- Heated battery for cold weather environments
- Modular construction for easy serviceability

APPLICATIONS

- Two-way Advanced Meter Infrastructure (AMI)
- Distribution Automation (DA)
- Demand Response (DR)
- Home Area Networks (HAN)
- Sensus VantagePoint® Lighting Control

Licensed Radio Spectrum

In North America, FCC/IC protected primary-use spectrum avoids competition with other wireless services, interference from other radio devices and the risk of being taken over by emergency service providers.

Fewer Access Points

Our point-to-multipoint architecture directly connects base stations to endpoints over large geographic areas – greatly reducing the number of network backhaul connections as well as O&M costs.

Resilient Network Design

Sensus Base Stations continue to provide real time data during outages and emergencies because of eight hour plus battery backup – enabling better workforce management and faster service restoration.

Small Footprint

Flexible pole or wall-mounting options enable strategic deployment with a discreet appearance.

Industry Leading Security

Sensus has achieved GE/Wurldtech™ Achilles® communications certification for critical infrastructure security against cyber threats.

FlexNet® M400B2 Base Station

Compact Point-to-Multipoint Base Station

PROPERTIES

Receive bandwidth	200 KHz
Transceivers	Single
Spectrum	Licensed 900 MHz PCS/MAS
Duplexing	Single transmit Sixteen receivers - simultaneous/dedicated
Applications	Single
Expandability	No
Compatibility	SNMP
FlexNet	Requires RNI 3.x or newer

ENCLOSURES - OUTDOOR - POLE/WALL MOUNT

Height	22″ (55.9 cm)
Width x Depth	22″ (55.9 cm) x 10.5″ (26.7 cm)
Capacity	One transceiver
Temperature	-40° to +122° F (-40° to +50° C)
Voltage	120 VAC
Battery backup	8 hours
NEMA rating	4
Air conditioned	No

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SmartPoint 520M

Pit Set Module

The SmartPoint® 520M Pit Set Module is a radio transceiver that provides water utilities inbound and outbound access to water measurement and ancillary device diagnostics via radio signal. The SmartPoint 520M is designed for submersible, pit-set environments.

TouchCoupler Design

The SmartPoint 520M Module utilizes TouchCoupler, the patented Sensus inductive coupling communication platform, to interface with the encoded meter. With TouchCoupler, the SmartPoint 520M Module can connect to the meter using existing two wire AMR installations instead of requiring utilities to access the meter to install a new three-wire connection. This results in a fast, efficient and reliable connection at minimal cost.

Operation

With its migratable, two-way communication ability, the M-Series SmartPoint functions as a walk-by/drive-by endpoint, fixed-base endpoint, or combination of the two. This flexibility increases utility data collection capabilities and streamlines operations. The SmartPoint 520M Module receives input from the meter register and remotely sends data to a walk-by/drive-by or fixed-base collection device. The SmartPoint 520M Module easily migrates from walk-by/drive-by to fixed base by simply installing a Base Station.

In walk-by/drive-by mode, the SmartPoint 520M Module collects data and awaits an activation signal from the Vehicle Gateway Basestation (VGB) or Hand-Held Device (HHD). Upon signal receipt, it transmits readings, the meter identification number and any alarms.

As a fixed-base endpoint, the SmartPoint 520M Module interacts with one or more strategically placed Base Stations located in the utility service area. Top of the hour readings and other diagnostics are instantly forwarded to the Regional Network Interface (RNI)™ at time of transmission. The FlexNet® communication network provides unmatched reliability by using expansive tower receiver coverage of metering end points, data/message redundancy, failover backup provisions and operation on FCC primary use (unshared) RF spectrum.

Powerful Transmission, Flexible Platform

The SmartPoint® 520M Pit Set Module offers several advantages that control both deployment and lifetime operation costs. Its powerful, industry-leading two watt transmitter broadcasts over large distances and minimizes collection infrastructure. And after the SmartPoint is installed, its migratable, two-way system platform can be updated without requiring personnel to visit each meter and/or inconveniencing customers.

BENEFITS

- Easily receives input from either walk-by/drive-by or fixed-base collection device
- Controls both deployment and lifetime operation costs
- Compact installation that saves time, space and money - without reducing system performance
- Delivers a fast, efficient and reliable connection at minimal cost
- Minimizes new infrastructure investment
- Enables effective leak detection

SmartPoint 520M

Pit Set Module

Additional Smartpoint 520M Module Features

The SmartPoint 520M Module obtains hourly readings and can monitor continuous flow over a programmable period of time, alerting the utility to leak conditions. In addition, the SmartPoint stores up to 840 consumption intervals (35 days of hourly consumption), providing the utility with the ability to extract detailed usage profiles for consumer information and dispute resolution. The SmartPoint also incorporates a two-port design, allowing the utility to connect multiple registers and ancillary devices (such as acoustic monitoring) to a single SmartPoint. This results in a compact installation that saves time, space and money - without reducing system performance.

SPECIFICATIONS

Service	Pit set installation interfacing the utility meter to the Sensus FlexNet communication network. Unit requires 1.75" diameter hole in pit lid; fits pit lid thicknesses up to 1.75"
Physical characteristics	Width: 4.43" x Height: 5.09" x Depth: 3"
Weight	1.0 lbs/16.0 oz
Color	Black
Frequency range	900 – 950 MHz, 8000 channels X 6.25 kHz steps
Modulation	Proprietary Narrow Band
Memory	Non-Volatile
Power	Lithium Thionyl Chloride batteries
Approvals	US: FCC CFR 47: Part 24D, Part 101C, Part 15 Licensed operation Canada: Industry Canada (IC) RSS-134, RSS-119
Operating temperature	- 22° F to +185° F - 30° C to + 85° C
Options	Dual or single port availability; TouchCoupler only, wired only
Installation environment	100% condensing, water submersible
Compatibility	TouchCoupler and Wired Version: Sensus Encoder Registers, Badger ADE water registers, Master Meter AccuLinx, and Hersey Translator (approved TR/PL Lead) Wired Version Only: Elster Encoder (Sensus protocol), Neptune ARB VI (ProRead), Hersey Translator, Zenner PMN Nitro 01, McCrometer flowcom FC100-00M, and Kamstrup flowIQ 2100 Refer to the 510M/520M SmartPoint® Module Water Meter and Ancillaries Compatibility Quick Guide for the latest compatibility information.
Warranty	20 years – Based on six transmissions per day. Refer to Sensus G-500 for warranty.

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510M/520M SmartPoint® Module

Water Meter and Ancillaries Compatibility Quick Guide

Sensus

Register Type	Model	Meter Type
ICE & ICE Opto	All meters that accept ICE & ICE Opto 3-wire.	Positive Displacement, Multi-jet, Compound, Turbine, Propeller, Fire Service
OMNI™	T2, C2, F2, R2	Floating Ball Technology
accuMAG™	accuMAG	Mag
iPERL®	iPERL	Mag
Permalog	Permalog+	Acoustic Technology
Sensus® Electronic Register+™ and E-Register	accuSTREAM, SR II	Positive Displacement
ally	ally	ally
Hydroverse	Hydroverse	Mag

Badger

Register Type	Model	Meter Type
ADE	All meters that accept ADE 3-wire and TouchCoupler support, Sensus Approved TR/PL lead, up to 8 wheels.	Disc, Turbine, Compound, Fire Service
HR-E LCD	All meters that accept HR-E LCD 3-wire, up to 8 wheels. Must be at least SmartPoint firmware version R1.2.1f or higher.	Disc, Turbo Series, Compound Series, Combo Series, Fire Service
E-SERIES 8 digits	All models with firmware version 1.36. 3-wire**	Ultrasonic

Neptune

Register Type	Model	Meter Type
Proread 4 wheel	All meters that accept Proread registers. 3-wire support	Positive Displacement, Turbine, Compound, Fire Service
E-coder with TouchCoupler 4 wheel	All meters with firmware version 01.02. Manufactured after 1/2016.	Positive Displacement, Turbine, Compound, Fire Service
Proread 6 wheel	All meters that accept Proread registers. 3-wire support	Positive Displacement, Turbine, Compound, Fire Service
E-coder 6 wheel	All meters that accept E-coder registers. 3-wire support (Proread protocol only)	Positive Displacement, Turbine, Compound, Fire Service
E-coder with TouchCoupler 6 wheel	All meters with firmware version 01.02. Manufactured after 1/2016.	Positive Displacement, Turbine, Compound, Fire Service
E-coder 8 wheel	All meters that accept E-coder registers. 3-wire support*	Positive Displacement, Turbine, Compound, Fire Service
E-coder with TouchCoupler 8 wheel	All meters with firmware version 01.02. Manufactured after 1/2016.	Positive Displacement, Turbine, Compound, Fire Service
ProCoder 8 wheel	All meters with firmware version 63.16. Manufactured after 7/2018. TouchCoupler and 3-wire**	Positive Displacement, Turbine, Compound, Fire Service

*SmartPoint firmware version 1.2 and above only
**SmartPoint firmware version 1.7 and above only

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Elster/Amco

Register Type	Model	Meter Type
Scancoder	All meters that accept Scancoder 3-wire support (Sensus protocol only).	Positive Displacement, Turbine, Multi-jet, Bulk combo, Fire service
InVision	All meters that accept InVision 3-wire support (Sensus protocol only).	Positive Displacement, Turbine, Multi-jet, Bulk combo, Fire service

Master Meter

Register Type	Model	Meter Type
AccuLinx V1.19	All meters that accept AccuLinx 3-wire and TouchCoupler, Sensus approved TR/PL lead.	Positive Displacement
Sonata 8 digits	3-wire and TouchCoupler, firmware version 5.01 or greater.**	Ultrasonic
Octave 8 digits	3-wire only.**	Ultrasonic

McCrometer

Register Type	Model	Meter Type
McCrometer flowcom FC100-00M 8 digits	3-wire reading. Firmware 2.4. Manufactured after 4/2015.	Propeller
ML255 battery powered register 8 digits	3-wire reading only. Firmware 5.09 or greater.**	Propeller
ML Series converter, AC powered 8 digits	3-wire reading only. Firmware 3.03 or greater.**	Propeller

Kamstrup

Register Type	Model	Meter Type
flowIQ 2100 4, 6 and 8 wheel	3-wire reading. Version C1.	Ultrasonic
flowIQ 2100 4, 6, and 8 wheel	3-wire and TouchCoupler version H1.**	Ultrasonic

Diehl

Register Type	Model	Meter Type
Hydrus 8 digits	3-wire support only.** Manufactured after 4/2018.	Ultrasonic

Zenner

Register Type	Model	Meter Type
PMN Nitro 01 4 wheel, 6 wheel	3-wire support only. Manufactured after 8/2015.	Multi-jet

Hersey/Mueller Systems

Register Type	Model	Meter Type
Translator	All meters that accept Translator 3-wire and TouchCoupler support, Sensus approved TR/PL lead.	Positive Displacement, Mag

*SmartPoint firmware version 1.2 and above only
**SmartPoint firmware version 1.7 and above only

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