ABB MEASUREMENT & ANALYTICS | APPLICATION NOTE

AquaMaster4 electromagnetic flowmeter

Increase confidence in your revenue billing

Make every drop count with ABB's AquaMaster4 electromagnetic flowmeters

Measurement made easy

Over 32 billion cubic meters of treated water is lost every year through leakage

Deliver accurate bills for true consumption – not estimates

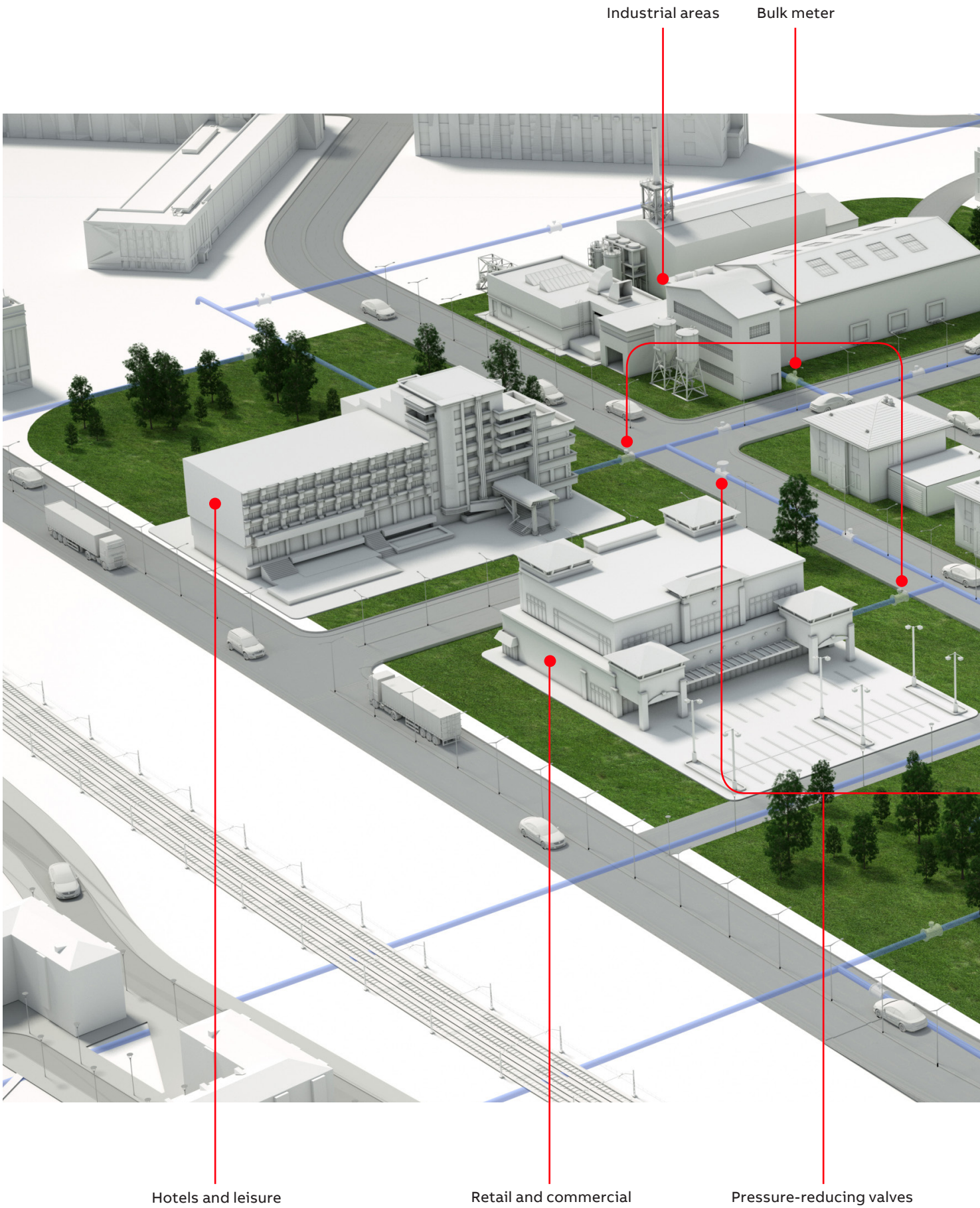
The purpose of a water distribution network is to supply users with water demanded and to supply this water with adequate pressure under various loading conditions. A municipal water supply system is subjected to a number of different loading conditions:

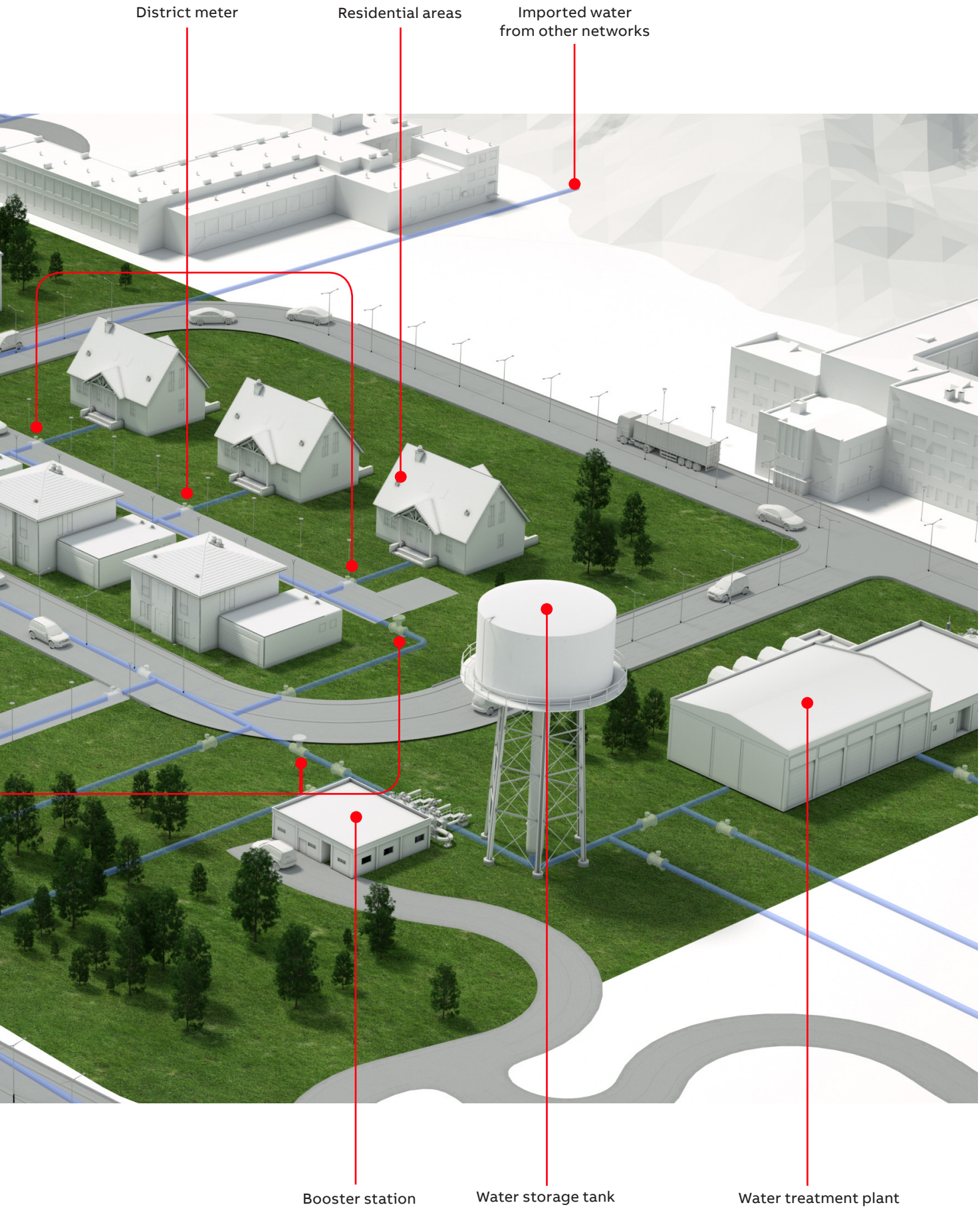
- Peak daily demands, varying throughout each day
- Critical load when pipes leak or burst
- Fire extinguishing demands at different nodes

Accurately billing for water supplied to customers is critical to the operational profitability (gap between revenues and operating spending) of any water utilities. There are many water utilities around the world that do not recover their operating costs through their utility billing let alone their capital costs. Typically a water utility needs to bill 30 to 50 % more than their operational costs in order to recover its capital costs.

A World Bank study has estimated that over 32 billion cubic meters of treated water is lost every year through leakage. The study also reveals that operators are missing out on over US$14 billion of revenue for water that is being delivered to customers, but is not being invoiced due to theft, corruption or inadequate metering.

Typical water distribution system




District meter
Residential areas
Imported water from other networks
Booster station
Water storage tank
Water treatment plant

Increasing operational efficiency

One of the ways utilities can increase their operational efficiency is with accurate knowledge of the load on the network

Continuous flow measurement is paramount to enable effective construction and calibration of network model. The flow data into and out of each zone provides utilities with a detailed understanding of per capita demand and, over time, information of growth of demand and also leakage. To achieve all this, the right choice of flowmeter technology and correct sizing are very important, as the meter needs to cope with peak daily flows, seasonal demand and night flows into a District Metered Area (DMA) or into sub-divisions of a DMA. In addition to these, accuracy is another important requirement to enable precise revenue billing and to gather total leakage data.

There are many day-to-day issues that either affect consumption volume or have the potential to corrupt the integrity of the consumption data, for example:

- choice of flow metering technology
- inaccuracies of flow meter reading due to disturbances in flow profile and
- non-revenue water

The application

The purpose of distribution system is to deliver water to consumer with appropriate quality, quantity and pressure. Distribution system is used to describe collectively the facilities used to supply water from its source to the point of usage – see schematic on page 3.

The Challenges

The selection of the right measurement technology is of paramount importance. Various types of flow measurement techniques can be used in closed pipe systems, with each measurement technique offering its own set of advantages and drawbacks. These options include orifice, mechanical, ultrasonic and electromagnetic technologies.

Orifice plates fitted on open pump discharges present a relatively inexpensive solution by measuring the amount of water flowing through a specifically sized opening. An orifice plate delivers a relatively accurate measurement, providing the orifice opening is accurately machined to the right size, as even a slight variation can have a significant impact on performance.

Mechanical propeller flowmeters are also a popular choice for water measurement applications. However, like any meter with moving parts subject to wear and tear, these and other mechanical-type meters can quickly suffer reduced accuracy; leading to either under or over-registration of flows. Propeller meters also tend to work best with specific pipe sizes and flow ranges. Also, the need for mechanical meters to be tested periodically, recalibrated and repaired means that they have to be removed, requiring users either to replace the meter with a temporary device or cease measurement altogether until the meter is refitted back into the line.

Ultrasonic flowmeters including portable clamp-on types, are another option. They use ultrasonic beams to assess the velocity of the fluid, which can then be used to derive a flow measurement. Aside from their higher cost, ultrasonic flowmeters suffer various drawbacks. Transit time meters, in particular, can struggle to handle flows with high levels of particulate matter, requiring a strainer to be fitted. Both transit time and Doppler meters can also be affected by velocity profile distortions, requiring from 10 to 40 upstream diameters, depending on the severity of the disturbance. The turndown of ultrasonic meters is also limited within an ideal range of 20:1 to 40:1. Ultrasonic meters can also be difficult to install and set up, especially where high accuracy is required.

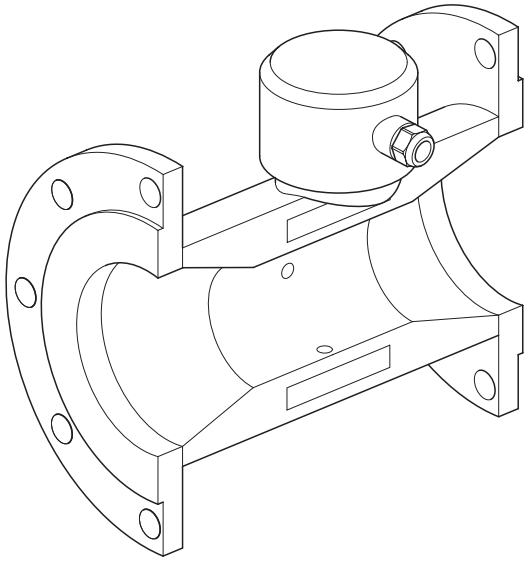
The accuracy of flowmeters can be affected not just by design but also by their susceptibility to tampering. Particularly where metering is conducted at the point of use, users have been known to make adjustments to achieve more favorable readings to enable them to either pay less or use more water.

The Solution

Due to its technical and economic advantages, electromagnetic flowmeters have become the preferred choice for flow measurement technology within the water industry.

The advantages of this technology include:

- minimal obstruction with very low head loss
- no moving parts
- availability for wide range of bore sizes
- no significant affects by temperature, pressure or fluid density changes
- no significant affects by profile distortion/swirl
- output directly and linearly related to flowrate
- measures with same high accuracy in either forward or reverse direction
- high turndown ration (1000:1) with long term stability of process value



Cutaway detail showing internal flowmeter bore

What can ABB offer?

In 1988 ABB invented the world's 1st battery powered electromagnetic flowmeter for DMA – AquaMaster. Within water distribution network and revenue metering applications, ABB's 4th generation AquaMaster Electromagnetic flowmeters is ideal technology that water utilities rely upon.

Available in line sizes from DN40 (1½ in.) to DN2400 (96 in.), AquaMaster4 delivers an unrivalled accuracy of up to ±0.2 % of reading ±0.5 mm/s (whichever is greater), Q3/Q1 range (R) of up to 1000 and long-term stability.

This high accuracy is enabled by a combination of ABB's unique 0D upstream and downstream sensor design at its nationally accredited flow laboratories.

AquaMaster4 integral and remote flowmeters

Flow measurement accuracy may be affected by disturbed flow profile resulting from valves and tee pieces (for example). As a result many electromagnetic flowmeter manufacturer specifies 10D upstream and 5D downstream straight pipe length to achieve their quoted accuracy. However in water distribution network especially in urban settings it is not always possible to meet this requirement. ABB's unique reduced bore sensor geometry addresses this by requiring 0D upstream and downstream straight pipe length. The reduced bore sensor is virtually insensitive to hydraulic disturbances as it conditions the upstream fluid flow profile within the sensor's central measuring zone; giving superior performance.

ABB's flow calibration facilities

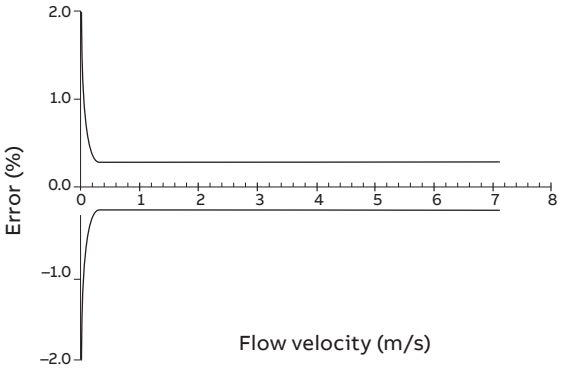
ABB's flow calibration facilities are certified by various national independent accredited bodies / laboratories. These are all are linked by the 'International Laboratory Accreditation Cooperation' (ILAC7), ensuring that, irrespective of where in the world a meter is calibrated, provided that it is calibrated at a nationally accredited laboratory, the calibration will be within the published uncertainty for that laboratory.

Advantages of ABB's calibration rig:

- ABB has one of the largest calibration facilities in the world, capable of pumping 2.5 m^3/s, enabling larger meters to be calibrated at high flowrates.
- All of ABB calibration facilities are continuously pumped enabling a flowmeter to calibrated at a steady flowrate (for example, over 300 or 600 seconds; or longer if required), to reduce a meter's random uncertainty errors during calibration.
- ABB's high turndown flowmeters (those with a high R number) can be calibrated over an extended flow range, guaranteeing accurate flowmeter performance over its full operating range.

Exchanging a mechanical DN150 (6 in.) mechanical meter with an accuracy of ±2 percent with an AquaMaster 4, for example, would yield an additional revenue for the operator of over US$4,700. Further increases in revenue can also be derived from the AquaMaster's extended flow range, which enables a greater range of maximum and minimum flows to be measured. Taking the above example, the AquaMaster's ability to measure previously unrecordable minimal night flow rates means that the operator could almost double their annual revenue to over US$9,000.

To manage non-revenue water effectively, ABB's Aquamaster4 enables water utilities to measure at very low flow rates accurately, for example in the night. This capability enables water utilities to separate leaks from consumption. Further the integration of pressure measurement with flow enables water utilities to plot flow and pressure together and have a deeper understanding of performance of the water distribution network.



Measurement accuracy plot – error (%) / flow velocity (m/s)

As a further assurance of a robust metering regime and lifelong accuracy, ABB also offers users its CalMaster3 in situ verification service for the AquaMaster4.

Performed by an ABB service engineer, this service verifies a meter's current operational status and also predicts any potential future faults. Users are issued with traditional calibration verification certificate complete with an uncertainty statement.

ABB calibration rig – certificated by ISO, UKAS, NATA, SIMT and NIST traceable

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