UFR – an innovative solution for water meter under registration – Case study in Jerusalem, Israel

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Abstract:

The paper will give a brief overview of how the UFR works, and will describe the trials that have been conducted in Jerusalem, before a decision was reached to install UFRs in the city. One reason for water meter under registration is the inability to measure low flow rates. The innovative **Unmeasured-Flow Reducer (UFR)** reduces the amount of water that flows below the measurement threshold (the starting flow rate) by means of changing the flow regime through the water meter at low flow rates. The UFR actually changes the flow regime through the water meter in such a way that a greater quantity of water passes through the water meter above the measurement threshold . The UFR does not affect the actual amount of water flowing through the water meter. The installation of the UFR, either upstream or downstream to the water meter, is likely to improve the measurement of water flow in that low flow rate region of measurement that, to date, water meters failed to measure (below the measurement threshold).

Unmeasured-Flow Reducer (UFR)

Keywords: UFR, water meter, under registration, apparent losses, measurement threshold.

Water meters at low flow rate

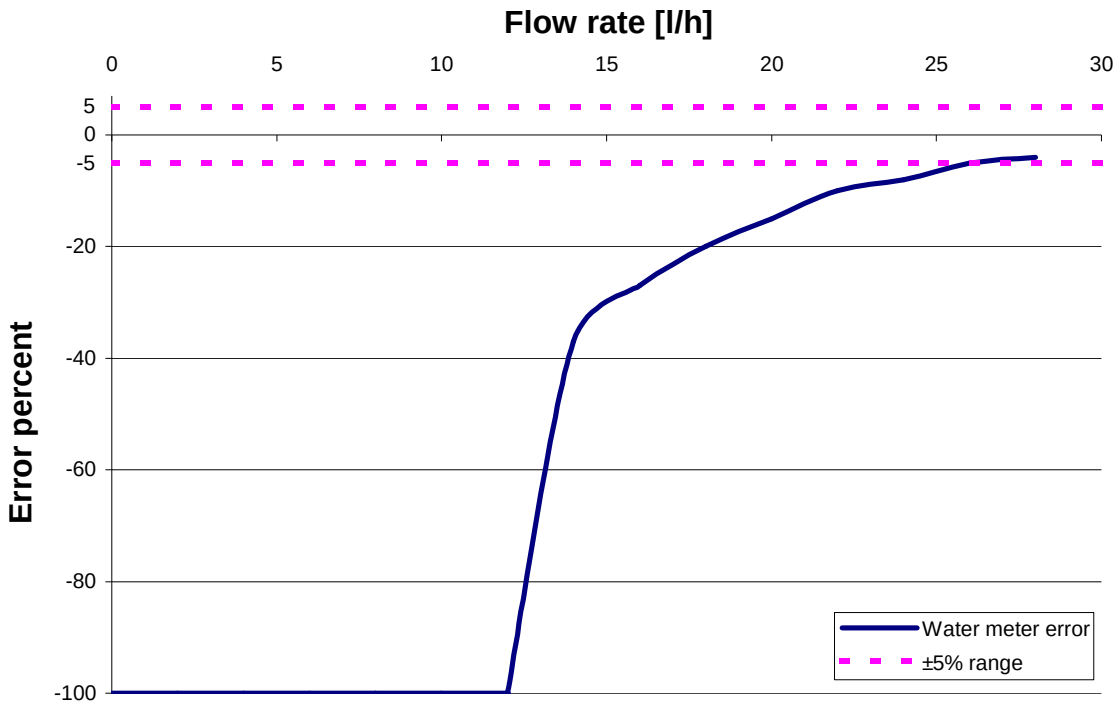
All water meters have difficulty in measuring very low flow rates. ISO standard (ISO 4064-1, Second edition, 1993) defines Qmin, Qt, Qn, Qmax, but it doesn't mention anything regarding the measurement threshold or starting flow rate, below which the water meter does not register flow. In the recent years, some of the water meter manufacturers have started to supply this data, but still, it relates only to water meters when they are new and doesn't take into account water meter aging.

The water meters installed in the Ein Karem (Jerusalem, Israel) district meter area (DMA), are multi jet type, Qn 2.5, class B.

A new multi jet, Qn 2.5, class B water meter, of the same type used in Ein Karem, was tested in the Aran laboratory: the results are shown in the graph below. The water meter doesn't measure at all up to 12 l/h so the measuring error is 100%. At 26 l/h the error curve reaches the ±5% range, defined by the aforementioned ISO standard as the permissible error between Qmin and Qt. According to this standard, for this particular type of water meter, Qmin is 50 l/h and so below this value no measuring error is defined.

An innovative solution to the problem of under measurement of flow at very low flow rates is the Unmeasured-Flow Reducer (UFR), a product of A.R.I. Flow Control, in which its main goal is to reduce the unmeasured flow through the water meter and hence reduce apparent losses.

Multi-jet Qn 2.5, low flow rate error curve



Purpose of the study in Ein Karem, Jerusalem

The main purpose of the study was to answer the following questions:

1. Is there in fact water flow, within the DMA, that the multi jet Qn 2.5, class B water meters, as described above, can't measure?
2. Can the UFR reduce the unmeasured flow?
3. Is the contribution of the UFR to the flow registration of the water meter significant?

Unmeasured flow through the multi jet, Qn 2.5, class B water meters of the DMAs in Ein Karem, Jerusalem

In order to find out if there is unmeasured flow, passing through the multi jet, Qn 2.5, class B water meters of Ein Karem, at low flow rates, a statistical test was conducted. The test procedure is as follows:

1. Verify that the water meter leak detector is stationary.
2. Close the shut off valve, before or after the water meter. (If the valve is old or faulty it might not seal, in that case this procedure is not reliable enough to determine if there is unmeasured flow or not).
3. Wait for about 60 seconds (during this time water would have drained from the household pipework, or as a leakage or as a low flow rate flow, for instance through a float valve into a water tank).
4. Open the shut off valve while watching the leak detector carefully. If there is a leakage in the household, the volume, equal to that of the drained water, will flow with enough energy to activate the water meter, and it will be seen on the leak detector. If there is no leakage, the leak detector will remain stationary.

Remark: This test is possible only for water meters with integral leak detectors.

This test showed that a large number of households have unmeasured water flows at low flow rates.

The author of this paper recommends that every water utility make this simple test, in order to understand if they have such a problem or not.

Possible reasons for low flow rates

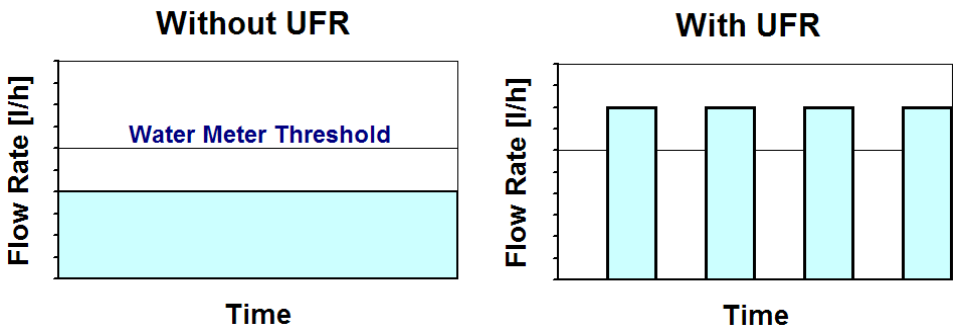
Leakages from: Taps, toilet tank seals, faulty pipework.

Filling (at a low flow rate) of: Water storage tanks, toilet tanks.

Unmeasured-Flow Reducer – (UFR)

What does the UFR actually do?

The UFR works by changing the way that the water flows through the water meter at low flow rates. Normally there is not enough energy in the flow to activate the water meter register at low flow rates. With a UFR installed the same flow is divided into measurable quantities of water that pass through the water meter at certain intervals, these quantities of water have enough energy to activate the water meter register and hence the flow is finally measured.

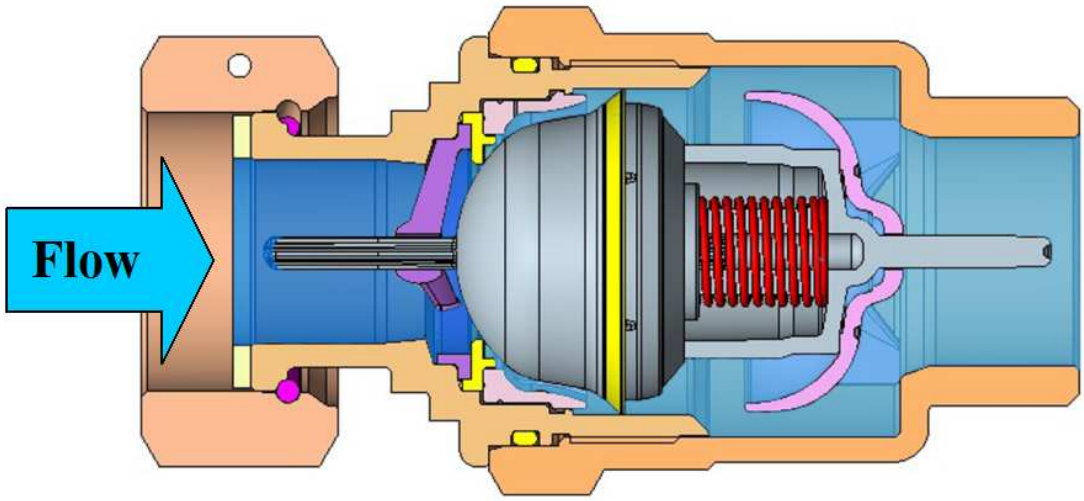


With a UFR installed, the water meter operates in cycles at low flow rates, where the water meter flow indicator (leak detector) is stationary most of the time and then rotates at regular intervals.

At higher flow rates (where the water meter operates satisfactory without the aid of the UFR), the UFR detects the higher flow rate and automatically goes into the override mode (i.e. the water meter measures flow as though the UFR was not installed in the water system). In the override mode the UFR (as in the low flow rate mode) also acts as a non-return valve, i.e. it closes when the downstream pressure exceeds the upstream pressure.

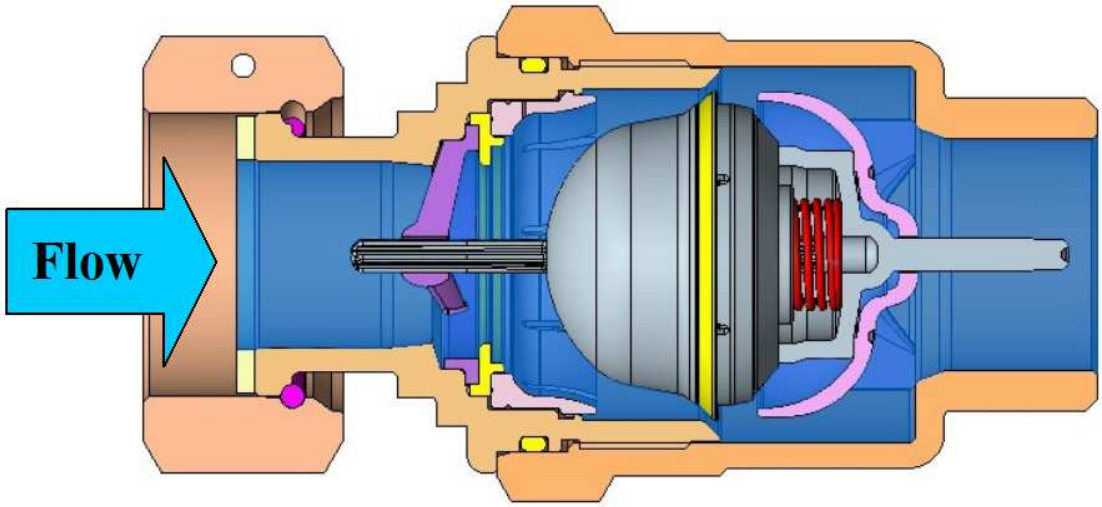
How does the UFR work?

The UFR is a differential non-return valve, designed in such a way that the pressure difference required to open it is more than that required to keep it open. The pressure difference to open the UFR is 0.4 bar, whilst the pressure difference to keep it open is 0.1 bar. When a leak develops the downstream pressure drops.



UFR closed; downstream pressure decreases because of leakage

When the downstream pressure drops below 0.4 bar of that of the upstream pressure, the UFR opens and allows for a flow rate above that of the measurement threshold.



UFR opens; downstream pressure equals that of upstream

The free flow of water through the UFR equalizes the pressure across the UFR and allows it to close. The continuing leak downstream to the UFR will make this operation repeat itself

over and over again.

Every time the UFR opens, a quantity of water passes through the water meter at a flow rate above the measurement threshold of the water meter and so the flow is measured.

Installation of UFRs in Ein Karem, Jerusalem

In March 2005, 120 UFRs and 360 UFRs were installed in two separate DMAs in Ein Karem, Jerusalem. The water meters in these DMAs are multi jet, Qn 2.5 class B.

The under registration percentage was recorded prior to and after the installation of the UFRs and is a comparison of the sum of the domestic water meter readings to that of the main water meter of the DMA. The table below summarizes the results.

Location	No. of Consumers	With or Without UFR	Period of Time [months]	Under-Registration [percent]
Ein Karem First DMA	120	Without UFR	8	16%
		With UFR	6	6.1%
		Contribution of UFR		9.9%
Ein Karem Second DMA	360	Without UFR	8	26%
		With UFR	6	18.8%
		Contribution of UFR		7.2%
		Average Contribution of UFR		**8.50%**

With respect to revenue calculations, it is very important to take into consideration the following:

Per litre, the reduction of apparent losses, after the water meter, is more cost effective than the reduction of real losses before the water meter. The reasons for this are:

- The loss of revenue due to one litre of water being unregistered by the water meter is substantially higher than the cost of supplying that same litre of water into the system.

- If water is billed according to a tier system, then the loss in revenue due to water meter under-registration will be according to the highest tier billed.

Conclusions:

Leakages and other unmeasured water flows at low flow rates were found in many of the households tested.

The UFR succeeded in the reduction of unmeasured flow and was found very effective in reducing apparent losses in Ein Karem, Jerusalem.

The contribution of the UFR to the flow registration of the water meter was very significant (8.5%).

In response to this study, the water company of Jerusalem decided to install UFRs in the city.

References:

F Arregui, E Cabrera Jr, R Cobacho., March 2006. Integrated Water Meter Management. London: IWA Publishing.

Reference Standards

ISO 4064-1, Second edition, 1993, Measurement of water flow in closed conduits – Meters for cold water – Part 1: Specifications