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# IN-SITU VERIFICATION TO REDUCE APPARENT LOSSES

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Supporting organisations:

RAND WATER PM WATER RESEARCH COMMISSION WRP



## OVERVIEW

IN-SITU METER VERIFICATION

- WHAT?
- WHY?
- WHERE?
- HOW?
- RESULTS AND FINDINGS

- CONCLUSION



## What is In-situ Meter Verification

- In-situ verification means that a unit or parameter can be measured in its position or onsite to determine if the performance of the meter is still in line with its original factory-calibrated values.
- Whether a meter is installed in a water or wastewater application, the accurate measurement of flow is a critically important requirement.
- An In-situ verification check does not calibrate a flowmeter but rather verifies the meter accuracy.
- This method provides means of checking flowmeter performance without the disruption and added expenditure associated with removing the meter and calibrating it in a laboratory.



## Why do we conduct In-situ verification

- All instrumentation, whether a flowmeter or another type of instrumentation, loses its accura time due to wear and tear and other factors stated below:
  - ✓ Meter Age
  - ✓ Incorrect installation
  - ✓ Incorrect pipe sizing
  - ✓ Inappropriate meter type
  - ✓ Low flow rates
  - ✓ Environmental impacts
- To correct this loss in accuracy, instrumentation needs to be regularly tested or verified, and re-calibrated if necessary.
- Regulation 131 of 2017 of the Department of Water and Sanitation requires that the accuracy of a water measuring device be "verified at least once every five years or for such period as required by the manufacturer"

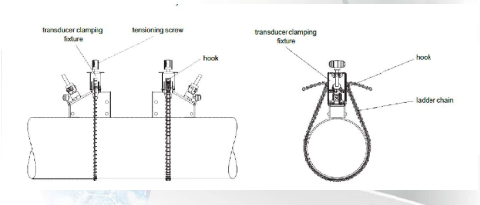
Common methods of verifying a flowmeter are:

- Using a master meter (Ultrasonic Clamp-on Meter)
- Volumetric calibration.



## How In-situ verification is conducted - Ultrasonic clamp-on meter

- A non-invasive device used to measure full pipe flow in closed conduits.
- These meters are unique in their ability to measure flow with little or no modification to existing pipe configuration






## Why do we conduct In-situ verification

- Using an ultrasonic meter to verify and re-calibrate your flowmeter is a valid method, but only if the ultrasonic meter itself has been recently calibrated, or verified and re-calibrated, through a process that can be traced back to some national or international standard.
- The South African National Accreditation System (SANAS) is mandated through the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act (Act 19 of 2006) to accredit calibration laboratories.
- Practical limitations of the meters performance and the limitations of the hydraulic system in which they are installed can restrict the flow range over which they can be tested/calibrated.

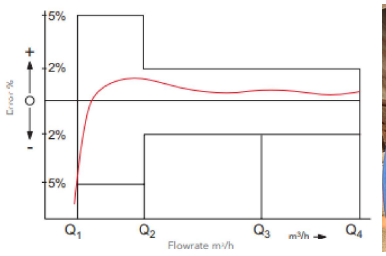
## Metrological Data – Xylem Water Meters

METROLOGICAL DATA ACC. TO MANUFACTURERS VALUES

| | Size | DN | 40 | 50 | 65 | 80 | 100 |
|---|---|---|---|---|---|---|---|
| $Q_s$ | Max. Peak Flow | m³/h | 60 | 90 | 120 | 200 | 300 |
| $Q_3$ | Continuous Flow | m³/h | 40 | 50 | 70 | 120 | 230 |
| $Q_{2h}$ | Transitional Flowrate horizontal | m³/h | 0.32 | 0.4 | 0.63 | 0.51 | 0.81 |
| $Q_{1h}$ | Minimum Flow horizontal | m³/h | 0.2 | 0.15 | 0.2 | 0.2 | 0.3 |
| $Q_{2v}$ | Transitional Flowrate vertical | m³/h | 0.4 | 0.51 | 0.81 | 0.8 | 1.28 |
| $Q_{1v}$ | Minimum Flow vertical | m³/h | 0.25 | 0.28 | 0.4 | 0.5 | 0.5 |
| | Starting Flow | m³/h | 0.05 | 0.05 | 0.07 | 0.1 | 0.11 |
| | Size | DN | 125 | 150 | 200 | 250 | 300 |
| $Q_s$ | Max. Peak Flow | m³/h | 350 | 600 | 1200 | 1600 | 2000 |
| $Q_3$ | Continuous Flow | m³/h | 250 | 450 | 800 | 1250 | 1400 |
| $Q_{2h}$ | Transitional Flowrate horizontal | m³/h | 1.02 | 1.6 | 4.0 | 6.3 | 16.0 |
| $Q_{1h}$ | Minimum Flow horizontal | m³/h | 0.5 | 0.8 | 2.0 | 3.5 | 9.0 |
| $Q_{2v}$ | Transitional Flowrate vertical | m³/h | 1.6 | 3.2 | 4.0 | 10.1 | 25.4 |
| $Q_{1v}$ | Minimum Flow vertical | m³/h | 1 | 1.6 | 2.5 | 6.3 | 15.9 |
| | Starting Flow | m³/h | 0.15 | 0.3 | 1.5 | 3 | 8 |



## Meter Design Curve






## Measurement principle and systems

- The measurement system consists of a transmitter, the ultrasonic transducers with the transducer cables and the pipe on which the measurement is conducted.
- The ultrasonic transducers are mounted on the outside of the pipe.
- Ultrasonic signals are sent through the medium and received by the transducers.
- The transmitter controls the measuring cycle, eliminates the disturbance signals and analyzes the useful signals. The measured values can be displayed, used for calculations and transmitted
- The transmission speed of an ultrasonic signal depends on the flow velocity of the carrier medium (water).



## The Transit - Time Difference Principle (Δt)

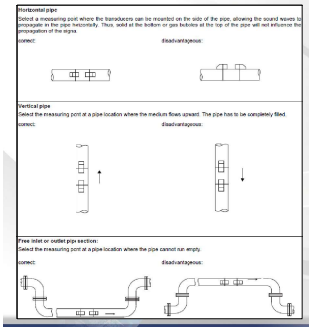
- Sound Speed (c) – Calculated from the measured time difference
- Flow velocity (v) – Calculated based on the measured transit-time difference (Δt).
- Volumetric flow rate (V) – Calculated by,
  V = (Pipe x-sectional Area)(flow velocity).
- Mass flow rate (m) – Calculated by,
  m = V x (operating Density of the medium).

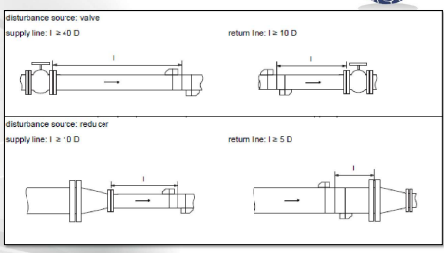
▪ *Note : Knowledge of quantities and their correct standard international units is required.*

## Methodologies to In-situ Verification Installations

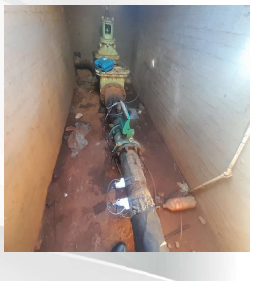
- Ultrasonic Meter should be calibration before utilising and ensure certificate is valid.
  - SANAS Accreditation
- Pipeline needs to be inspected
- Preparation of the pipe.
  - Cleaning and ensuring pipe
  - Removing any lining in position of transducers.
- Identify possible transducer positioning.

## Preparation for Installation



## In-situ Verification on Electromagnetic Flow Meters

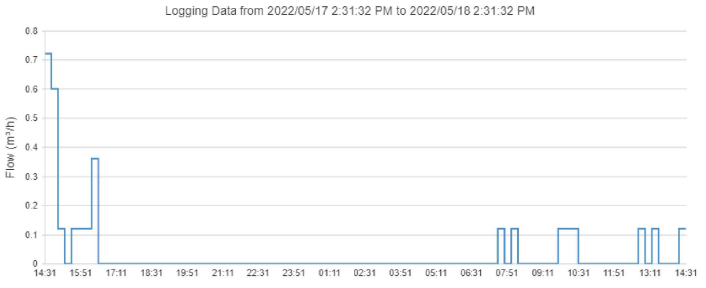

## In-situ Verification on Mechanical Flow Meters

## In-situ verification challenges/limitations

- Illegible meter dials.
- Damaged meter dials.
- Meter reading error where readings are captured manually.
- Incorrect scale factor considerations
  - 1 x m3, 10m3, x 100 m3

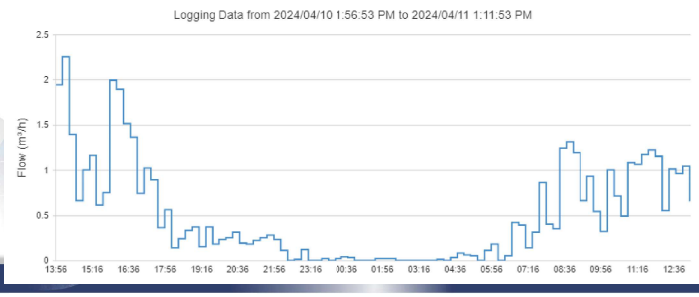
## Low Flow Rates

BEFORE




## Low Flow Rates

AFTER




## In-situ Meter Verification Errors

- All water meters must also be verified to prove that the measurement of water used is accurate to within +/- 5% error margin, this however is depended on various factors such as meter age, flow rates, environmental impacts, meter size.
- To achieve this level of accuracy, the correct verification method must be selected for each installation.

## In-situ verification measurement errors

- These can be caused by non-uniform pipe thickness, differing water temperature, air bubbles, oval pipe.
- Signal between transducers and pipe work, low signal strength caused by pipe makeup, pipe build up rust.
- To do this, record site details will need to be kept on dimensional characteristics of the pipe, set-up parameters, diagnostics parameters and relevant observations.
- This data can then be used to verify or confirm measurements made on site and reduce the potential for human error.



## Percentage error margin Calculations

- $\text{Percentage Error} = \left[\frac{\triangle \textit{Meter Readings}}{\triangle \textit{UDM Readings}} - 1\right] \text{x } 100\%$

- Meter Consumption = △Meter Readings
- UDM Consumption = △UDM Meter Readings



## Relative Error - Calculations

- The ultrasonic clamp-on meter is considered the true measurement (known).
- Bulk Meter is the observed measurement.

Verification consideration (Ultrasonic Meter)

- Start reading & end reading remains the same. Verification is considered as: No Flow

Error margin within -5% and +5%

Error % = -100

## In-situ verification results

| Consumer Name & Address | Meter Serial No | Start Date | Completion Date | Start Reading (m³) | | Completion Reading (m³) | | Consumption (m³) | | Consumption Difference (m³) | Error in % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ultrasonic Meter | Consumer Meter | Ultrasonic Meter | Consumer Meter | Ultrasonic Meter | Consumer Meter | | |
| Verification 1 | SN 2984471 | 2024/04/10 | 2024/04/11 | 36041,352 | 2012,956 | 36053,185 | 2030,429 | 11,833 | 17,473 | 6,040 | -34,58% |
| Verification 2 | SN 9826511 | 2024/04/10 | 2024/04/11 | 1132,490 | | 26029,219 | | 24896,729 | 0,000 | -24896,729 | -100,00% |
| Verification 3 | SN 8729363 | 2024/04/10 | 2024/04/11 | 490837,332 | 605455,260 | 490045,510 | 610373,220 | 5208,178 | 4917,960 | -290,218 | -5,58% |
| Verification 4 | SN 34517431 | 2024/04/10 | 2024/04/11 | 765371,980 | 5253481,360 | 782371,236 | 5270879,080 | 16999,376 | 17397,720 | 398,344 | 2,34% |
| Verification 5 | SN 56281900 | 2024/04/11 | 2024/04/12 | 26048,41 | 1107943,76 | 34816,88 | 1115444,240 | 8770,469 | 7500,480 | -1269,989 | -14,48% |
| Verification 6 | SN 09271734 | 2024/04/11 | 2024/04/12 | 782377,271 | | 785542,471 | | 3165,200 | 0,000 | -3165,200 | -100,00% |
| Verification 7 | SN 13273482 | 2024/04/11 | 2024/04/12 | 496046,307 | 121077,160 | 496434,838 | 121468,240 | 388,531 | 391,080 | 2,549 | 0,66% |
| Verification 8 | SN 21394676 | 2024/04/11 | 2024/04/12 | 36054,145 | 568317,820 | 36710,952 | 570860,500 | 2656,807 | 2542,680 | -114,127 | -4,30% |
| Verification 9 | SN 4648299 | 2024/04/16 | 2024/04/17 | 500296,545 | 1225794,650 | 509350,807 | 1234741,320 | 9054,26 | 8946,67 | -107,59 | -1,19% |
| Verification 10 | SN 8321945 | 2024/04/16 | 2024/04/17 | 42368,946 | 146105,460 | 43027,393 | 146760,050 | 658,55 | 654,59 | -3,96 | -0,60% |
| Verification 11 | SN 83491210 | 2024/04/16 | 2024/04/17 | 789887,667 | 696854,130 | 793737,375 | 700852,680 | 3849,71 | 3998,55 | 148,84 | 3,87% |
| Verification 212 | SN 3839016 | 2024/04/16 | 2024/04/17 | 34878,325 | 32091,000 | 35145,967 | 32346,290 | 266,64 | 255,29 | -11,35 | -4,26% |

## METER ACCURACY ERROR

- Meter Age
- Incorrect installation
- Incorrect pipe sizing
- Inappropriate meter type
- Low flow rates
- Environmental impacts



## In-situ meter verification installations



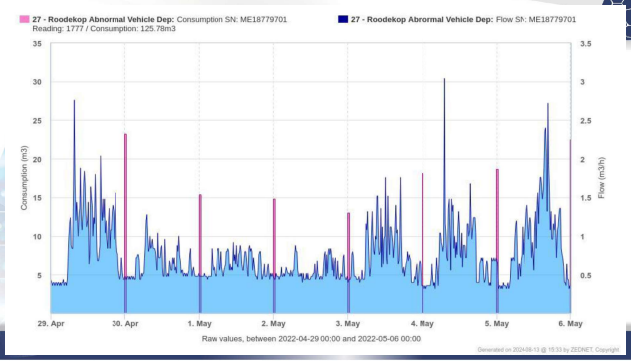

## Meter inaccuracies due to broken or incorrect customer and water meters.



## Bulk Meter Findings




## Low Flow Rates





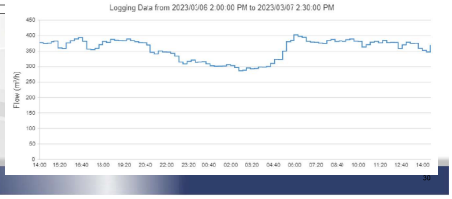

## Low Flow Rates

| | |
|---|---|
| Meter Size | 100 |
| Make | Sensus Meistream |
| Pipe O/D | 114.9 |
| Pipe Thickness | 5.8 |
| Lining Material & Thickness | No Lining |
| Transducer Spacing | 34.7 |
| Date Installed | 2022/04/28 10:43:00 AM |
| Date Removed | 2022/04/29 10:59:00 AM |
| Duration Of Operation | 1 days 0 hours 12 minutes |
| Path Method & Traverse | 3 Diagonal |
| Sensors | Standard |
| Meter Reading Start (m³) | 1 940.8200 |
| Meter Reading End (m³) | 1 963.3000 |
| Meter Consumption (m³) | 22.6800 |
| Ultrasonic Start (m³) | 124 815.5000 |
| Ultrasonic End (m³) | 124 832.7240 |
| Ultrasonic Consumption (m³) | 17.2240 |
| Difference Between Meter & Ultrasonic (m³) | 5.4560 |
| Error % | 31.68% |



## In-Verification Flow Impacts

| | |
|---|---|
| Meter Size | 100 |
| Make | sen |
| Pipe O/D | 114.9 |
| Pipe Thickness | 4.5 |
| Lining Material & Thickness | No Lining |
| Transducer Spacing | 108 |
| Date Installed | 2023/03/08 1:06:00 PM |
| Date Removed | 2023/03/07 2:05:00 PM |
| Duration Of Operation | 1 days 0 hours 47 minutes |
| Path Method & Traverse | 2 Reflection |
| Sensors | Standard |
| Meter Reading Start (m³) | 1 507 211.9200 |
| Meter Reading End (m³) | 1 541 222.4000 |
| Meter Consumption (m³) | 9 060.0000 |
| Ultrasonic Start (m³) | 1 193.0350 |
| Ultrasonic End (m³) | 9 193.0300 |
| Ultrasonic Consumption (m³) | 8 856.2600 |
| Difference Between Meter & Ultrasonic (m³) | 274.6100 |
| Error % | 3.14% |

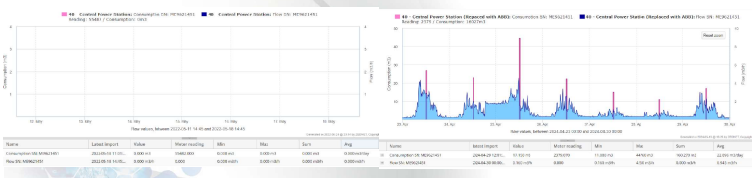




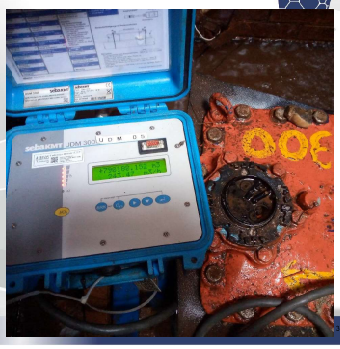

## Low Flow Rates

BEFORE

AFTER



## Meter Conditions – Vandalized meters, broken dials





## Conclusion

- In-situ verification plays a pivotal role in ensuring the accuracy of water meters, which directly impacts the reliability of billing systems.
- Regular field checks and calibration of meters enable utilities to identify and address potential issues before they escalate.
- In-situ verification provides valuable data that can be used to identify patterns and trends in meter performance across the distribution network.
- This data-driven approach allows utilities to make informed decisions about meter management, optimize maintenance schedules, and invest in upgrades that further reduce NRW.
- Investing in in-situ verification processes can lead to substantial long-term savings by reducing the need for extensive system overhauls or costly corrections of billing errors.




If you can't measure it. You can't manage it



## THANK YOU