Metrology for Real-World
Domestic Water Metering

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Guides, recommendations for assessing water meters close to operation conditions

Further need(s) (or proposals) for action from the perspective of ISO/OIML/WELMEC

Content

- Technical guide for the assessment of the performance of domestic water meters under dynamic load changes beyond the current OIML R49 methods
- Good Practice Guide for testing domestic water meters with different water qualities (i.e. hardness, pH and particles such as rust, sediments)
- Conclusions, outputs
- Further open questions outside the project
- Standardization bodies influenced by results of the project

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Actions done during the project

- Development of load profiles based on consumption measurements onsite
- Development of test rigs for water meter measurements under dynamic load changes – new or modification of test rigs of partners and validation by the pilot study EURAMET project No. 1506
- Validation of test rigs for static flow by the comparison EURAMET project No. 1507
- Development of testing protocols, flow profiles, water mixtures and reference conditions
- Analysis of the results and recommendations (proposals) for testing

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Recommendation for realisation of test rigs under dynamic load changes

- changing flow rate within 1 s – it means changing flow rate for maximum flow rate change of 1000 l/h and lower flow rate changes in 0.1 s to 0.3 s
- from 0 l/h up to almost instantaneous flow rate change of (at least) 1000 l/h to be realized with one test rig
- recommended temporal resolution of monitoring changes in reference value equal or better 0.3 s
- reference: high resolution is required in grams, litres, ms
- temperature during measurements: 20 °C $\pm$ 2 °C.

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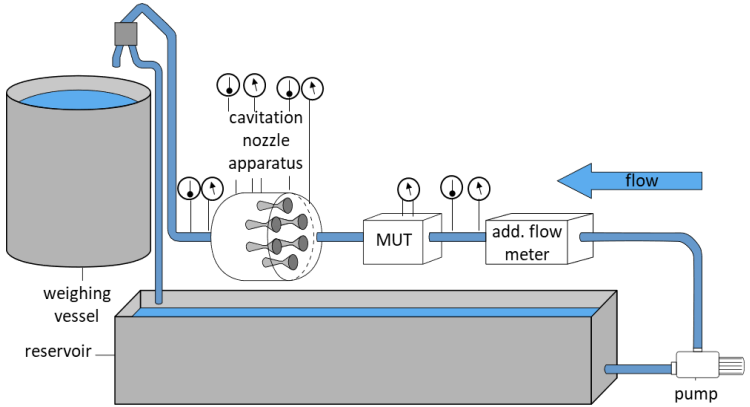
Test methods and flow change technologies

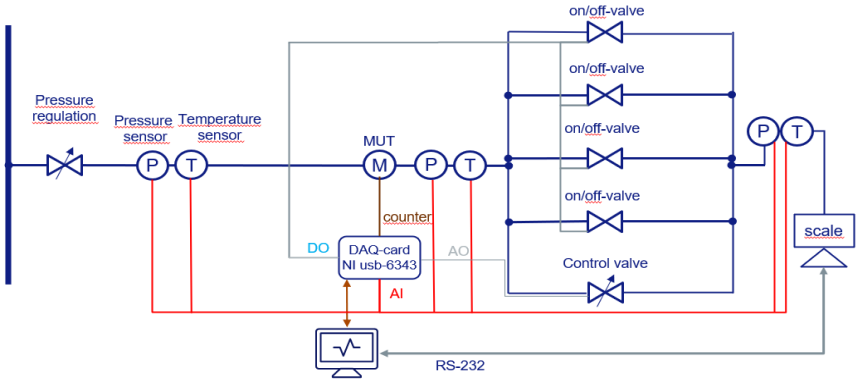
- Gravimetric reference and cavitation nozzles



		Technical requirements
Flow generator	Pump	Maximum flow 1000 l/h to 3000 l/h
Measuring volume	Weighing vessel	≥ 120 kg
Temperature	Temperature sensors	(10 to 30) °C
Temperature stability	Cooling system	≤ 1 °C
Pressure	Pressure sensors	1 bar to 6 bar
Flow change generator	Fast valves	< 1 s for (0 to 10) m^3/h
Sampling rate system		100 ms

Test methods and flow change technologies

- Gravimetric reference and fast valves



		Technical requirements
Flow generator	Pump	Maximum flow 1000 l/h to 3000 l/h
Measuring volume	Weighing vessel	≥ 120 kg
Temperature	Temperature sensors	(10 to 30) °C
Temperature stability	Cooling system	≤ 1 °C
Pressure	Pressure sensors	1 bar to 6 bar
Flow change generator	Fast valves	< 1 s for (0 to 10) m^3/h
Sampling rate system		100 ms

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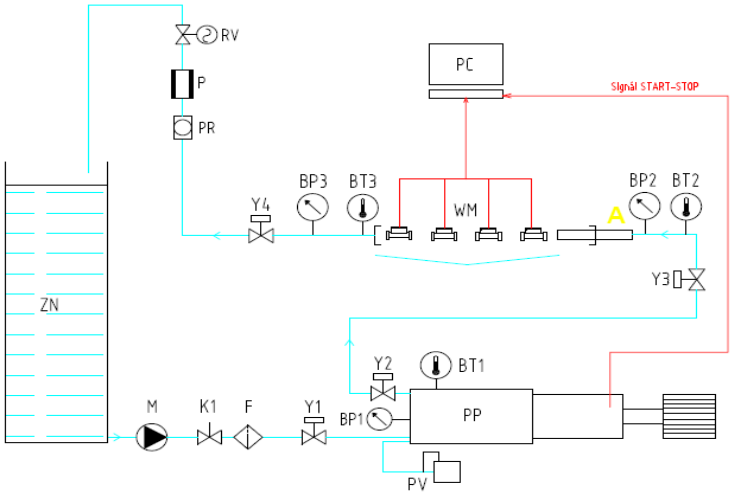
Test methods and flow change technologies

- Volumetric piston prover reference and fast piston position changes



		Technical requirements
Flow generator	Piston prover	Maximum flow 1000 l/h to 5000 l/h
Measuring volume	Piston prover	≥ 100 L
Temperature	Temperature sensors	(10 to 30) °C
Temperature stability	Cooling system	≤ 1 °C
Pressure	Pressure sensors	1 bar to 6 bar
Flow change generator	Piston prover	≤ 1 s for 5 m^3/h
Sampling rate system		100 ms

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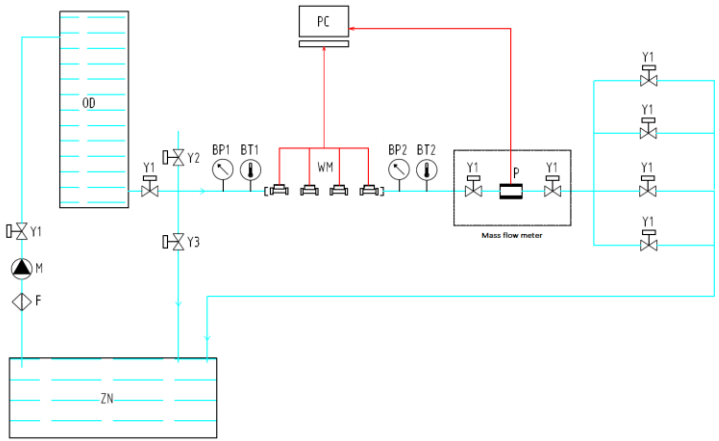
Test methods and flow change technologies

- Mass flow meter reference and fast valves



		Technical requirements
Flow generator	Pump	Maximum flow 1800 l/h
Measuring volume	Mass flow meter	≥ 100 L
Temperature	Temperature sensors	(10 to 30) °C
Temperature stability	Cooling system	≤ 1 °C
Pressure	Pressure sensors	1 bar to 8 bar
Flow change generator	Fast valves	≤ 0.1 s
Sampling rate system		100 ms

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Proposals for testing and test protocols for dynamic load changes

- The following data are required to be recorded during the test
  - Actual flow profile, number of cycles
  - Initial supply pressure
  - Temperature during the test
  - Volumes (indicated, actual)
- To cover range of flow rate of tested water meter
- To use an agreed dynamic load profile or two different dynamic flow profiles.

Determination of errors (of indication) by load profiles application

		At start	At end	
Application No.:	Ambient temperature:			°C
Model:	Ambient relative humidity:			%
Date:	Ambient atmospheric pressure:			MPa
Observer:	Time:			

Test method:	
Load changes technology:	
Volume measures/weighbridge used - m^3 or kg:	
Water conductivity (electromagnetic induction meters only) - S/cm:	
Length of straight pipe before meter (or manifold) - mm:	
Length of straight pipe after meter (or manifold) - mm:	
Nominal diameter DN of pipe before and after meter (or manifold) - mm:	
Describe flow straightener installation if used:	

Meter serial No.: **Orientation (V, H, other):**

Flow direction: **Location of indicating device:**

Application conditions	Actual flow profile	Initial supply pressure	Average temp.	Initial reading water meter	Final reading water meter	Indicated volume water meter	Actual volume reference	Error relative water meter	MPE
			T_w	$V_i(i)$	$V_i(f)$	V_i	V_a	E_m	
	L	MPa	°C	m^3	m^3	m^3	m^3	%	%
Flow profile 1									
Flow profile 1									
Flow profile 1									
							$\bar{E}_{m2}$		
							$\bar{E}_{m3}$		

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Recommendation for testing with different water qualities

- Preparation of the test waters - *Mixing recipes*
- There are two ways how a good mixing of water and chemicals:
  - The devices under test are installed in a bypass line and the pump of the rig is set to a much higher flow rate and most of the water is pumped back into the storage tank
  - A storage tank with a sufficiently large capacity is filled with water of a defined quality

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Recommendation for testing with different water qualities

- Two regimes can be used:
  - a static test regime in which the flow rate is kept constant based on size of water meter (at 750 L/h for Q3 2.5 m3/h) and
  - a dynamic test regime in which a flow profile is repeatedly run by dynamic flow profile (also dependededs on size of meter)
- Test points should cover the relevant measuring range of the water meter
  - from minimum (Q1) to maximum (Q4)
- Accuracy measurements before and the endurance test,
- Reference conditions

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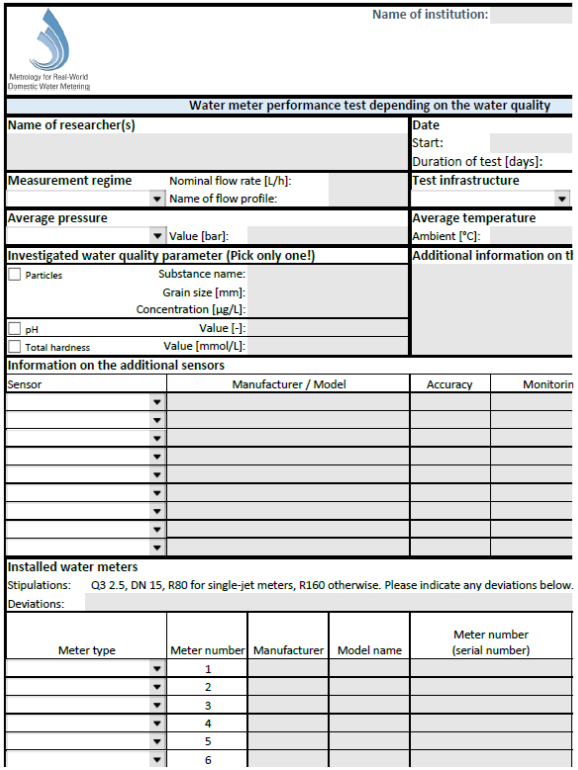
Proposals of test protocols for testing with different water qualities

- When performing the endurance test, it is important that the following parameters are logged, at minimum:
  - flow rate,
  - liquid temperature,
  - liquid pressure upstream and downstream,
  - indicated volume,
  - number of cycles run during dynamic tests
- In addition, pH and total hardness of the test water need to be measured regularly.



Name of institution:

Metrology for Real-World Domestic Water Metering

Water meter performance test depending on the water quality

Name of researcher(s)	**Date** Start: Duration of test [days]:
Measurement regime Nominal flow rate [L/h]: Name of flow profile:	**Test infrastructure**
Average pressure Value [bar]:	**Average temperature** Ambient [°C]:
Investigated water quality parameter (Pick only one!) ☐ Particles — Substance name: Grain size [mm]: Concentration [µg/L]: ☐ pH — Value [-]: ☐ Total hardness — Value [mmol/L]:	**Additional information on t**

Information on the additional sensors

Sensor	Manufacturer / Model	Accuracy	Monitorin

Installed water meters

Stipulations: Q3 2.5, DN 15, R80 for single-jet meters, R160 otherwise. Please indicate any deviations below.

Deviations:

Meter type	Meter number	Manufacturer	Model name	Meter number (serial number)
	1			
	2			
	3			
	4			
	5			
	6			

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Conclusions

- Based on results of the project, it should be discussed if meters ought to be tested and calibrated closer to real-world and not under laboratory conditions as is currently the case
- The quality of the water that passes through a household water meter in the course of its life cycle can have a significant influence on its measurement accuracy and thus on its service life
- For Central Europe, a proposal for such a test procedure related to chemo-physical water properties has been developed
- Based on analysis from the results proposals for a new test regimes are provided
- Cold water was used in all measurements. Regarding hot water, a similar procedure should be suitable
- The determination of the maximum permissible error (MPE) for measurements under dynamic load changes for example by weighing mean for MPE 5 % and 2 % is a further task for international committees dealing with water metering

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Further open questions outside the project

- Issues already presented with some agreed proposals
  - review of non-exploitation of the MPE (agreed by WELMEC and CEN)
  - testing of the mechanical water meters - (agreed by WELMEC and CEN)
    - Definition of horizontal position and relating testing
    - Required samples for testing
    - Calculation of standard deviation
    - Static pressure test in relation to water meters temperature classes
    - Testing related various rations R (Q3/Q1)

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Further open questions outside the project

- In the stage of proposal
  - Sampling mode of electronic water meters
  - Special equipment or additional tool in connection with Annex 1, article 7.6 MID
  - Life time of the water meters and thermal energy meters
  - Testing of electronic water meters
    - Software testing outside MID, missing information in OIML R49 and ISO 4064
    - Some issues of EMC testing for electronic meters
    - AC mains voltage dips, short interruptions and voltage variations (OIML R-49 , ISO 4064 chapter 8.8)
    - EMC testing - performance tests related to influence factors and disturbances - cases A to E (OIML R-49 , ISO 4064 chapter 8)

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Standardization bodies influenced by results of the project

- **ISO/TC 30/SC 7** has set up a Working Group for the general review of ISO 4064 (initially Parts 1 and 2) and the results from MetroWaMet will be included in the discussions. An impartial Project Leader has been appointed.
- **OIML/TC 8/SC 5** has submitted a proposal to set up a Working Group for the general review of OIML R 49. The proposal will be considered in October. The review will take place in parallel with the review of ISO 4064 to ensure the standards remain harmonized
- **The BSI mirror committee** for ISO/TC 30/SC 7, CPI/30/7, has a meeting arranged for the week after the workshop to discuss the likely impact on ISO 4064 and OIML R 49
- **WELMEC WG13** works continuously at regular meetings and addresses issues related to establishment a common understanding which supports the implementation of European regulatory framework on metrology. WELMEC WG13 works closely with **CEN/TC 92/WG 2** and addresses open issues related to standardization in joint meetings. Another joint meeting is scheduled for February 2022. The results from MetroWaMet will be included in the discussions

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