HEAT METER LABORATORY OF ENERGETIKA LJUBLJANA D.O.O.

Technical characteristics andcapabilities of testing facilities

The laboratory for heat meters, of the heat supply sector of Energetaika Ljubljana, carries out certification of heat meters as the only laboratory in the Republic of Slovenia. He has obtained accreditation and designation from MGRT - Office for Metrology of the Republic of Slovenia.

Control/testing procedures of measuring instruments in the laboratory comply with national, OIML and EN documents and standards (EN 1434 for heat meters, OIML R75 for heat meters and OIML R49 for water meters)

Number of persons employed in the lab: 5

Approximate number of verifications in the lab per year: cca 4500

Average time elapsed between submission of meter and completion of documentation: 7 days

Accessibility:

- for any customers.

Meters for which application:

- cold water meters (potable water): yes
- hot water meters: yes
- heat meters: yes

Main purpose of testing facility:

- for scientific investigations (traceability measurements, endurance tests, influences of flow profile, test of the installation components e.g. valves, etc): yes
- for calibrations (special / common): not any more
- for verifications (initial / subsequent): yes

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ACCREDITATION: SIST EN ISO/IEC 17020

The heat meter laboratory was built in 1991 and 2009- the testing device for complete heat meters. In laboratory are 4 **testing devices**:

- **Volukal** in fig. 1. for testing and calibration of flow sensors of heat meters and cold and hot water meters.

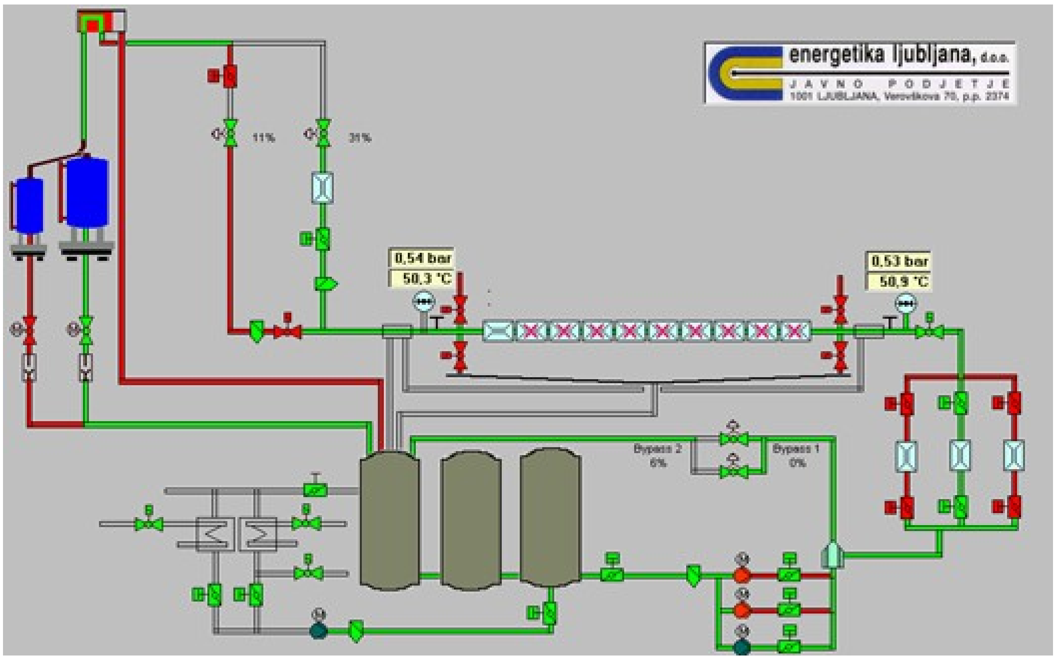

Fig. 1: Basic circuit diagram of the test facility for flow sensors and water meters

 Characteristics of testing facilities and calibration capabilities

- Flow range / nominal pipe size: 6 l/h …..160 000 l/h ; DN 150
- Pressure range / pressure settable yes/no: ≤ 5 bar / settable yes

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- Temperature range / temperature settable yes/no: 20°C ≤ t ≤ 75°C / settable yes
- Liquid (water from supply, distilled/deionised water, treated water e.g. with additives or with glycol, conductivity μS/cm): water from district heating net (demineralisated water) in water tanks, conductivitiy nearly 150 μS/cm at 50°C
- Measured quantities
  - Volume flow: - yes
  - Volume: yes
  - Mass: yes
- Mode of measurement
  - flying start/stop: yes
  - standing start/stop: yes
  - gravimetric : balances
  - volumetric : master meters (electromagnetic meters-MID)
- Conversion mass→volume resp. volume→mass: density calculation/density standard: density calculated by H.Bettin, F Spieweck: Die Dichte des Wassers als Funktion der Temperatur nach Einführung der ITS 90, PTB – Mitteilungen Nr. 3/1990.
- traceability of standards, calibration intervals: The reported measurement results are traceable to national standards and thus to interantionally units (SI).
- stability of flow rate, temperature and pressure: < 0,2% ; 0,5 K; 0,2 bar
- mode of operation:

  - supply tanks : basement (7 m^3)
  - pumps and their power: 3 centrifugal pumps

Types of flow sensors under test: all types and principles (US meters, MID, Coriolis, mechanical ....)

- Restriction to special interfaces between flow sensors under test and testing facility: interfaces for the most common flow sensors present
- measurement uncertainty of testing facilities/procedures in use – BMC (*P* =95 %):

  6 l/h ≤ q ≤ 25 l/h ; ≤ 0,3 %

  25 l/h < q ≤ 100 l/h ; ≤ 0,3 %

  100 l/h ≤ q ≤ 160 m^3/h ; ≤ 0,2 %

The testing rig is shown in Fig 1. and consists of three storage tanks with a total volume of ca. 7 m^3 for the warm water mode up to 75 °C.

For the verification of cold water meters is possibility to cooling the water with cooling agregate or with network water through the heat exchanger.

Primary measuring for the test volume are weighing instruments working according to the principle of electromagnetic force compensation. They determine the reference volume and does the measurement deviation with regard to density.

The weighing instruments as well as the temperature sensors installed in the test facility are calibrated regular time intervals.

The verification - testing procedure for flow meters / water meters can be carried out by different methods.

In the "Flying mode" the flow will be built up to the value by which the water meters will be tested later. The water is deflected back to the storage tank immediately. Having reached stationary conditions which are characterised by constant flow and constant temperature conditions the water is deflected to the preselected weighing instrument in a certain period of time. After reaching the chosen testing volume the water is deflected again past the weighing instruments into the storage tanks.

In the "Start-stop mode" the flow is rising fast from zero to the reference value and the water is deflected on one of the two weighing instruments. After reaching the reference value the flow is also reduced quickly to zero.

Well as in "Flying mode" as in "Start-stop mode" weighing instruments are generally used as measuring standards. But it is also possible to use master meters as measuring standards in all modes. As a rule, the testing is done in "Flying mode" by means of a weighing instrument. The measuring procedure is controlled by the meter(s) to be tested themselves by triggering a start pulse for the comparison measurement with the master meter. The pulse rate of the master meter is very high usually leading to a high resolution of the comparison measurement.

At each testing point, the measuring deviation of the master meter is determined by the weighing instrument. On the whole the determination of the measuring deviation of the

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meter to be tested depends on the calibration of the weighing instrument used, the accuracy of the determination of density as well.

Flow meter control procedures are performed in accordance with applicable standards and recommendations - below:

EN 1434-5: 2022

EN 1434-5:2022 (E)

6.2 Flow sensors

The verification of the flow sensor shall be carried out within each of the following flow rate ranges at a liquid temperature of (50 ± 5) °C for heating applications and (15 ± 5) °C for cooling applications.

a) $q_i \leq q \leq 1{,}2\, q_i$

b) $0{,}1\, q_p \leq q \leq 0{,}11\, q_p$

c) $0{,}9\, q_p \leq q \leq 1{,}1\, q_p$

If the pattern approval certificate so provides, the verification may be carried out with cold water in accordance with the procedures laid down in the certificate.

When testing the flow sensors, the guidelines in the pattern approval certificate shall be followed (e.g. requirements for water conductivity, water temperature, straight inlet/outlet tubes).

To enable rapid testing of the flow sensor, it is customary to bypass the output signal used by the calculator. However, for at least one test, this signal shall be included.

Test of flow sensors shall be done above minimum operation pressure specified by the manufacturer with examination of absence of cavitation.

- **Termokal** in fig. 2. for testing and calibration of platinum temperature sensors of heat meters.

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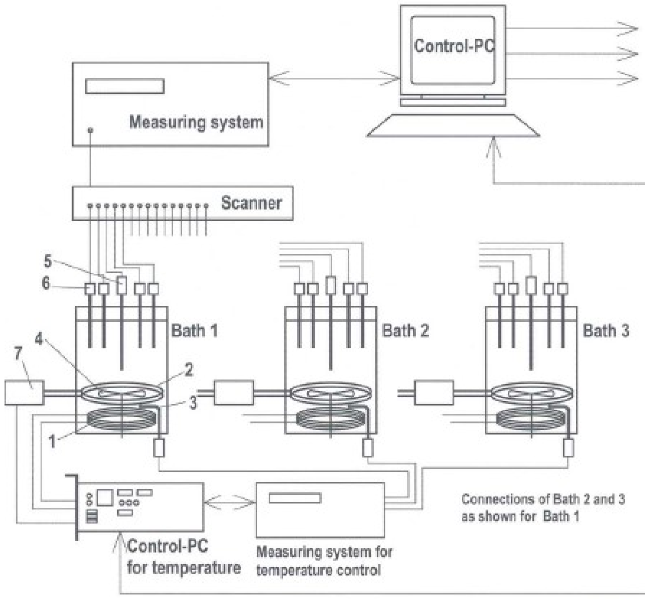

Fig. 2: TERMOKAL - Test plant for temperature-sensors

Specifications:

- Temperature range: 0°C to 180°C
- Temperature-unformity in the testing zone: better than ±10mK over 15 min.
- BMC (k=2): better than 0,03°C
- The Pt25 reference sensors have a time stability of 5 ppm/year.
- They (Pt 25) also have a low temperature coefficient of 1 ppm/°C

The test plant Termokal developed by the AUSTRIAN RESEARCH CENTERS SEIBERSDORF is a calibration plant for platinum resistance thermometers. Up to 12 thermo-meters of all common nominal values from 25 to 1000 Ohm can be tested simultaniously in the temperature range between 0°C to 180 °C.

The Termokal-plant consists of:

- 3 + 1 precision calibration baths
- a measuring system
- software for control of the plant

Calibration bath:

The calibration baths are of cylindrical design, made of stain-less steel. A mixing wheel, arranged at the bottom of the bath, ensures a constant flow and a uniform temperature distribution. The temperature of the bath is controlled by integrated cooling and heating-coils.

The geometrical design of the baths was developed, optimized and tested by the AUSTRIAN RESEARCH CENTERS SEIBERSDORF over many years, to ensure optimum flow as well as highest temperature distribution stability (spatial and temporal). The homogeneity of the temperature profile in the measuring area of the bath is periodically checked.

Measuring system:

The resistance of the sensors to be tested is measured by comparing the voltage drop at the specimen and at a high precision reference resistance with injected current. Disturbances are eliminated resp. compensated by opti-mum choice of materials and measuring technology.

The measuring system consists of high resolution digital voltmeter, PC, current source and reference sensors for the temperature of the bath.

Temperature sensors control procedures are performed in accordance with applicable standards and recommendations - below:

EN 1434-5: 2022

6.3 Temperature sensor pair

6.3.1 Error in temperature difference

The individual temperature sensors of the temperature sensor pair shall be tested, without their pockets, in the same temperature bath at temperatures within each of the three temperature ranges in Table 1.

Table 1 — Test temperature ranges

Test points	Test temperature range	
θ_1	$\theta_{\min}$ to $\left(\theta_{min} + 10K\right)$	
θ_2	$\frac{\theta_1 + \theta_3}{2} \pm 5K$	
θ_3	$\theta_{max} \le 150°C$	$\left(\theta_{max} - 10K\right)$ to $\theta_{\max}$
	$\theta_{max} > 150°C$	$\left(\theta_{max} - 30K\right)$ to $\theta_{\max}$ but in any case more than 140 °C

NOTE If specified in the pattern approval certificate, variations in the temperature ranges and the number of temperatures are permissible.

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- **Kompukal** in fig. 3. for testing and calibration of calculators of heat meters.

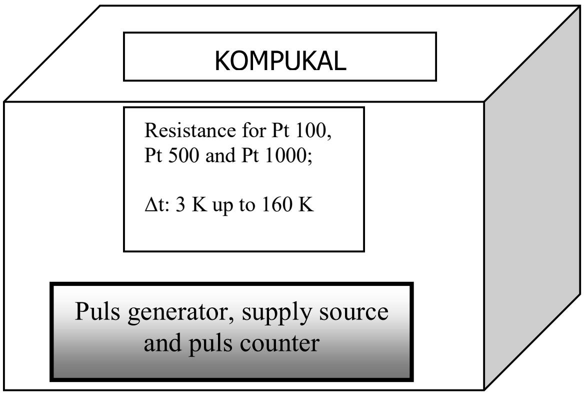

Fig 3: Kompukal: testing device for heat meter calculators.

Testing device Kompukal is simulator for temperature difference and volume pulses for calibration and control of heat meters calculators.

Specification:

- Resistances for simulation for temperature differences for Pt 100, Pt 500, and Pt 1000;
- Δt: 3 K ..... 160 K
- time stability of 5 ppm/year.
- low temperature coefficient of 1 ppm/°C
- Contact resistance is better than 0,6 mOhm.

The testing device Kompukal simulates the temperature difference (supply/return) and flow. From the tested computing unit, it measures HF pulses - energy pulses (kWh) at simulated values over a period of time.

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The procedures for checking the calculation units of heat meters are carried out in accordance with the applicable standards and recommendations - below:

EN 1434-5: 2022

6.4 Calculator

The calculator shall be tested, at least within each of the following temperature difference ranges:

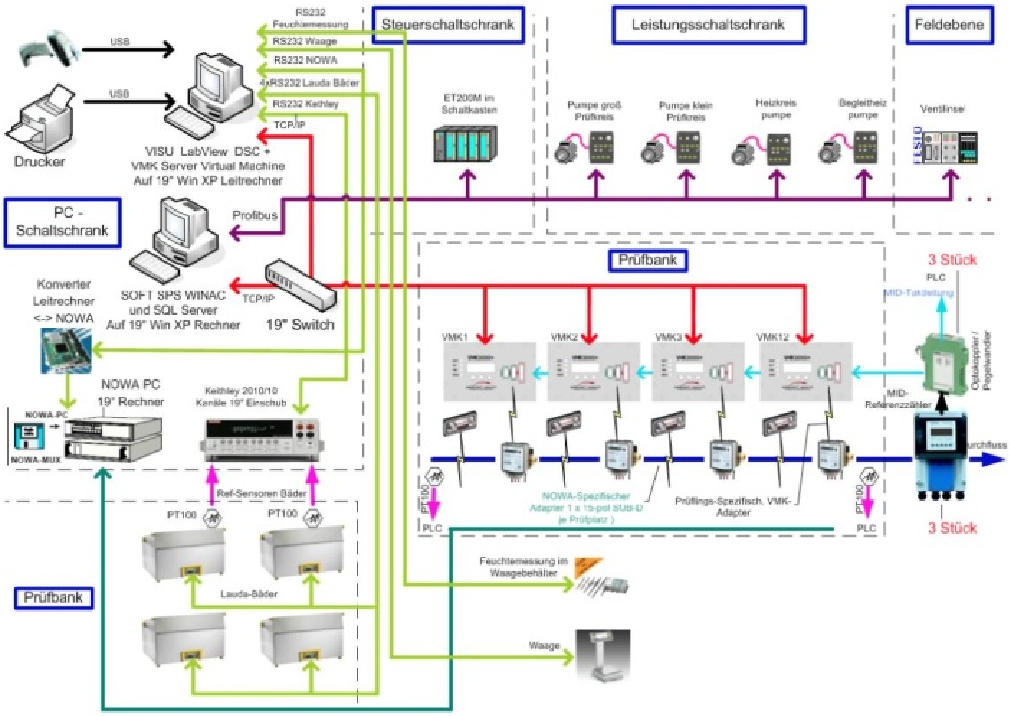
For heating applications:

a)	$\Delta\Theta_{min}$	$\leq \Delta\Theta \leq$	$1{,}2\ \Delta\Theta_{min}$
b)	10 K	$\leq \Delta\Theta \leq$	20 K
c)	$\Delta\Theta_{max}$ - 5 K	$\leq \Delta\Theta \leq$	$\Delta\Theta_{max}$

ENERKAL: Since 2009 we have special test equipement for kompakt heat meters and cool meters.

One of the test devices in the laboratory is the so-called Enerkal, where accuracy control is carried out based on energy measurements, under realistic operating conditions. During the test, the flow of hot water (50 +/- 5°C) is established through the flow meter, and the temperature difference Δt between the supply and return is established through immersed temperature sensors in the thermostatic bath (at temperatures between 50°C and 130°C). The result is a comparison of the measured amount of thermal energy on the meter with the reference amount achieved with standards, in a certain time interval, at three flows and three Δt.

The scheme of the Enerkal system is shown in the diagram below (in German language)



Such a process requires high-end hardware and information software, verified reference equipment that is traceable to the international level. At the same time, the system must enable the synchronization of all components on the side of the test site to each test subject. Everything must be in accordance with the procedures required by EU standards and other normative documents in the field of heat meters certifications (OIML). The measurement uncertainty of the measurements must be less than 1/5 of the permissible measurement error of the heat meter being tested.

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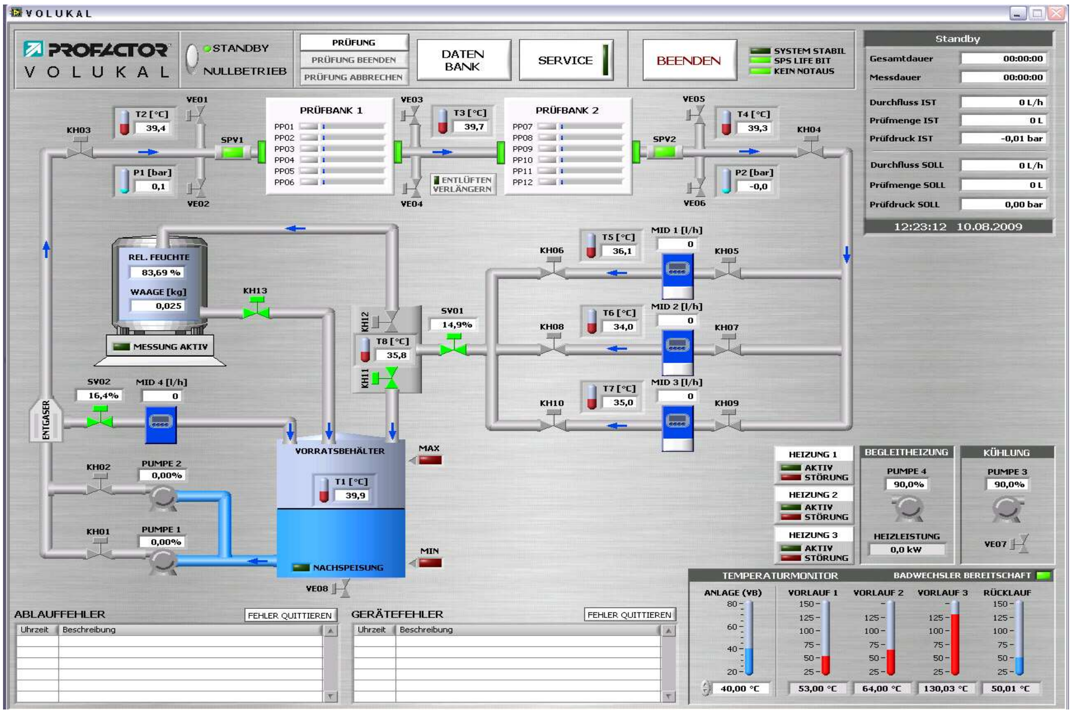
Schematic of the main components of the test rig Enerkal:



During the measurement, the robotic arm moves the temperature sensors from one bath to another.

The procedures for checking the calculation units of heat meters and complete meters are carried out in accordance with the applicable standards and recommendations - below:

EN 1434-5: 2022

6.7 Complete meter

The verification of the complete meter shall be carried out, at least within each of the following ranges.

For heating applications:

a)	$\Delta\Theta_{min}$	$\leq \Delta\Theta \leq$	$1{,}2\ \Delta\Theta_{min}$	and	$0{,}9\ q_p$	$\leq q \leq$	$1{,}1\ q_p$
b)	10 K	$\leq \Delta\Theta \leq$	20 K	and	$0{,}1\ q_p$	$\leq q \leq$	$0{,}11\ q_p$
c)	$\Delta\Theta_{max}$- 5 K	$\leq \Delta\Theta \leq$	$\Delta\Theta_{max}$	and	q_i	$\leq q \leq$	$1{,}2\ q_i$

For cooling applications:

a)	$\Delta\Theta_{min}$	$\leq \Delta\Theta \leq$	$1{,}2\ \Delta\Theta_{min}$	and	$0{,}9\ q_p$	$\leq q \leq$	$1{,}1\ q_p$
b)	$0{,}8\ \Delta\Theta_{max}$	$\leq \Delta\Theta \leq$	$\Delta\Theta_{max}$	and	$0{,}1\ q_p$	$\leq q \leq$	$0{,}11\ q_p$
c)	$0{,}8\ \Delta\Theta_{max}$	$\leq \Delta\Theta \leq$	$\Delta\Theta_{max}$	and	q_i	$\leq q \leq$	$1{,}2\ q_i$

The outlet temperature shall be in the temperature range of (50 ± 5) °C for heating applications and (15 ± 5) °C for cooling applications, if not otherwise stated in the pattern approval certificate.

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