EURAMET P1061

COMPARISON OF AIR TEMPERATURE CALIBRATIONS

Instructions for the part 1
version 1

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Espoo 2009
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1 Background

It was agreed in the EURAMET TC-T Meeting in Delft in April 2008 that MIKES will coordinate a comparison of air temperature calibrations. The main objective of the project is to investigate the reliability and equivalence of calibration methods used by NMIs in calibrating air thermometers, i.e. thermometers that are used for measuring air temperature and are also calibrated in air (not immersed in a liquid bath). The focus of this project is in the errors due to self-heating and thermal radiation. The results can also be benefitted in developing RH CMC review protocol.

Because there were 18 countries expressing interest in taking part in the comparison, strict limits were set for time periods for each participant. It was also decided to split the project in two parts: The first one will be carried out with three participants. After this first loop, it will be decided if any modification is needed to the measurement scheme or the instruments. The results of this first part will be reported and published only in relative to each other, i.e. in such way that the same instruments can be used in the second part without losing the impartiality.

In this paper, instructions are given for the first part of the project. Final project protocol will be written after completing the first part.

2 Organization

2.1 Method

In this project the effects specific to air temperature measurements and calibrations are studied by comparing calibrations performed by the participants with facilities of different types.

The comparison is carried out using an ASL F250 thermometer bridge with two Pt 100 probes and an HMT335 thermohygrometer as the transfer standards. The comparison will cover the range -40 °C to +180 °C. Each laboratory will carry out measurements at five measurement points covering the whole air temperature calibration range of the laboratory.

Between August 2008 and January 2009, MIKES carried out several calibrations for the transfer standards in air. The PRTs with the ASL bridge were also calibrated in liquid baths twice.
2.2 Participants

Participants of the first part of the project are:

<table>
<thead>
<tr>
<th>Table 1</th>
<th>List of participants</th>
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<tbody>
<tr>
<td>Central Office of Measures (GUM)</td>
<td>Poland</td>
</tr>
<tr>
<td>Centre for Metrology and Accreditation (MIKES)</td>
<td>Finland</td>
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<td>Centro Español de Metrología (CEM)</td>
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<td>Spain</td>
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<tr>
<td>Hungarian Trade Licensing Office (MKEH)</td>
<td>Hungary</td>
</tr>
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</table>

2.3 Scheme

- Hungary: weeks 8 to 9 / 2009
- Spain: weeks 10 to 12 / 2009
- Poland: weeks 13 to 14 / 2009
- MIKES: weeks 14 to 15 / 2009

2.4 Measurements

In this project, measurements are carried out in the points: -40, -30, -20, -10, -5, +10, +20, +30, +40, +50, +60, +70, +80, +90, +120, +150, +180 °C. Only MIKES carries out measurements at all of these points.

**Calibration in air**
Each participant will carry out a full set of five point calibration with an ascending order of the points. At three points (maximum, minimum and one in between) measurements are repeated in descending order.

The results of each laboratory will be compared to each other using polynomial fittings.

Each laboratory chooses the five points from the list given above. It is, however, recommendable that the selected points cover the whole range of interest somewhat evenly (your maximum and minimum temperature and 3 points in between) to ensure the reliability of the fittings.

During the calibration in air, a black painted cover is on the PRT A (see Section 3)

**Calibration in liquid bath**
At each laboratory, the ASL with two PRTs will be calibrated in liquid baths at two points +10 °C and +80 °C before the calibration in air. If there is time within the time slot of a laboratory the bath calibration may be repeated after the calibration in air.

Before the calibration in a liquid bath, a black painted cover is removed from the PRT A (see Section 3). The cover must not be immersed in a liquid.
The thermohygrometer HMT335 must not be exposed to direct contact with water or other liquids.

3 Transfer standards

3.1 Digital thermometer

An ASL F250 (s/n 1365030997) digital thermometer is used as a resistance bridge in this comparison. It is used with two Pt 100 probes:

- Probe A: L=250 mm, d= 2.2 mm; stainless steel covered by thin black painted stainless steel tube (manufacturer: Pentronic)
- Probe B: L=230 mm, d= 5 mm (manufacturer: Hart Scientific)

The probe A is connected to the front panel of the ASL bridge but the probe B is connected to the rear panel.

The black cover of the probe A is removed before immersing the probe in a liquid bath by pulling the cover and its handle apart (see fig. 3.1). Before starting measurements in air the cover is re-installed.

Only the resistance readings are recorded.
3.2 Thermohygrometer

The probe of the thermohygrometer HMT335 (s/n Z4610004) must not be exposed to direct contact with water or other liquids. Temperature measurements can be carried out in the whole range of this comparison. Although both relative humidity and temperature readings should be recorded, only the temperature readings are for the comparison.

The transmitter body should be kept at room temperature.

A 24 VDC supply is connected to the blue (-) and red (+) wires.

3.3 Package

The thermometer bridge, PRTs and the thermohygrometer are transported in a single wooden transport case. The PRTs are located horizontally below soft material (see figures below).
Figure 3.2  The transport case opened; first layer of soft material removed.

Figure 3.3  The transport case opened; location of mains cable, ASL F250 and HMT335 (with the probe).
Figure 3.4 The transport case opened; location of PRTs.
4 Reporting and analysis

Laboratories will report their results using a specific Excel file delivered by the pilot. The report will include:

- For each measurement point:
  - Local reference value for the air temperature
  - Readings of the transfer standards (ASL: resistance; HMT335: temperature and relative humidity)
  - Mean values and corresponding standard deviations are reported.
  - Standard and expanded uncertainties of the reference value and the calibration result are reported.

- For the calibration of the ASL transfer standard using a liquid bath:
  - Local reference value for the liquid temperature
  - Readings of the transfer standard (resistance)
  - Mean values and corresponding standard deviations are reported.
  - Standard and expanded uncertainties of the reference value and the calibration result are reported.

- Background information:
  - Description of the test environment and the reference instruments used in the comparison
  - Description how the effects of thermal radiation, self-heating and hysteresis have been taken into account in calculating the results/uncertainty

The results will be compared to each other using curve fittings.

Errors due to thermal radiation and self-heating (+ convective heat transfer) are of special interest.

Each laboratory should send the report file on the results to the coordinator within 4 weeks after sending the instruments to the next laboratory (if the dead-line is exceeded, the results will not be included in the final analysis).

Espoo 13 February 2009
Martti Heinonen
## Contact details

<table>
<thead>
<tr>
<th>Name of the laboratory</th>
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