



TUBITAK UME
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Technical Protocol

***Comparison of the platinum resistance thermometer
(PRT) between the temperature range -56 °C and 420 °C***

TUBITAK UME-G3SI-10-03
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CONTENTS

<u>CONTENTS</u>	<u>2</u>
<u>1. INTRODUCTION</u>	<u>3</u>
<u>2. PARTICIPATING LABORATORIES</u>	<u>4</u>
<u>3. PROVISIONAL SCHEDULE</u>	<u>4</u>
<u>4. TRANSPORTATION OF THE EQUIPMENT</u>	<u>5</u>
<u>5. PROCEDURES</u>	<u>5</u>
<u>6. REPORTING OF DATA</u>	<u>8</u>
<u>APPENDIX - A PROTOCOL APPROVAL</u>	<u>10</u>
<u>APPENDIX - B ARTEFACT RECEIVED</u>	<u>11</u>

1. Introduction

All participants of this comparison should follow the instructions, which are given below. Moreover, each laboratory should follow its normal practice when realising the comparison. It is intended to carry out a comparison of industrial platinum resistance thermometers between the temperature range -56 °C and 420 °C as a EURAMET project.

This document comprises the conditions for the measurement and reporting of the platinum resistance thermometer comparison for all participants. The pilot laboratory of this comparison is TUBITAK UME Temperature Group Laboratories.

The comparison between the range covering -56 °C and 420 °C will be carried out by using a platinum resistance thermometer which will be selected by UME for its good stability.

The thermometer is fragile so it must be handled with care. When not in use, it should be stored in a safe place in the groove of the protecting foam. The thermometer will be hand carried from laboratory to laboratory. **The procedures required by the Department of Customs of each country must be strictly obeyed when the thermometer is shipped outside EU. In this case, the Carnet form must be carefully and accurately completed.** It is the responsibility of the laboratory carrying the transfer PRT to the next laboratory to present the Carnet to Customs when leaving the country and upon arrival in the country of destination. Personnel at the receiving laboratory must check the Carnet forms very carefully upon receipt. It is the duty of the pilot laboratory to find out a solution between the different participants (in this loop) for taking in charge the ATA carnet fees.

If thermometer has not been received in due time the pilot must be immediately informed in order the timetable be revised accordingly.

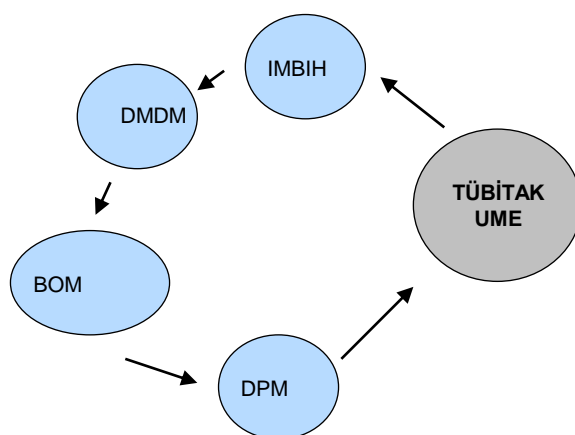
All participants will calibrate one thermometer. They will establish a calibration report and send it to TUBITAK UME.

From the delivered data, TUBITAK UME will establish the difference between participating laboratories. TUBITAK UME will establish, as well, the uncertainty associated with the calculated difference.

2. Participating Laboratories

Laboratory	Address	Person responsible for the intercomparison
Bureau of Metrology (BoM)	Bull. Jane Sandanski 109 a MK-1000 Skopje R. FYR Macedonia	Ms.Olgica Petrusova Phone: +389 2 2403 676 Fax: +389 2 2444 677 e-mail: olgica.petrusova@bom.gov.mk
Directory of Measures and Precious Metals(DMDM)	Mike Alasa 14 11000 Belgrade, Serbia	Ms Slavica Simic Phone: +381 11 2024 425 Fax: +381 11 21 81 668 e-mail: temperature@szmdm.sv.gov.yu
General Directorate of Metrology (DPM)	Rruga Sami Frashëri 33, AL- Tirana	Ms. Majlinda Hoxha Phone:+35542233174 Fax: +355 4 2228 244 e-mail: majlinda.hoxha@dpmk.gov.al
Institute of Metrology of Bosnia and Herzegovina (IMBiH)	Dolina 6, BA-71000 Sarajevo Bosnia-Herzegovina	Haris Memić Phone: +387 33 561 461 Fax: +387 33 714 711 e-mail: haris.memic@met.gov.ba
TUBITAK Ulusal Metroloji Enstitüsü	TUBITAK UME, P.O. Box 54, 41470 Gebze-Kocaeli	Aliye Kartal Doğan Phone + 90 262 6795000 Fax + 90 22 6795001 e-mail: aliye.dogan@ume.tubitak.gov.tr

3. Provisional schedule



It is anticipated that the comparison will be started by **October 15, 2010**.

At the beginning of the circulation, TUBITAK UME will make the first calibration with the PRT (see table I). Then the circulation of the platinum resistance thermometer in the loop will be initiated.

For a given laboratory, the time allowed for a calibration (over the range -56°C to 420°C) is approximately estimated to be 4 weeks. The travelling time between two labs could be rated at 1 week.

Table 1. Schedule of comparison

Period	Task	Lab.
1 August to 1 October, 2010	Selection and calibration of 2 PRTs	UME
	Starting the circulation of a PRT	
15 October to 15 November, 2010	Calibration of the circulating PRT	DMDM
22 November to 22 December, 2010	Calibration of the circulating PRT	BOM
25 December 2010 to 25 January 2011	Calibration of the circulating PRT	IMBIH
1 February to 1 March 2011	Calibration of the circulating PRT	DPM
10 March to 10 April, 2011	Check the stability of the circulating PRT	UME

4. Transportation of the equipment

As soon as the equipment is delivered/sent, the coordinator shall be informed (e.g. by e-mail). The equipment is then unpacked, and an inspection carried out. If the equipment has any visible damage due to transportation, this must be reported to the coordinator before the calibration begins.

The equipment is hand carried (personal transport) to the next laboratory.

The participating laboratory covers expenses of transportation to the next laboratory.

5. Procedures

The goal of the training comparison is to compare the high accuracy realization of the relevant temperature range by means of secondary level equipments as the participating laboratories routinely establish them. Each laboratory, therefore, must calibrate one PRT according to its customary process.

The PRT, supporting the comparison will be carefully selected by pilot laboratory paying a special attention to the stability of the instrument. The PRT is expected to have 100 Ohms of nominal value at 0 °C with a diameter 6 mm and length 300 mm.

The objectives of the comparison exercise can be summarized as following:

- to provide the opportunity to SEE laboratories to acquire experience in participating in comparisons
- to check the measurement capabilities in the field of temperature of the participating laboratories
- to provide input for improvement
- to prepare the participating laboratories for future submission of technically valid calibration measurement capabilities (CMC)

Task of Pilot lab:

- To select and calibrate PRT
- To check the stability of the travelling instrument,
- To perform a calibration covering the full range at the beginning of the loop. The pilot will also perform a calibration of the full range at the end of the loop.
- To organize the PRT circulation within the loop.
- To collect the calibration reports sent by the participants and to establish an analysis of the results

Task of Participating Labs:

The travelling PRT is to pass through the following sequence:

- 1) a measurement at ice-point (0 °C)
- 2) a stabilisation procedure
- 3) a second measurement at ice-point (0 °C)
- 4) After satisfying the requirements of the stabilisation procedure, the measurements at the calibration points suggested by the protocol should be taken.

Upon receipt of the PRT, the host laboratory must inspect the device for damage. Then the host laboratory must complete and forward (by e-mail or fax) the attached “Artefact Received Form” to pilot to report the condition of the artefact. If there is damage, the pilot laboratory will give instructions on how to proceed.

If the thermometer has not been received in due time, the pilot laboratory must be immediately informed to revise the timetable and inform the further laboratories of the revision.

If no damage has been sustained and after reporting to the pilot laboratory, the host must measure the resistance of the travelling PRT in ice-point (0 °C). The resistance value at ice-point $R(0\text{ °C})$ must be communicated to the pilot laboratory. After receiving approval from the pilot laboratory to proceed with the comparison, the host laboratory can begin the PRT stabilization procedure ;

- Carefully insert the PRT into a furnace at 450 °C.
- Anneal the PRT for two hours at 450 °C
- Carefully remove the PRT from the furnace
- Re-determine the value of $R(0\text{ °C})$

If the decrease in the calculated zero-point resistance of the PRT after annealing is equivalent to 5 mK or greater proceed to a second PRT stabilization procedure. Re-determine the value of $R(0\text{ °C})$. If the decrease is less than 5 mK then the complete calibration can be performed. After completing all of the above measurements, a report will be sent to TUBITAK UME.

The comparison will be carried out in the temperature range from -56 °C to 420 °C. The measurements should be taken at nominal temperature points -56 °C , -40 °C, -20 °C, 0 °C, 50 °C, 156 °C, 232 °C, 350 °C and 420 °C. At least 10 data should be recorded for every calibration point. Existing calibration techniques as practiced by the participating laboratories must be used. Measurements should be taken in order of decreasing temperatures for the calibration points above 0 °C whereas it should be taken in order of increasing temperatures for below 0 °C values.

Care should be taken to avoid the thermometer experiencing thermal shocks.

6. Reporting of data

Each laboratory should fill the table given below (Table II) for every calibration point. If the measured reference temperature value is away from the nominal value, a Callender van Dusen (CvD) equation will be used to express the required value.

Table II. Calibration results

Nominal Temperature Value /°C	Measured Resistance / Ω	Uncertainty /°C
-56		
-40		
-20		
0		
50		
156		
232		
325		
420		

The uncertainty budget should also be given according to the parameters listed as a table below (Table III).

Table III. Uncertainty budget

	<i>Uncertainty arising from</i>	<i>Sensitivity Coefficient C_i</i>	<i>Statistical Distribution</i>	<i>Estimated Value</i>
A1	Repeatability			
B1	Reference Thermometer			
B2	Axial and radial temperature homogeneity of the liquid bath			
B3	Multimeter / Bridge - resolution - short term drift - calibration certificate			
B4	Hysteresis (<i>difference between initial and final ice point measurements</i>)			
B5	Standard Resistor -calibration certificate -stability of the maintenance bath			
B6	Interpolation Equation using CvD			

Also the details of instrumentation, liquid baths, bridges or multimeters, techniques used in the realisation of the comparison should be given as a separate document.

Consequently, all laboratories should fulfill the following requirements

- Expression of the measurement values for every calibration point,
- Expression of uncertainty budget for every calibration point,
- Expression of the interpolation equation,
- Expression of resistance values at given nominal temperature values,
- Additional notes which is felt necessary for the participants to give

During evaluation, values measured by UME will be taken as reference values and the deviations for all participants' values will be calculated accordingly.

The comparison uncertainty and the E_n values will be computed according to the values suggested by all laboratories.

Appendix - A PROTOCOL APPROVAL

This approval concerns only the protocol of the measurement. Here it is asked a formal approval from **participating laboratory** to this project.

Name of participating lab:

☐ We approve the protocol and we agree to participate in the comparison

☐ We do not approve the protocol and we agree not to participate in the comparison

Date _____

Name _____

Responsibility _____

Signature _____

Appendix - B ARTEFACT RECEIVED

Name of participating lab:

The _____ and its ATA Carnet was received at _____
(PRT reference) (name of laboratory)

on _____
(date)

The condition when it was received was:

- ☐ in good physical and working order
- ☐ damaged (*explain*)

Signature