

SADCMET Regional Interlaboratory Comparison

SADC.T-P1

Liquid-in-glass thermometry

Report: draft A

Contact person:

Hans Liedberg,

CSIR-NML
P O Box 395
0001 Pretoria
South Africa
Tel: +27-12-841 2753
Fax: +27-12-841 2131/4458
E-mail: hliedber@csir.co.za

Introduction

This report describes the results of the interlaboratory comparison (ILC) SADC.T-P1, comparing liquid-in-glass thermometer calibration capabilities from 0°C to 50°C.

The ILC was proposed at the SADC MET Working Group on Thermometry meeting held on 23 March 1999 in Mauritius. Invitations to participate were sent to all SADC countries. The countries that participated are listed in the final circulation schedule below.

This ILC is designated as a regional pilot comparison. Based on its success, it is hoped that a regional key or supplementary comparison, covering the working ranges of the participating laboratories more completely, may be organised in the near future.

Measurement procedure

Two mercury-in-glass thermometers were circulated to 7 laboratories (including the pilot laboratory):

Description: Enclosed-scale mercury-in-glass thermometers

Manufacturer: Amarell

Serial numbers: 73-00 and 74-00

Full range: -11,8°C to 52,2°C

Graduation: 0,1°C

The thermometer 74-00 was a backup, if the thermometer 73-00 were to be damaged.

The comparison protocol, containing detailed instructions for the handling and measurement of the thermometers, is attached as an appendix. The inspection and measurement procedure may be summarised as follows:

- 1) a visual inspection using a magnifying glass
- 2) rejoining, if necessary, of the mercury column
- 3) a rest period of 3 days after the initial inspection and possible re-joining of a broken mercury column
- 3) a measurement at the ice point
- 4) measurements at 10°C, 20°C, 30°C, 40°C and 50°C
- 5) a second measurement at the ice point

It was not necessary for any laboratory to rejoin the mercury column of either thermometer. However, the thermometer 73-00 broke before measurement at BOBS.

Final circulation schedule

Contact details of the participants:

Contact person	Laboratory	Postal address	Country	Tel	Fax	Email
Mr Hans Liedberg / Mrs Brigitte Monard	CSIR-NML	PO Box 395, 0001 Pretoria	South Africa	+27-12-841 2753	+27-12-841 2131/4458	hliedber@csir.co.za
Dr Satya P Varma / Dr Y P Singh	NPL	New Delhi 110012	India	+91-11-578 6592	+91-11-585 2678/576 4189	spvarma@csnpl.ren.nic.in
Mr Christian Ng Ha Kwong	MSB	Moka	Mauritius	+230-433 3648	+230-433 5051/5150	msb@intnet.mu
Mr Joel M Kioko / Mr Kenneth K Sende	KEBS	PO Box 54974, Nairobi	Kenya	+254-2-502 543/211	+254-2-503 293	kebs@africaonline.co.ke
Ms Julia Rose / Mr Archange Sophola	SBS - NPL	PO Box 953, Victoria, Mahe	Seychelles	+248-375 333	+248-375 151	sbsorg@seychelles.net
Mr Victor Mundembe	SIRDC – NMI	PO Box 6640, Harare	Zimbabwe	+263-4-86 0321/33	+263-4-86 0350/1	vmundembe@sirdc.ac.zw
Mr Keeper Morgan / Mr Emmanuel Tabona	BOBS	P/Bag BO 0048, Gaborone	Botswana	+267-56 4044	+267-56 4042	k_morgan@boobstandards.bw

Laboratory	Measurement period
CSIR-NML	2 to 3 Jan 2001
National Physical Laboratory (NPL), India	14 to 25 Jan 2001
CSIR-NML	27 Feb 2001
Mauritius Standards Bureau (MSB)	20 to 23 April 2001

CSIR-NML	22 May 2001
Kenya Bureau of Standards (KEBS)	15 to 16 August 2001
Seychelles Bureau of Standards – NPL (SBS - NPL)	19 to 20 Sept 2001
CSIR-NML	21 Nov 2001
SIRDC - NMI	8 to 9 Dec 2001
CSIR-NML	14 to 28 Jan 2002
Botswana Bureau of Standards (BOBS)	28 Feb to 18 March 2002
CSIR-NML	2 April 2002

Data analysis

The initial measurements at CSIR-NML are used as the reference values.

The differences Lab Value – Reference Value (LV - RV) are determined as follows:

LV - RV = correction determined at participating lab – correction determined during reference measurements

En values (deviations normalised with respect to the uncertainties of the laboratories) are used to quantify the agreement between the participating laboratory and the reference values:

$$En = (LV - RV) / \sqrt{(U_{LV}^2 + U_{RV}^2)},$$

where U_{LV} and U_{RV} are the expanded uncertainties of measurement ($k=2$).

The reduced correction, i.e. the difference between the correction at temperature T and the correction at 0°C ($corr_T - corr_{0°C}$), is also reported.

Results

The type of reference thermometer, heat source and immersion depth (total or partial) used by each laboratory is given in the table below:

Laboratory	Ref thermometer	Heat source	Rising / stable temp	Immersion
CSIR-NML	Industrial PRT (4-wire)	Ice point, stirred water bath	Rising	Total
NPL, India	Standard PRT	Ice point, stirred water bath	Stable	Total
MSB	Heto F161 (PRT ?)	Ice point, stirred water bath	Stable	Total
KEBS	LIG thermometers	Ice point, stirred water bath	Stable	Total
SBS – NPL	LIG thermometers	Ice point, stirred water bath	Stable	Partial
SIRDC - NMI	100 Ω PRT	Water / ethylene glycol bath	Stable, rising	Total
BOBS	LIG thermometer	Ice point, stirred water bath	Stable	Partial

The attached spreadsheet "SADCTP1Results.xls" lists all the results received.

Uncertainty budgets for the labs are also attached. These were calculated by CSIR-NML based on information received from the participants. The degrees of freedom of several components were assigned quite arbitrarily, limited information being available to estimate them.

All laboratories have $En < 1$, with the exception of those indicated below:

Lab	Temperature (°C)	LV-RV (°C)	En value
KEBS	50	0,14	1,93
BOBS	10	0,13	1,15

The following points were noted:

KEBS: The deviation at 50°C is larger than would be expected to be caused by inadequate immersion of the travelling thermometer. (For example, if the average emergent liquid column temperature was 35°C, the thermometer would have to be immersed to the –8°C mark or less, for it to read low by this amount.)

BOBS: There were some difficulties achieving suitable immersion depths at 10°C and 20°C.

Conclusions

The results of this ILC are, in general, most satisfactory. With minor exceptions, the laboratories were able to keep to the original circulation schedule. The success of this pilot comparison provides a strong motivation to organise a regional supplementary comparison, to compare the Best Measurement Capabilities (BMCs or

CMCs) of the labs over a wider temperature range. Industrial platinum resistance thermometers (IPRTs) with a readout may be suitable travelling thermometers. (They are more robust than liquid-in-glass (LIG) thermometers, and can generally be used over a wider temperature range.) The types of thermometers calibrated by the labs, their temperature ranges and Best Measurement Capabilities should be taken into account when deciding on the protocol for such a comparison.