

SADCMET Supplementary comparison

Comparison on Tape Measure

Technical Protocol

Pilot Laboratory:

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1. Introduction

Following the decision of a SADCMET meeting held in South Africa in 2018 as per SADCMET strategic plan, Zimbabwe's Scientific and Industrial Research Centre National Metrology Institute (SIRDC-NMI) hosted a Dimensional Interlaboratory Comparison training workshop from the 11th to the 13th of February 2019. The workshop was sponsored by PTB Germany. It is during this period that the SADCMET Technical Committee for Length agreed to start comparisons in different parameters and artifacts.

The parameters chosen included **Tape Measure**. One Tape Measure of 30m was chosen in order to cover the accreditation range of most of the participating National Metrology Institutes (NMIs). It was further agreed that the intercomparison be upgraded to AFRIMETS level in order for one of the objectives, registration of Calibration and Measurement Capabilities (CMCs) in the International Bureau of Weights and Measures Key Comparison Data Base (BIPM KCDB) to be fulfilled.

This technical protocol has been drawn in consultation with the participants following the guidelines established by the BIPM[1]. The comparison project is funded by PTB.

2. Objectives

The objectives of this comparison are to:

- A. Assess the equivalence of the tape measure calibration among the participants and to underpin the relevant claim of the Calibration and Measurement Capability in the International Bureau of Weights and Measures Key Comparison Data Base (BIPM KCDB).
- B. Enable the participating NMIs to meet the requirements of ISO17025:2017 international accreditation
- C. Save as a tool for procedure and method validation and to
- D. Ensure harmonization of standards and demonstrate measurement uniformity of SADC NMIs.

3. Organisation

3.1. Participants

- 3.1.1. Tanzania Bureau of Standards (Metrology Laboratory) is acting as a pilot laboratory among the participants in the comparison.
- 3.1.2. The participating institutes are Zimbabwe (SIRDC NMI), National Metrology Institute of South Africa (NMISA), Zambia Metrology Agency (ZMA), Malawi Bureau of Standards (MBS), Namibia Standards Institute (NSI), Mauritius Standards Bureau, Botswana Bureau of Standards (BOBS), Tanzania Bureau of Standards (TBS), Mozambique () and Democratic Republic of Congo (Office Congolais Controle). Details are in table 1.

Table 1 Participants

	Participant	Correspondence	E-mail Address Phone number	Address
1	Zimbabwe (Pilot)	Burnhard P. Gandah	Email: bgandah@sirdc.ac.zw Tel: +263242860346	SIRDC National Metrology Institute, 1574 Alpes Road, Hatcliffe, Harare
2	South Africa	Oelof Kruger (AFRIMETS TCL Chair) Zanele Nzimande	Email: okruger@nmisa.org Email: znzimande@nmisa.org Tel: 012 841 3057	NMISA, Bldg 5, CSIR, Meiring Naude Road - South Africa
3	Malawi	Truwe Munkhondya		
4	Mauritius	Vaneeda Ramasawmy		
5	Mozambique	Emidio Mulchande		
6	Namibia	George Mabakeng		
7	Tanzania	Angela K Charles	Email: angela.charles@tbs.go.tz Tel: +255714215038	Tanzania Bureau of Standards P. O. BOX 9524, Dar Es Salaam Tanzania
8	Zambia	Natasha Chichone		
9	Botswana	Ntima		BOBS, Botswana Bureau of Standards, Private Bag BO48, Main Airport Road, Plot No. 55745, Gaborone - Botswana

- 3.1.3. All the participants must be able to demonstrate traceability to an independent realization of the SI unit of length, the meter or make clear the route of traceability to SI unit, the meter via another named laboratory.
- 3.1.4. By their declared intention to participate in this comparison, the laboratories accept the general instructions and the technical protocols written down in this document and commit themselves to follow the procedures strictly.
- 3.1.5. Once the protocol has been agreed, no change to the protocol may be made without prior agreement of all the participants.

3.2. Form of comparison

- 3.2.1. The comparison will primarily be carried out through calibration of the artifact which is a 30m tape measure
- 3.2.2. The sequence of measurements will be as in table 2.
- 3.2.3. The comparison will consist of one round. Every Laboratory will have a period of one month in which to
- i) Receive the artifact
 - ii) Perform measurements
 - iii) Send the artifacts to the next participant.
- 3.2.4. The participant should immediately report to the pilot lab when a problem that delays the predetermined schedule occurs.

3.3. Time Schedule

- 3.3.1. The proposed commencement date of the intercomparison is May 2019.
- 3.3.2. Each participant NMI will have one month (two weeks from the date of receiving the artefact for measurements and a further two weeks to pass the artefacts on to the next Laboratory)

- 3.3.3. Each Laboratory should submit measurements results (report) to the pilot within one month after completion of its measurements.
- 3.3.4. When all measurements are completed, the participants will be given a deadline date for submitting the results, and if they do not meet the deadline, they might be disqualified. Table 2 summarises the schedule.

Table 1 : Schedule of the comparison

Laboratory	Starting date of measurement
South Africa	01/05/2019
Mauritius	01/06/2019
Tanzania	01/07/2019
Malawi	01/08/2019
DRC	01/09/2019
Zambia	01/11/2019
Mozambique	01/12/2019
Zimbabwe	01/01/2020
Botswana	01/02/2020
Namibia	01/03/2019
Zimbabwe (Pilot)	01/04/2019

3.4. Handling of Artefacts

- 3.4.1. Upon receipt of the artifact a return form (appendix A9) must be filled in and returned to the pilot lab. The tape should be examined immediately upon receipt. The condition of the artifact and the associated package should be noted and communicated to the pilot lab if there is anything abnormal found.
- 3.4.2. If there is any damage or problem found that may potentially affect the comparison measurements, the participant should immediately report it to the pilot lab by e-mail. If the pilot lab finally decides the artifact be repaired after sufficient communication, the participant should deliver the artifact to South Africa for repair.
- 3.4.3. When the comparison measurements are completed, the artifact should be repackaged in their original container. Please ensure that the content of the package is complete by checking the packing list that was delivered together with the artifacts. The original packaging container should be used unless if it is significantly damaged. If the participant decides to make a new container the coordinator should first be informed.
- 3.4.4. The participant should inform the contact person of the next participant and the coordinator of the pilot lab of the delivery schedule when the artifact package is ready to be sent.

3.5. Transportation of Artifacts

- 3.5.1. It is important that the tape should be transported in a manner such that it will not be lost, damaged or handled by un-authorized persons. The artifacts should be packaged in a container that is suitably robust to protect them from being deformed or damaged during transportation.
- 3.5.2. Transportation is the responsibility of each participating institute. Each participating institute should cover the cost for its own measurements, one-way transportation including insurance, customs clearance, and any expense to be incurred in its own country.
- 3.5.3. After completion of measurements the institute should hand deliver the artifacts to the next participant. For easy customs clearance participants are expected to use the SADC movement of intercomparison samples for test and calibration forms and letters for transporting artifacts. A letter from the Participating institute such as in appendix B should also accompany the artifacts.
- 3.5.4. The comparison will be terminated in the event of total loss of artifacts and a report will be prepared based of the collected results.

4. Description of Artifacts

The package contains 1 tape measure of 30m long serial number TM12

5. Measurement Instructions

5.1. Traceability

- 5.1.1. Temperature measurement should be made using the International Temperature Scale of 1990(ITS-90).
- 5.1.2. Length measurement should be traceable to the latest realization of the SI unit the meter.

5.2. Measurand

- 5.1.3. The Calibration is performed on the length scale of the tape measure so that the error of indicated size is measured.
- 5.1.4. The calibration process should be performed in a laboratory capable of maintaining environmental conditions of temperature at 20.0 ± 1.0 °C. It is highly recommended that the tape, and standards used are brought into the laboratory at least 12 hours before any measurement is performed.
- 5.1.5. The exact temperature of the laboratory during the comparison measurements should be reported.
- 5.1.6. Correction of temperature mismatch should be made, and the corresponding uncertainty should be included in the uncertainty budget in case of need.

5.3. Calibration Instruction

The participant shall determine the value of error of tape at the following intervals (1, 5, 10, 15, 30)m. This should be done according to the laboratory's internal procedures. Appendices A1 to A7 should be completed.

6. Reporting of Results and Measurement Uncertainties

6.1. Uncertainties

- 6.1.1 The report should contain a comprehensive uncertainty budget, comprising all the contributions to the total uncertainty. The uncertainty of measurements shall be estimated according to the ISO Guide to the Expression of Uncertainty in Measurements. A result will not be considered complete without an associated uncertainty and will not be included in the draft report unless it is accompanied by an uncertainty supported by a complete uncertainty budget.
- 6.1.2 In the uncertainty budget, the following uncertainty contributions should be included (but is not limited to):
- 1) Uncertainty contributor due to the resolution of instrument.
 - 2) Contributor due to the reference standards used in measurements.
 - 3) Uncertainty contributor due to the temperature effect.
- 6.1.3 Each uncertainty component should come with a probability distribution function and a degree of freedom. Finally, the combined standard uncertainty, the resultant probability distribution function, and the effective degree of freedom should be reported (Level of Confidence 95% approximated by using coverage factor k equal to 2).

6.2. Reporting of Results

- 6.2.1 The participant should submit the report by e-mail in word and pdf format to the pilot within one month after completion of measurements. In case of any discrepancy found between the two reports, the pdf version will be regarded as a definitive version and used for drafting the comparison report.
- 6.2.2 Within four months following the receipt of all measurement reports from the participating laboratories, the pilot laboratory will analyze the results and prepare first draft reports on each comparison. These will be circulated to the participants for comments and corrections. The procedure outlined in the BIPM Guidelines will be followed.
- 6.2.3 The Guidelines require that after conclusion of the circulation of the artifact the pilot laboratory will prepare a draft (Draft A) of the final report within four months and will send it to the participants. Draft A will be confidential and participants will have two months to send their comments on the draft [1,5].
- 6.2.4 If a Laboratory's result is anomalous, it can decide at this stage to withdraw its results, or if explanation is found, can correct it.
- 6.2.5 The pilot laboratory will prepare a second draft B on the basis of the comments received, where the withdrawn results will not appear. Where there has been a correction the original and the corrected result with an explanation are reported.

- 6.2.6 After discussions have been made the report will be submitted to AFRIMETS TCL for approval and publication in the KCDB.
- 6.2.7 Reference value to be used in this comparison is the mean of the results from participating labs
- 6.2.8 The measurement results from the participants together with their associated uncertainties and the reference values will be used to calculate Normalised Error (En values) as follows

$$E_n = \frac{|x_{\text{ref}} - x_{\text{lab}}|}{\sqrt{U_{\text{ref}}^2 + U_{\text{lab}}^2}}$$

Where

- x_{ref} is the reference value and ⁷
- U_{ref} is the reference expanded uncertainty..
- x_{lab} is the laboratory value
- U_{lab} is the laboratory expanded uncertainty.

A.1 Measurement Results

Laboratory:.....

Tape 30m: Serial Number: TM12

Nominal value (mm)	Standard deviation of Std used(mm)	Deviation of (mm)	Total deviation (UUT-STD) (mm)	Measure Value (mm)	Estimated Uncertainty
0					
1000					
5000					
10000					
15000					
30000					

Date:

Signature:

A.2 Description of the measuring system and procedure

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(If possible, photos of the setup can be attached to the e-mail)

Make and type of standard

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Procedure of the measuring setup:

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A.3 Uncertainty of measurement

Uncertainty of measurement of tape measure

<i>Source of uncertainty</i>	x_i	$u(x_i)$	ν_i	$c_i = \partial\beta_i / \partial x_i$	$u_i(\beta_i)/sec$
Standards					
Resolution					
Temperature diff. between UUT and Std					
CTE diff.					
		<i>veff.</i>			
		<i>t distribution</i>		$u_c^2(\alpha_{il})$	

Combined standard uncertainty: $u_c(\alpha_i) = \dots\dots\dots$

Expanded standard uncertainty: $= \dots\dots\dots$

A.4 Return Form

Attention: Angela Kanausha Charles

Tanzania Bureau of Standards
Metrology Laboratory
P.O. Box 9524
Dar es Salaam, Tanzania

e-mail: angela.charles@tbs.go.tz

We confirm having received the artefacts for the SADCMET – _____, on a Line Standards 30m Tape measure:

(date of receiving)

Report of artefact condition:

(After visual inspection)

No damage has been observed

OR

Damage has been observed (*detailed comments*):

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Laboratory:

Name:

Signature:

APPENDIX B

Example of a letter for security control

This must be modified depending on the people and NMIs involved in the transfer of the artifacts

April 2019

I the undersigned, _____, Director of Tanzania Bureau of Standards (TBS) certify that _____, from the Metrology Dimensional laboratory is carrying _____(list of artefacts) from TBS, Tanzania to Malawi Metrology Agency, _____ (address of receiving Lab)

These artefacts are made of stainless steel and are of huge metrology (scientific) value. They are sent between participating National Metrology Institutes and/or Bureau of Standards for inter-laboratory comparison. The standards are very delicate and must not be manipulated by unauthorized persons. Improper handling during transportation would make them useless. They are specially packed in containers that will ensure they remain clean and protected during transportation.

It is important that they travel in the cabin as hand luggage and not in the baggage hold. They are safe and do not pose any risk to the health and safety of fellow passengers.

Prof A, Ngenya
Director General
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Tel: +2552450206
Email: athumani.ngenya@tbs.go.tz

REFERENCES

- [1] Measurement Comparisons in the CIPM MRA (CIPM MRA-D05 Vers 1.6), <https://www.bipm.org/utis/common/documents/CIPM-MRA/CIPM-MRA-D-05.pdf>
- [2] CIPM MRA Guidelines for Authorship of Key, Supplementary and Pilot study comparison reports (CIPM MRA- G-04 vers 1, <https://www.bipm.org/utis/common/documents/CIPM-MRA/CIPM-MRA-G-04.pdf>)
- [3] CCL Service Classification (DimVIM) Version 11 (2018).
- [4] Protocol for SADCMET.LS11
- [5] Protocol for AMP.L-S7