Technical Protocol for AFRIMET Supplementary Comparison on

1. External Micrometer

2. Caliper

3. Dial Gauge

- 4. Setting rods (Optional)
- 5. Feeler gauges (Optional)
- 6. Pin gauges (Optional)

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1. Introduction

1.1. The aim of this comparison is to assess the equivalence of the <u>hand</u> <u>instruments (External Micrometers, Calipers and Dial Gauges), Setting rods</u> (optional), Feeler Gauges (optional), and pin gauges (optional) calibration among the participants and to underpin the relevant claim of the Calibration and Measurement Capability (CMC) in BIPM KCDB. This comparison could support 6 CMCs or more by the BIPM KCDB.

1.2. This technical protocol has been prepared by NIS, Egypt for supplementary comparison in the frame of the AFRIMETS.

2. Organization

2.1. Participants

- 2.1.1. NIS, Egypt is acting as a pilot laboratory among the participants in the AFRIMETS supplementary comparison.
- 2.1.2. All the participants must be able to demonstrate traceability to an independent realization of the meter, or make clear the route of traceability to the meter via another named laboratory.
- 2.1.3. 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.
- 2.1.4. Once the protocol has been agreed, no change to the protocol may be made without prior agreement of all the participants.

2.2. Participant Details

| | Table 1: list of participants with their contact information | | | | | | | |
|----|--|--|---|--|--|--|--|--|
| | Participant | Correspondence | E-mail Address Phone number | Address | | | | |
| 1 | NIS (Pilot) (Egypt) | Osama Terra (Organizer) Ahmed Elmelegy (Pilot lab.) | <u>Osama.terra@gmail.com</u> +201141172900 <u>ahmedme3@yahoo.com</u> +201112145450 | Tersa Street, Haram, Giza, Egypt. P. code: 12211, P.O. Box: 136 Giza | | | | |
| 2 | LPEE/LNM (Morocco) | Lhossain Mechkour | <u>mechkour@lpee.ma</u> Tel : +212 5 22 48 87 94 | km 7, Route d'El Jadida, Casablanca – Maroc | | | | |
| 3 | GSA (Ghana) | Paul Date | <u>date_105@msn.com</u> Tel.: + 233 302 500065 | P.O. Box MB 245 Okponglo, Legon-Madina Road, Accra | | | | |
| 4 | NMI/SON (Nigeria) | Bede Obayi | beobayi@yahoo.com | 52, Lome Crescent, Zone 7, Wuse, Abuja | | | | |
| 5 | NMIE (Ethiopia) | Tadesse Gergiso Birhan Tesfaye | <u>tdsgrs@gmail.com</u> <u>bire31@yahoo.com</u> Tel : +251 116 67 19 69 | B67, 1405 Street, Woreda 6,Bole Sub city, Addis Ababa,Ethiopia.P.O. Box: 5722 Addis Ababa | | | | |
| 6 | KEBS (Kenya) | Calvin Bore | <u>borec@kebs.org</u> +254 20 6948 359 | Dimensional Laboratory, Kenya Bureau of Standards, P.O. Box 54974 - 00200, Nairobi, Kenya. | | | | |
| 7 | TBS (Tanzania) | Joseph James Angela Charles | <u>mahillajj@yahoo.co.uk</u> joseph.mahilla@tbs.go.tz angela.charles@tbs.go.tz | Morogoro/Sam Nujoma Roads, Ubungo, P.O. Box 9524 Dar.es. Salaam | | | | |
| | | | Tel.: + 255 22 2450206 | Dai-es-Salaalii | | | | |
| 8 | MBS (Malawi) | Truwe Munkhondya | truwemunkhondya@mbsmw.org | Malawi Bureau of Standard 19 Hayter/ Johnstone Road P O BOX 946 | | | | |
| 0 | | | +265884014144 | Blantyre . Malawi | | | | |
| 9 | ZMA (Zambia) | Daniel Mutale | dmmutalezs@gmail.com +260 955135366 | Zambia Metrology Agency Plot # 4526 Lechwe House Freedom Way, Lusaka, Zambia. P.O.Box: 30989 Lusaka | | | | |
| 10 | SIRDC- NMI (Zimbabwe) | Burnhard Gandah | bgandah@sirdc.ac.zw burnhardg@gmail.com Tel: +263 778330014 | 1574 Alpes Road, Technology Drive Hatcliffe P.O. Box 6640 Harare | | | | |

| 11 | BOBS (Botswana) | Modiriemang Kame Pamidzani Ntima | kame@bobstandards.bw Ntima@bobstandards.bw Pamidzani.ntima@gmail.com Tel. (+267) 3903200 Tel. (+267) 72607660 | Private Bag B0 48 Gaborone |
|----|----------------------------|--|---|---|
| 12 | MSB (Mauritius) | Tomeswar Pryam Vaneeda Ramasawmy | tpryam@msb.intnet.mu vramasawmy@msb.intnet.mu +230 433 3648 | Mauritius Standards Bureau Villa Road, Moka Postal code – 80805 Mauritius |
| 13 | NMISA (South Africa) | Zanele Nzimande Kenneth Manana | ZNzimande@nmisa.org kmanana@nmisa.org Tel. +27 12 841 2944 | Private Bag X34 Lynnwood Ridge Pretoria 0040 |

2.3. Form of Comparison

- 2.3.1. The comparison will principally be carried out through calibration of the artifacts which are External Micrometer, Caliper, Dial gauge, Setting Rods (optional), feeler gauges (optional), and Pin Gauges (optional).
- 2.3.2. Sequence of measurements will be: Pilot Participant1 Participant2 Pilot.
- 2.3.3. The comparison will consist of one round. Each participant will have two weeks period for measurements and then must send the artifacts to the next participant right away so that the artifacts can be delivered to the next participant within one month after finish of measurements. The participant should immediately report to the pilot lab when the problem happens to delay the predetermined schedule.

2.4. Timetable

Each participant will have around two weeks to finish the measurement. The item should be delivered to the next participant within 20 days after completing the measurement (including transport time and customs).

| Table 2: Time Table | | | | | | | |
|---|-------------------|-------------------|--|--|--|--|--|
| Activity | Start Date | End date | | | | | |
| First calibration at NIS, Egypt | 25 November 2019 | 10 December 2019 | | | | | |
| Delivery to LPEE/LNM, Morocco | 11 December 2019 | 31 December 2019 | | | | | |
| Calibration at LPEE/LNM, Morocco | 1 January 2020 | 15 January 2020 | | | | | |
| Delivery to GSA, Ghana | 16 January 2020 | 5 February 2020 | | | | | |
| Calibration at GSA, Ghana | 6 February 2020 | 20 February 2020 | | | | | |
| Delivery to NMI/SON, Nigeria | 21 February 2020 | 10 March 2020 | | | | | |
| Calibration at NMI/SON, Nigeria | 11 March 2020 | 25 March 2020 | | | | | |
| Delivery to NMIE, Ethiopia | 26 March 2020 | 15 April 2020 | | | | | |
| Calibration at NMIE, Ethiopia | 16 April 2020 | 30 April 2020 | | | | | |
| Delivery to KEBS, Kenya | 1 May 2020 | 20 May 2020 | | | | | |
| Calibration at KEBS, Kenya | 21 May 2020 | 5 June 2020 | | | | | |
| Delivery to TBS, Tanzania | 6 June 2020 | 26 June 2020 | | | | | |
| Calibration at TBS, Tanzania | 27 June 2020 | 12 July 2020 | | | | | |
| Delivery to MBS, Malawi | 13 July 2020 | 3 August 2020 | | | | | |
| Calibration at MBS, Malawi | 4 August 2020 | 20 August 2020 | | | | | |
| Delivery to ZABS, Zambia | 21 August 2020 | 10 September 2020 | | | | | |
| Calibration at ZABS, Zambia | 11 September 2020 | 30 September 2020 | | | | | |
| Delivery to SIRDC/NMI, Zimbabwe | 1 October 2020 | 20 October 2020 | | | | | |
| Calibration at SIRDC/NMI, Zimbabwe | 21 October 2020 | 5 November 2020 | | | | | |
| Delivery to BOBS, Botswana | 6 November 2020 | 26 November 2020 | | | | | |
| Calibration at BOBS, Botswana | 27 November 2020 | 12 December 2020 | | | | | |
| Delivery to MSB, Mauritius | 13 December 2020 | 2 January 2021 | | | | | |
| Calibration at MSB, Mauritius | 3 January 2021 | 18 January 2021 | | | | | |
| Delivery to NMISA, South Africa | 19 January 2021 | 9 February 2021 | | | | | |
| Calibration at NMISA, South Africa | 10 February 2021 | 28 February 2021 | | | | | |
| Delivery to NIS, Egypt | 1 March 2021 | 20 March 2021 | | | | | |
| Calibration at NIS, Egypt | 21 March 2021 | 5 April 2021 | | | | | |
| Final Chance for Submitting the Results | 6 April 2021 | 20 April 2021 | | | | | |
| Pre-Draft A, B | 21 April 2021 | 20 June 2021 | | | | | |

Table 2: Time Table

Each participant should submit measurements results (report) to the pilot within two weeks after completion of its measurements.

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.

2.5. Handling of Artifacts

- 2.5.1 The artifact should be examined immediately upon receipt. The condition of the artifacts and the associated package should be noted and communicated to the pilot lab if there is anything abnormal found.
- 2.5.2 If there is any damage or problem found to potentially affect the comparison measurements, the participant should immediately report it to the pilot lab by e-mail. If the pilot lab finally decides to repair it after sufficient communication, the participant should deliver the artifact to NIS for repair.
- 2.5.3 When the comparison measurements are completed, the artifacts 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 it is significantly damaged. Please inform the coordinator if the participant decides to make a new container.
- 2.5.4 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.
- 2.5.5. When applicable, the participants should adjust the zero position of the measuring instruments before starting the measurements (example, zeroing Micrometer should be made).

2.6. Transportation of Artifacts

- 2.6.1. It is important that the artifact should be transported in a manner such that they 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 the artifacts from being deformed or damaged during transportation.
- 2.6.2. Transportation is at each participating lab's responsibility and cost. Each participating lab should cover the cost for its own measurements, one-way transportation including insurance, customs clearance, and any expense to be occurred in its own country.
- 2.6.3. It is recommended to use DHL express service (or any other fast courier service) to speed up comparison since only a maximum of 20 days is planned for transport and custom procedure. Insurance should be provided that cover the lost or damaged items.

2.6.4. The artifacts should be packaged as shown in the photos below (Fig.1) (Vaseline should be applied to pin gauges before packing):



Figure 1: photograph of the packaged artifacts.

3. Description of artifact

3.1. <u>External Micrometer</u>

NIS artifact is an external micrometer as shown in figure 2 that ranges from 75-100 mm.



Figure 2: photograph of a micrometer (similar one).

3.2. <u>Caliper</u>

NIS artifact is an external Caliper as shown in figure 3 that ranges from 0-300 mm.



Figure 3: photograph of a caliper (similar one).

3.3. Dial Gauge

NIS artifact is a dial indicator as shown in figure 4 that ranges from 0-10 mm.



Figure 4: photograph of a dial gauge (similar one)

3.4. Setting Rods (Optional)

NIS artifact is three setting rods as shown in figure 5 that has nominal lengths of 50 mm, 75 mm, 125 mm.



Figure 5: photograph of setting rods (similar one)

3.5. Feeler Gauges (Optional)

NIS artifact is a feeler gauge set that consists of 13 blatts with thickness from (0.05 - 1 mm) as shown in figure 6.



Figure 6: photograph of feeler gauges (similar one).

3.6. Pin Gauges (Optional)

NIS artifact is 5 pin gauges with nominal diameters of (0.5, 0.75, 1.0, 5.0 and 10 mm) as shown in figure 7.



Figure 7: photograph of pin gauges (similar one)

4. Measurement Instructions

4.1. Traceability

- 4.1.1 Temperature measurement should be made using the International Temperature Scale of 1990(ITS-90).
- 4.1.2 Length measurement should be traceable to the latest realization of the meter.

4.2. Measurand

- 4.2.1 The Calibration is performed on the length scale of the external micrometer, Caliper and dial gauge.
- 4.2.2 The length of three setting rods, the thickness of 5 feeler gauges, and the diameter of five pin gauges can be measured optionally.
- 4.2.3 The calibration process should be performed in suitable laboratory accommodation maintained at a temperature of 20°C.
- 4.2.4 The exact temperature of the laboratory during the comparison measurements should be reported.
- 4.2.5 Correction of temperature mismatch should be made and the corresponding uncertainty shouldbe included in the uncertainty budget in case of need.

4.3. Calibration Instruction

4.3.1. External micrometer

- Calibration can be carried out according to the standard ISO 3611:2010 or any other similar standard.
- Error of the indicated size at the following 9 points within the micrometer scale (75, 77.5, 80.1, 82.7, 85.3, 87.9, 90, 95.2 and 100 mm) should be reported.
- The offset reading at zero must be adjusted to 75.000 mm.

4.3.2. Caliper

- Calibration can be carried out according to the standard ISO 13385–1:2011 or any other similar standard.
- Error of the indicated size at the following 10 points (0, 3.3, 10, 20, 40, 50, 100, 150, 200 and 300 mm) should be reported when using the external jaws of a caliper.
- Error of the indicated size at points of (50, 100 mm) should be reported when using the internal jaws of a caliper.
- Error of the indicated size at 100 mm only should be reported when using the caliper stem (depth rod).

4.3.3. Dial Gauge

- Calibration can be carried out according to the standard ISO 463:2006 or any other similar standard.
- Error of the indicated displacement at the following 5 points (0.05, 0.5, 2.1, 5.4, and 10 mm) should be reported when using the dial gauge at the positive direction only (increasing direction). Each point should be reported separately.

4.3.4. Setting rods (optional)

- Calibration can be carried out according to the standard ISO 1938-1:2015 or any other similar standard.
 - Length of the three setting rods with nominal lengths of 50 mm, 75, 125 mm should be measured and reported.

4.3.5. Feeler gauges (optional)

- Calibration can be carried out according to the standard ISO 2808:2019 or any other similar standard.
- Thickness of five blatt of the feeler gauges set should be measured. The nominal thicknesses of these blatts are (0.2, 0.4, 0.6, 0.8 and 1.0 mm).
- The measurement should be performed at the free half- part of the feeler gauge.

4.3.6. Pin gauges (optional)

- Calibration can be carried out according to the standard ISO 1938-1:2015or any other similar standard.
- Diameter of five pin gauges should be measured. The nominal thicknesses of these pin gauges are (0.5, 0.75, 1.0, 5.0 and 10 mm).
- The measurement should be performed at the center of the pin gauge.

5. Reporting Results and Uncertainty

- 5.1. The report on the measurement results of each participant should include a description of the participant's measurement facility or a reference to a published work of the facility. It would be desirable to present photograph of the facility.
- 5.2. The report should include the information about the traceability which the participant hasestablished and maintained.
- 5.3. 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.
- 5.4. In the uncertainty budget, the following uncertainty contributions should be included (but is not limited to):
 - Uncertainty contributor due to the repeatability and reproducibility during measurements.
 - Uncertainty contribution due to the reference standards used in calibration.
 - Uncertainty contribution due to the temperature effect.
 - Uncertainty contribution due to measurement resolution.
- 5.5. Each uncertainty component should come with a probability distribution function and a degreeof freedom. Finally, the combined standard uncertainty, the resultant probability distributionfunction, and the effective degree of freedom should be reported (Level of Confidence 95%).
- 5.6. The participant should submit the report by e-mail in word and pdf format to the pilot within <u>two weeks</u> after completion of measurements. In addition, the printed report should be sent tothe pilot lab by air mail. In case of any discrepancy found between the two reports, the printedone will be regarded as a definitive version and used for drafting the comparison report.

- 5.7. Within two weeks 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.
- 5.8 The reference value will be calculated from the weighted mean of all participants after removing any outlier.