የኢትዮጵያ አክሬዲቴሽን አገልግሎት ETHIOPIAN ACCREDITATION SERVICE	**Policy on Uncertainty in Calibration**	**Copy No.** **Page 1 of 11** **Document No. PM10 /02** **Revision no. 1.1** **Effective Date. 2023-02-07**

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1. Purpose

As per ISO/IEC 17025, 'General requirements for the competence of testing and calibration laboratories', calibration and testing laboratories requires to establish procedures for the evaluation of uncertainty of measurement. ISO/IEC Guide 98-3:2008 - "Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM: 1995)" establishes general rules for evaluating and expressing uncertainty in measurement. And to this describes an unambiguous and harmonized way for evaluating and stating the uncertainty of measurement results in testing and calibration laboratories.

ILAC has published a policy document ILAC P14: 01/2013 "ILAC Policy for Uncertainty in Calibration" for the harmonization in the expression of uncertainty of measurement on calibration certificates and on scope of accreditation of calibration laboratories.

2. SCOPE

This document is in line with ILAC-P14 i.e. 'ILAC Policy for Uncertainty in Calibration' sets the policy regarding the requirements for the:

a) Evaluation of the calibration and measurement capability (CMC), which forms part of scope of accreditation of calibration laboratories
b) Evaluation of uncertainty of measurement in calibration and measurement
c) Reporting of uncertainty on the certificates of calibration and measurement.

3. TERMS AND DEFINITIONS

The terms and definitions given in this document are taken from the relevant terms and definitions given in JCGM 200:2012 International vocabulary of metrology - Basic and general concepts and associated terms (VIM):

a. Calibration Laboratory

In this policy, "calibration laboratory" further means a laboratory that provides calibration and measurement services.

b. Calibration and Measurement Capability

In the context of the CIPM MRA and ILAC Arrangement, a CMC is a calibration and measurement capability available to customers under normal conditions as described in the laboratory's scope of accreditation granted by a signatory to the ILAC Arrangement or as published in the BIPM key comparison database (KCDB) of the CIPM MRA.

c. Best Existing Device

Best Existing Device is understood as a device to be calibrated that is commercially or otherwise available for customers, even if it has a special performance / stability or has a long history of calibration.

d. Measurand

Quantity intended to be measured

4. REFERENCES

a) ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories.

b) ILAC-P14:01/2013, ILAC Policy for uncertainty in calibration

c) ISO/IEC Guide 98-3:2008 - "Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM: 1995)"

d) EA-4/02 M: 2013, Evaluation of the uncertainty of measurement in calibration

e) JCGM 200:2012, International vocabulary of metrology — Basic and general

concepts and associated terms (VIM)

f) ISO Guide 35:2006, *Reference materials – General and statistical principles for certification*

5. POLICY ON THE ESTIMATION OF UNCERTAINTY OF MEASUREMENT IN CALIBRATION

Accredited calibration laboratory shall estimate and report the uncertainty of measurement in compliance with the "Guide to the Expression of Uncertainty in Measurement" (GUM) of all calibrations and measurements covered by their scope of accreditation.

6. CONCEPT OF CALIBRATION AND MEASUREMENT CAPABILITY

In the context of the CIPM MRA and ILAC Arrangement, and in compliance with the CIPM-ILAC Common Statement, the following definition is agreed upon:

a) A CMC is a calibration and measurement capability available to customers under normal conditions as described in the laboratory's scope of accreditation granted by a signatory to the ILAC Arrangement; or
b) As published in the BIPM key comparison database (KCDB – Appendix C) of the CIPM MRA.

Under CMC, the measurement or calibration should be:

c) Performed according to a documented procedure and have an established uncertainty budget under the management system of the NMI or the accredited laboratory;
d) Performed on a regular basis (including on demand or scheduled for convenience at specific times in the year); and
e) Available to all customers.

7. PART – A

7.1 POLICY ON SCOPES OF ACCREDITATION OF CALIBRATION LABORATORIES

7.1.1. Accredited calibration laboratory shall include the calibration and measurement capability (CMC) in the scope of accreditation expressed in terms of:

a) measurand calibration / measurement method / procedure and/or type of instrument/parameter to be calibrated/measured
b) measurement range and additional parameters where applicable, e.g. frequency of applied voltage, Phase for active/reactive power.
c) uncertainty of measurement (this could be given either in the same unit or in the form of a relative uncertainty).

Note: *As far as practicable, the scope of accreditation shall have the SI units of measurements.*

7.1.2 There shall be no ambiguity on the expression of the CMC in the scopes of accreditation and, consequently, on the smallest uncertainty of measurement that can be expected to be achieved by a laboratory during a calibration or a measurement. Whenever the measurand covers the range of values, particular care should be taken by employing one or more of the following methods for expression of the uncertainty:

a) A single value, which is valid throughout the measurement range / part of the measurement range.
b) A range. In this case the calibration laboratory should have proper assumption for the interpolation to find the uncertainty at intermediate values.
    i. The recommended ranges shall be split on the basis of capability of the reference standard(s)/master(s) used and different methods/procedures adopted by the laboratory. It is preferably

advisable to split ranges to ensure linear relationship between CMC ranges and measurement ranges of the parameter.

ii. Wherever linearity is not feasible in a range, it is recommended that the other form of regression equation (i.e. polynomial, exponential) can be used. However, in all the cases, a more conservative fit should be applied by correcting the best fit equation. Or else uncertainties at those points may be specified separately for the relevant part of the range.

c) An explicit function of the measurand or a parameter.

d) A matrix where the values of the uncertainty depend on the values of the measurand and additional parameters.

e) A graphical form, provided there is sufficient resolution on each axis to obtain at least two significant figures for the uncertainty.

f) Open intervals (e.g., “U < x”) are not allowed in the specification of uncertainties.

7.1.3 The uncertainty covered by the CMC shall be expressed as the expanded uncertainty having a specific coverage probability of approximately 95%. The unit of the uncertainty shall always be the same as that of the measurand or in a term relative to the measurand, e.g. percent. Usually the inclusion of the relevant unit gives the necessary explanation.

7.1.4. Calibration laboratories shall provide evidence that they can provide calibrations to customers in compliance with 1.1 b) so that measurement uncertainties equal those covered by the CMC. In the formulation of CMC and to demonstrate the competence, the laboratories shall choose a “best existing device” as a DUC (Device Under Calibration) and shall take notice of the performance of the “best existing device” which is available for a specific category of calibrations. When estimating the uncertainty component in the CMC, a reasonable amount of contribution to uncertainty from repeatability shall be included and contributions due to reproducibility should be included, when available. There should, on the other hand, be no significant contribution to the CMC uncertainty component attributable to physical effects

that can be ascribed to imperfections of even the best existing device under calibration or measurement.

Note;

1. *Reasonable amount of contribution to uncertainty from repeatability generally means the repeatability in a short span of time. If any part of the repeatability is not to be taken, it should be supported by technical justification.*
2. *Reasonable amount of contribution to uncertainty from reproducibility is to be taken where necessary and required by the Standard method.*
3. *Wherever possible and identifiable, Imperfection of best existing devices like hysteresis, relative accuracy etc. are not to be taken directly. However, Type A (Repeatability) cannot be considered as imperfection in this context.*
4. *The resolution of device to be considered when reading the variations in observations on DUC; in cases where variations are read on reference standard; the resolution of reference standard to be considered.*

For some calibrations a “best existing device” does not exist and/or contributions to the uncertainty attributed to the device significantly affect the uncertainty. If such contributions to uncertainty from the device can be separated from other contributions, then the contributions from the device may be excluded for arriving at CMC value. For such a case, however, the scope of accreditation shall clearly identify that the contributions to the uncertainty from the device are excluded while evaluating CMC value.

Note: *The above case is generally applicable to high end calibration where Reference standard better than DUC does not normally exist.*

7.1.5. For the first time demonstration of calibration of the parameter or DUC in the assessment, the CMCs will be based on the actual representative demonstration during the assessment. In subsequent assessments, the laboratory may apply for better CMCs. Such CMCs may be considered;

a) Either based on the past records of routine calibrations done by the laboratory, justifying the calculations with the evidence of - procuring better

reference standard, appropriate environmental control and performing calibration using best existing device.

b) Or based on the actual demonstration during the assessment.

However, in the former case, the laboratory shall demonstrate the practice and process followed with any available device.

Note: *The uncertainty covered by the CMC for the reference value measurement is not identical with the uncertainty associated with a reference material provided by reference materials producer. The expanded uncertainty of a certified reference material will in general be higher than the uncertainty covered by the CMC of the reference measurement on the reference material.*

8. PART – B

POLICY ON STATEMENT OF UNCERTAINTY OF MEASUREMENT ON CALIBRATION CERTIFICATES

8.1. As per ISO/IEC 17025 calibration laboratories shall report the uncertainty of measurement and/or a statement of compliance with an identified metrological specification or clauses thereof in the calibration certificate.

Accredited calibration laboratories shall report the uncertainty of measurement complying the below mentioned requirements:

8.2. The measurement result shall normally include the measured quantity value y and the associated expanded uncertainty U. In calibration certificates the measurement result should be reported as y ± U associated with the units of y and U. Tabular presentation of the measurement result may be used and the relative expanded uncertainty U / |y| may also be provided if appropriate. The coverage factor and the coverage probability shall be stated on the calibration

certificate. To this an explanatory note shall be added, which may have the following content:

"The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95 %."

Note: The expression of uncertainty shall be in line with ISO Guide 98 -3 (GUM 1995). A symbol ± shall not be used when uncertainty is independently stated.

a) The numerical value of the expanded uncertainty shall be given to, at most, two significant figures. Further the following applies: The numerical value of the measurement result shall in the final statement be rounded to the least significant figure in the value of the expanded uncertainty assigned to the measurement result.
b) For the process of rounding, the usual rules for rounding of numbers shall be used, subject to the guidance on rounding provided i.e. in ISO/IEC Guide 98-3:2008 - Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM: 1995).

8.3. Contributions to the uncertainty stated on the calibration certificate shall include relevant short- term contributions during calibration and contributions that can reasonably be attributed to the customer's device. Where applicable the uncertainty shall cover the same contributions to uncertainty that were included in evaluation of the CMC uncertainty component, except that uncertainty components evaluated for the best existing device shall be replaced with those of the customer's device. Therefore, reported uncertainties tend to be larger than the uncertainty covered by the CMC. Random contributions that cannot be known by the laboratory, such as transport uncertainties, should normally be excluded in the uncertainty statement. If, however, a laboratory anticipates that such contributions will have significant impact on the uncertainties attributed by the laboratory, the

customer should be notified according to the general clauses regarding tenders and reviews of contracts in ISO/IEC 17025.

8.4. As the definition of CMC implies, accredited calibration laboratories shall not report a smaller uncertainty of measurement than the uncertainty of the CMC for which the laboratory is accredited. It is further emphasized that the uncertainty smaller than CMC shall not be reported in any form.

Note: As far as practicable, the SI units of measurements shall be used in the calibration certificates/reports.

Revision No.	**Date approved**	**Revision History**
1	2022-05-09	The document is revised due to the name Ethiopian Nation Accreditation office (ENAO) change to Ethiopia Accreditation Service (EAS) and new logo developed.
1.1	2023-02-07	• Correction done on page 1 that, this document was prepared by Meseret Tessema replaced by Zewdu Ayele (new quality manager). • Former director general was resigned and replaced by Mrs. Meseret Tessema.