ACCREDITATION UNIT

POLICY FOR **EVALUATION** OF MEASUREMENT UNCERTAINTY **AND** ITS IMPLEMENTATION

Issued on 2008-02-20
Revised on: 2021-04-05
JAS-P03, rev. f

Purpose

To demonstrate the procedure for **EVALUATION** of measurement uncertainty and its implementation

Scope

Accreditation Unit (**JAS-**AU) requirements pertaining to measurement uncertainty are described. This document is intended for all **JAS**-AU accredited and enrolled calibration and testing laboratories.

Authorship

This publication has been written by the Technical Committee, and approved by the Accreditation Director.

Official language

The text may be translated into other languages as required. The English language version remains the definitive version.

Copyright

Further information

This policy is mandatory for laboratories, and shall be implemented on March, 2021
For further information about this publication, kindly contact **JAS-A**U.
This document is also available **JAS-AU website** where you can check updates directly.

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1 Introduction

The formal definition of the term "**measurement uncertainty**" is as follows:

"Non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used". [6]

- Notes:
  1- The parameter may be, for example, a standard deviation (or a given multiple of it), or the half-width of an interval having a stated level of confidence.
  2- Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information.
  3- It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty, including those arising from systematic effects, such as components associated with corrections and reference standard, contribute to the dispersion.

2 Terms and Definitions

For the purpose of this document, the relevant terms and definitions given in the "International Vocabulary of Metrology – Basic and General Concepts and Associated Terms" (VIM) [6][7] and the following apply:

2-1 Calibration Laboratory

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

2-2 Calibration and Measurement Capability

Calibration and Measurement Capability (CMC) is a calibration and measurement capability available to customers under normal conditions

a) as described in the laboratory's scope of accreditation granted by a signatory to the arrangement; or
b) As published in the BIPM key comparison database (KCDB) of the CIPM MRA

3 Evaluation of Uncertainty of Measurement

3.1 Laboratories shall identify the contributions to measurement uncertainty. When evaluating measurement uncertainty, all contributions that are of significance, including those arising from sampling, shall be taken into account using appropriate methods of analysis.

3.2 A laboratory performing calibrations, including of its own equipment, shall evaluate the measurement uncertainty for all calibrations.

3.3 A laboratory performing testing shall evaluate measurement uncertainty. Where the test method precludes rigorous evaluation of measurement uncertainty, an estimation shall be made based on an understanding of the theoretical principles or practical experience of the performance of the method.

NOTE 1 In those cases where a well-recognized test method specifies limits to the values of the major sources of measurement uncertainty and specifies the form of presentation of the calculated results, the laboratory is considered to have satisfied 7.6.3 by following the test method and reporting instructions.

NOTE 2 For a particular method where the measurement uncertainty of the results has been established and verified, there is no need to evaluate measurement uncertainty for each result if the laboratory can demonstrate that the identified critical influencing factors are under control.

4 Factors Contributing to Measurement Uncertainty

The calibration and testing laboratory should take into consideration the different factors which may contribute to the overall uncertainty. Some examples are given below:

1- Definition of the measurand.
2- Sampling procedure.
3- Transportation, storage and handling of samples.
4- Preparation of samples.
5- Environmental and measurement conditions.
6- Repeatability/Reproducibility
7- Variation in the test procedure.
8- **Resolution of** Measuring instruments.
9- Calibration standards or reference materials.
10- Software and/or, in general, methods associated with the measurement.
11- Uncertainty arising from correction of the measurement results for systematic effects.

5 Policy on the Implementation of the Concept of Uncertainties

5.1. Only uncertainty of measurement in calibration and quantitative testing are considered for the time being. A strategy on handling results from qualitative testing has to be developed later.

5.2. Uncertainty of measurement has to be taken into account when testing procedures and/or testing results are compared with each other or against specification.

5.3. An understanding of the concept of uncertainty of measurement is important in order to choose the testing methods that are fit for purpose.

5.4. The overall uncertainty of measurement should be consistent with the given requirements.

5.5. The economic aspects related to the methods have always to be taken into consideration.

5.6. Testing laboratories **shall, where applicable,** report **measurement u**ncertainty **when it is relevant to the validity or application of the test results, a customer's instruction so requires, or the measurement uncertainty affects conformity to a specification limit.** This should at least be the case where testing results have to be compared to other testing results or other numerical values, such as specifications.

5.7. In any case, the testing laboratories **shall–keep records of the evaluated measurement uncertainty**

5.8. As a general rule, the implementation of the concept of **measurement u**ncertainty should go in line with the implementation of ISO/IEC 17025.

5.9. It is understood that there are some areas where the implementation of uncertainty is difficult to apply. In these cases, the laboratory should try to develop an acceptable procedure for the **evaluation** of **measurement** uncertainty.

5.10. Where uncertainty **evaluations** are applicable, it is required that testing and calibration laboratories calculate measurement uncertainty in accordance with **the GUM JCGM 100:2008 UKAS Guideline M3003** (Expression of Uncertainty and Confidence in Measurement) and European Guideline EA-4/02 (Evaluation of the Uncertainty of Measurement in Calibration). These uncertainties must be supported by uncertainty budgets, and they will be represented as expanded uncertainties typically using a coverage factor of k=2 to give approximately 95% confidence level.

The coverage factor and the coverage probability shall be stated on the calibration certificate. An example of such an explanation **may** be the statement "Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2”. Statements of uncertainty which do not specify at least the coverage factor and the confidence level are incomplete and they are inadequate for the purpose of demonstrating that **metrological** traceability has been achieved.

5.12 The numerical value of the expanded uncertainty shall be given to, at most, two significant digits. Where the measurement result has been rounded, that rounding shall be applied when all calculations have been completed; resultant values may then be rounded for presentation. 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 Section 7 of the GUM.

5.13 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. 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.

5.14 As the definition of CMC implies, accredited calibration laboratories shall not report a smaller measurement uncertainty than the uncertainty described by the CMC for which the laboratory is accredited.

5.15 As required in ISO/IEC 17025, accredited calibration laboratories shall present the measurement uncertainty in the same unit as that of the measurand or in a term relative to the measurand (e.g. percent).

5.16 CMCs shall not be expressed in PPM or PPB values.

5.17. Calibration Laboratories have to calculate their CMC (Calibration and measurement capability); this has to be calculated and will be checked and approved completely during initial assessment and frequently during surveillance. The CMC will be noted on the annex of the accreditation certificate for the scope (e.g. for customer information). Calibration laboratories have to give a statement of measurement uncertainty of the calibration on each calibration certificate.

When using a standard test method there are three cases:

- When using a standardized test method, which contains guidance to the uncertainty evaluation, testing laboratories are not expected to do more than to follow the uncertainty evaluation procedure as given in the standard.
- If a standard gives a typical uncertainty of measurement for test results, laboratories are allowed to quote this figure if they can demonstrate full compliance with the test method.
- If a standard implicitly includes the uncertainty of measurement in the test results**,** there is no further action necessary.

Testing laboratories should not be expected to do more than take notice of, and apply the uncertainty-related information given in the standard, i.e. quote the applicable figure, or perform the applicable procedure for uncertainty **evaluation**. Standards specifying test methods should be reviewed concerning **evaluation** and statement of uncertainty of test results, and revised accordingly by the standards organization.

6 Example of Guidance Document:

- UKAS M3003, Edition - **4: -October 2019**, available from www.ukas.com
- EA-4/02 M: 2013, Expression of the Uncertainty of Measurement in Calibration, available from www.european-accreditation.org.

7 References

[1] ISO/IEC 17025:**2017**, General requirements for the competence of testing and calibration laboratories.

[2] ILAC-G17:2002, introducing the concept of uncertainty of measurement in testing in association with the application of the standard ISO/IEC 17025.

[3] ISO Guide 35:**2017 Guidance for characterization and assessment of homogeneity and stability**

[4] JCGM 100:2008 GUM, Evaluation of measurement data – Guide to the expression of uncertainty in measurement. (Available from www.BIPM.org).

[5] ISO/IEC Guide 99:2007, International vocabulary of metrology - Basic and general concepts and associated terms (VIM).

[6] JCGM 200:2012 International vocabulary of metrology – Basic and general concepts and associated terms (VIM) (Available from www.BIPM.org).

[7] ILAC-P14:**09/2020** : ILAC Policy for **Measurement** Uncertainty in Calibration