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In-house calibrations and measurement uncertainty



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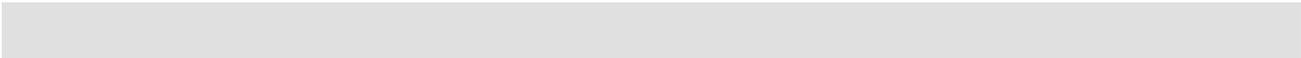
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In-house calibrations and measurement uncertainty

1. Introduction

This technical note has been provided to support NATA Policy Circular 12 on the performance of calibrations in-house. It provides additional guidance and information on the following topics:

- definitions;
- measurement uncertainty;
- references; and
- training courses.

2. Definitions

Where available, definitions from ISO/IEC Guide 99, International vocabulary of metrology – Basic and general concepts and associated terms (VIM) are used.

Calibration

Operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication. (ISO/IEC Guide 99)

Note: These include (but are not limited to) the actions identified in the calibration column of the General Equipment Table in the NATA Standard Application Document.

Check

Measurement of at least one point in a range of a measuring instrument, system or material against a known value to confirm that it has not deviated significantly from its original calibrated value. It can also be an examination of the condition of an instrument or material to determine that it has not been adversely affected by use.

Note: The majority of testing facilities perform checks on equipment which have been calibrated externally by a calibration facility. These are the actions referred to in the checks column of the Calibration Table in the Field Application Document for each field of testing. These are NOT in-house calibrations and do NOT have to be listed in the In-House Calibration section of the Assessment Information Document.

In-house calibration

Calibration where results are used for internal purposes only, i.e. within a facility or organisation, to support the testing or calibration activities for which the facility is accredited.

Measurement

Process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity (ISO/IEC Guide 99)

Measurement uncertainty

Non-negative parameter characterising the dispersion of the quantity values being attributed to a measurand, based on the information used (ISO/IEC Guide 99)

Pre-calculated uncertainty

A value for the measurement uncertainty that has been pre-determined under specified conditions and is then applied to all relevant calibration or test results to which the same conditions apply. This means the facility does not need to recalculate the measurement uncertainty every time that a particular calibration or test is performed.

The facility can use a pre-calculated uncertainty or a set of pre-calculated uncertainties provided it can demonstrate that the:

- calculated value(s) is (are) applicable to all relevant calibrations or tests. This means the size of each component of the uncertainty estimation must be large enough to cover the maximum values expected under normal conditions. This can be demonstrated for any calibration or test by defining limits on the size of each component that is likely to change, e.g. repeatability. Procedures must be in place to ensure that either the uncertainty of measurement is re-estimated or the calibration or test is abandoned in the event that any of these maximum expected values are exceeded;
- test documentation shows that the size of such components is within the specified limits. If expected values have been exceeded test records or worksheets should indicate this and the action taken;
- components relating to the calibration of the reference instruments being used to perform the calibration or test are reviewed and incorporated, as appropriate, each time the reference instrument is recalibrated.
- A pre-calculated uncertainty could also be expressed in the form of an equation which may, for example:
 - include a fixed component, and a component proportional to the range, e.g. % or ppm; or
 - fixed components for discrete steps where the uncertainty allocated for the range is the largest uncertainty calculated for any part of that range.

Testing

Determination of one or more characteristics of an object of conformity assessment, according to a procedure, typically applying to materials, products or processes (ISO/IEC 17000).

Traceability chain

Sequence of measurement standards and calibrations that is used to relate a measurement result to a reference. A traceability chain is used to establish traceability of a measurement result. (ISO/IEC Guide 99)

3. Calibration and measurement uncertainty

Calibration essentially involves applying a known input to an instrument and comparing this with the output of the instrument. In this way, the output of the instrument is related to the 'true' value of the quantity being measured, usually at a number of points in the range of the instrument.

Therefore, the results of the calibration can be reported as either one, or a combination of, the following:

- compliance with a specified requirement;
- a table showing the input and the associated instrument reading, and usually the difference between them;
- an equation describing the relationship between the input and the instrument reading;
- and, of course, the uncertainty associated with the reported result(s).

Wherever practical, standard reporting formats for the specific calibrations should be followed.

The adequacy of the calibration or testing process output is dependent on the process inputs including any environmental or operator effects. If there is a variation in certain inputs, then the output (result) can be expected to vary. Understanding the variation of the test or calibration result with a variation of input is the basis for the determination of measurement uncertainty as the uncertainty of the output (result) is a combination of the uncertainties of measurement of the inputs.

Experienced and appropriately trained facility staff will have an understanding of which input factors have the most influence on the test output and approximately how big that influence is. These input factors can be expressed as components that contribute to an overall measurement uncertainty of the test output but it does not really matter whether the term 'measurement uncertainty' is used. The important thing is that staff responsible for the results understand what factors have an influence on the final result, their relative importance and how tightly they need to be controlled, and the quantitative relationship between their uncertainty and the uncertainty of the result.

It is not possible to specify a set of input quantities for use in measurement uncertainty estimations which apply to all fields of testing and calibration because process inputs vary both in type and in relative consequence for different tests. Some examples are provided in the references included in this Technical

Note and on the NATA website (www.nata.com.au) under 'Technical Publications > Uncertainty of Measurement > Traceability'.

Note: Spreadsheets can also be a useful tool for the calculation of the total measurement uncertainty, once the components of the uncertainty have been identified and a value assigned to them.

4. References

The following documents describe how to go about estimating measurement uncertainty and also provide some worked examples. It is strongly recommended the most relevant document(s) are obtained and used to ensure relevant staff are appropriately trained.

1. Assessment of uncertainties of measurement for calibration and testing laboratories. R R Cook.

Note: This is a NATA publication produced to summarise the main features of the ISO GUM. It also includes some worked examples of measurement uncertainty calculations, primarily for calibrations.

2. Guide to the expression of uncertainty in measurement—ISO/IEC GUM (ISO/IEC Guide 98-3)
3. CITAC/EURACHEM Guide: *Quantifying Uncertainty in Analytical Measurement*. Available from <http://www.eurachem.org/index.php/publications/guides/quam>.

Note: This publication is aimed at chemical and biological testing facilities. It contains a number of worked examples, mostly for testing processes.

The following references provide some practical information on calibration, checks and traceability:

1. AS/NZS ISO 10012—Measurement management systems—Requirements for measurement processes and measuring equipment.
2. NATA Field Application Documents—Part of the NATA accreditation criteria and available from the NATA website.
3. NATA Policy Circular 11—*Policy on metrological traceability*, available from the NATA website.

5. Measurement uncertainty training

There are a number of training courses available on the subject of measurement uncertainty and traceability. Some organisations currently providing face-to-face courses are:

The National Measurement Institute (NMI)

Details are available at the National Measurement Institute website (www.measurement.gov.au).

Metrology Training International Pty Ltd (MTI)

To obtain more information visit the website www.uncertainty.com.au or e-mail mettrain@optusnet.com.au.

AMENDMENT TABLE

The table below provides a summary of changes made to the document with this issue.

Section	Amendment
Queries	Section Removed