

## Using Reference Materials to Establish Metrological Traceability

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*Traceability of measurements enables results to be compared across space and time and is a requirement of ISO/IEC 17025. This note describes the steps that need to be applied to chemical measurement methods to ensure traceability of the results. Reference materials are key to achieving traceability of measurement results. The ERM® range of certified reference materials are produced by three of Europe's top metrology institutions. ERM® reference materials have stated traceabilities and provide a means of ensuring reliability and comparability of the results of chemical analysis.*

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### INTRODUCTION

All chemical measurement results depend upon and are ultimately traceable to the values of measurement standards of various types, such as those for mass, volume and the amount of a particular chemical species. If results obtained by different laboratories are to be comparable, it is essential that all results are based on reliable measurement standards whose values are linked to a stated reference. If there are differences in the quality of the measurement standards used in different laboratories, discrepancies will inevitably arise when different laboratories analyse the same sample. It is a requirement of standards such as ISO/IEC 17025 [1] that test results should be traceable, preferably to national or international standards.

### DEFINITION

*"Traceability is a property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties" [2].*

### TRACEABLE MEASUREMENTS

The value of the result for an unknown quantity obtained from a comparison with the value of a calibration standard (where the uncertainty of the result is the uncertainty of this comparison plus the uncertainty of the standard) is traceable to the value of the calibration standard provided the method used for the comparison is *valid* and the *uncertainty* of the calibration standard is known.

#### **Application to chemical measurements**

Method development establishes an optimised procedure which can be used to compare a

sample and standard. Validation shows that, in terms of its performance, this procedure is fit for the purpose in hand and has the appropriate uncertainty.

Calibration establishes the relationships between the values provided by the measurement system with the values of the reference standards.

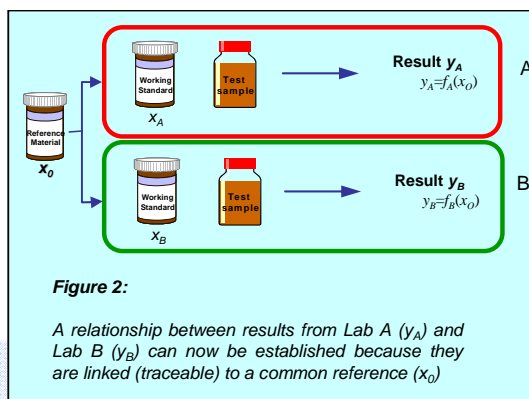
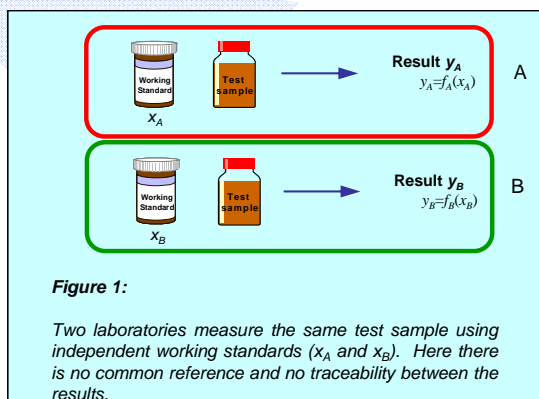
Traceability or control has to be established for each parameter specified in the procedure. Traceability is established through the use of measurement standards (e.g. certified reference materials) which are appropriate for each parameter. These certified reference materials are selected on the basis of fitness for purpose.

#### **Establishing Traceable Results**

The following steps are necessary to establish traceable results [3]:

- 1) Specify the measurand and acceptable uncertainty.
- 2) Choose a suitable method of estimating the value, *i.e.* a measurement procedure with associated calculation (equation) and measurement conditions.
- 3) Demonstrate (validation) that the calculation and measurement conditions include all the 'influence quantities' that significantly affect the result.
- 4) Identify relative importance of each influence quantity. A methodology to help analysts categorise the degree of control to be applied to realising a particular experimental value has been developed [4].
- 5) Choose and apply appropriate certified reference materials and standards.
- 6) Estimate the uncertainty of the result.

Figures 1 and 2 show how calibration using a common reference material provides comparability between laboratories and allows a meaningful comparison of results.



## A STRATEGY FOR ESTABLISHING TRACEABILITY

### To achieve traceability

- The method must be properly validated and applied within its stated scope. If not, erroneous results may still be produced, even if all measurements and standards are traceable.
- The method must be carried out using the **appropriate stated references**.

### Key steps to select the appropriate stated references

- Write down and understand the equation used to calculate the analytical result.
- Identify any 'reagents' or equipment with specified values detailed in the method.
- Identify the fixed conditions used in the method.
- Obtain appropriate 'stated references' for use in the practical measurement or realisation of the experimental value.

### What are 'appropriate stated references'?

- Any 'reference point' that an analyst uses to obtain or realise a particular quantity value in practice.
- Physical calibrations are well established, e.g. calibrated weight; reference thermometer; volumetric glassware; stopwatch.
- Chemical calibrations can be established in the same way using pure or matrix certified reference materials (calibrants) or other well-characterised pure materials.

### What is appropriate?

- The analyst must decide, based on:
  - The degree of control that is required in obtaining or realising a particular value in practice.
  - The extent to which the quantity affects the result.
  - The uncertainty of each stated reference must be appropriate.

1 International Standards Organisation (2005) ISO/IEC 17025: General Requirements for the competence of testing and calibration laboratories. ISO, Geneva

2 International Vocabulary of Basic and General Terms in Metrology. ISO, Geneva, 1993, 2nd edition. ISBN 92-67-01075-1

3 Eurachem/CITAC 2003, Traceability in Chemical Measurement. A Guide to achieving comparable results in chemical measurements (www.eurachem.ul.pt)

4 Meeting the Traceability Requirements of ISO/IEC 17025. An Analyst's Guide. 3rd Edition. V Barwick and S Wood (Editors), LGC Limited, September 2005. ISBN 0-948926-23-6