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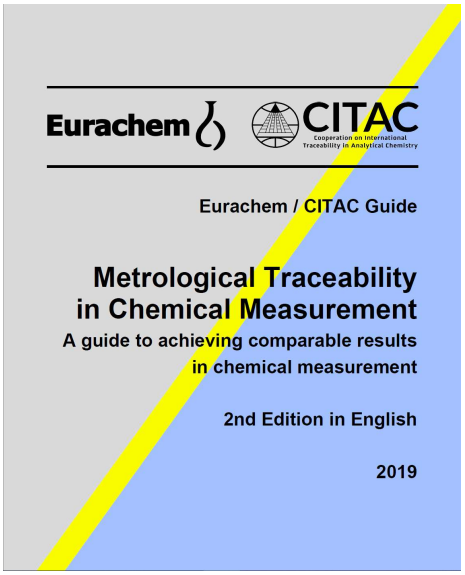
Metrological Traceability Part 1: Principles of the Eurachem Guide

S Ellison



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The Guiding Principle

A measurement result arises from an equation

$$y = f(x_1, x_2 \ldots \quad x_m)\Big|_{x_{m+1},\, x_{m+2} \ldots \quad x_n}$$

which is **assumed to hold**

under certain conditions

y is traceable to $x_1 \ldots . x_n$

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Implications: 1

If $y = f(x_1, x_2 \ldots \quad x_m)\Big|_{x_{m+1}, x_{m+2} \ldots \quad x_n}$

- The sole* requirement for y to be traceable to higher references is that $x_1 \ldots x_n$ are traceable to higher references or are defined constants
- Calibration or control for $x_1 \ldots x_n$ is sufficient

other than MU requirements

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Implications: 2

2. If we assume completeness for

$$y = f(x_1, x_2 \ldots \quad x_m)\Big|_{x_{m+1}, x_{m+2} \ldots \quad x_n}$$

- The assumption(s) involved must be tested and shown to hold

This is an essential part of method validation

Validation is crucial
to practical traceability

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Further implications

- Measurement uncertainty need only consider $x_1 \ldots x_n$
  - Nothing else affects the result y
- Validation and QC materials/references are not in the equation or specified conditions
  - No need to consider them part of the 'traceability chain'
- A result is traceable to/via *all of its input and control values*

  ∴ Cannot usually expect a simple statement of traceability to a single reference standard.

Part 2:
Understanding metrological traceability – a survey-based exploration of perceptions

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Why survey perceptions of traceability?

- Metrological traceability is a fundamental concept in metrology and accreditation
- The concept is simple in principle but can be intricate in practice
  - The role of validation and QC materials in establishing traceability is not immediately clear
  - The effect of 'recalibration' on traceability is not considered in most guidance
  - Traceability for values obtained by interlaboratory study have been widely discussed – often negatively.

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Survey format

- Online survey operated via Google Forms
- Two respondent classification questions
  - Organisation type and Field of study
- Two main sections
  - Part 1:
    Five laboratory scenarios, increasing in complexity
  - Part 2: (Optional)
    Four RM certification scenarios of increasing complexity
- All but closing comment questions were check-box or multiple response with free text 'Other' field
- No questions were mandatory and respondents were permitted to edit responses or submit further responses at a later date

WARNING
Voluntary response surveys are not representative

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Timing and distribution

- Launched by email and via social media 11 January 2019.
- Primary audience – analytical chemists via the Eurachem network
- Intentionally distributed to NMI contact and invited contributions from other fields
- Reminders and prompts issued Feb 2019
- Closed: 22 March 2019

464 responses received before closure

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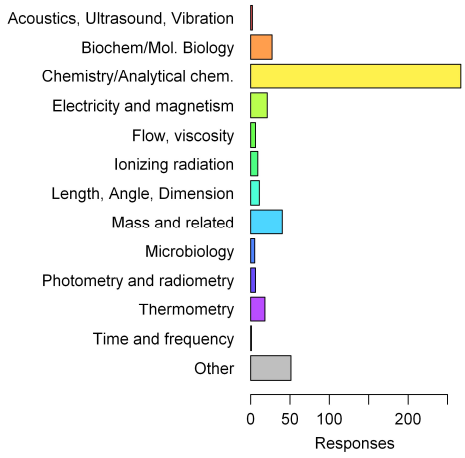
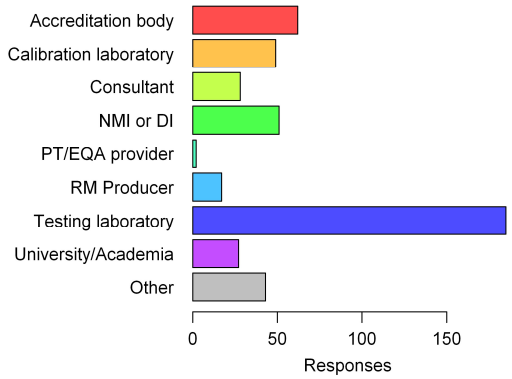
Response categories

Measurement sector



Organisation type



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Response Summary (Undifferentiated)

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Scenario 1: Single calibration standard

DESCRIPTION

A sample is weighed, following an accredited procedure, using an instrument that has been calibrated at the time of measurement with a measurement standard (in kg) provided by an accredited calibration laboratory. The calibration laboratory calibrates using standards provided by their National Measurement Institute (NMI) (for example, NIST, PTB, NMIJ, ...).

Simple instrument, single calibrant

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Scenario 1: Question/responses

Which statement below best represents your view of the metrological traceability of the result (measured mass)?

- The measurement result is traceable to the value of the calibration standard
- The measurement result is only traceable to the provider of the calibration standard
- The measurement result is traceable to the SI
- The measurement result is traceable to the National Measurement Institute
- The measurement result is traceable to the calibration laboratory
- The measurement result is traceable to the kilogram
- No guarantee of metrological traceability can be given
- Other [Free text]

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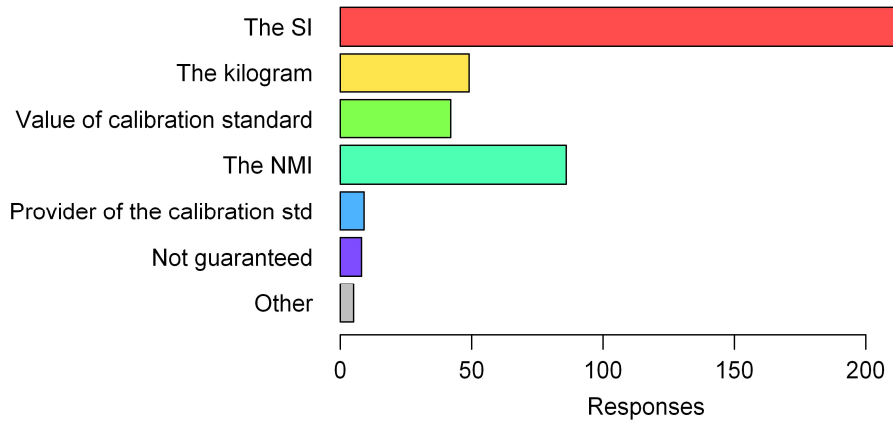
Scenario 1: Question/responses

Which statement below best represents your view of the metrological traceability of the result (measured mass)?



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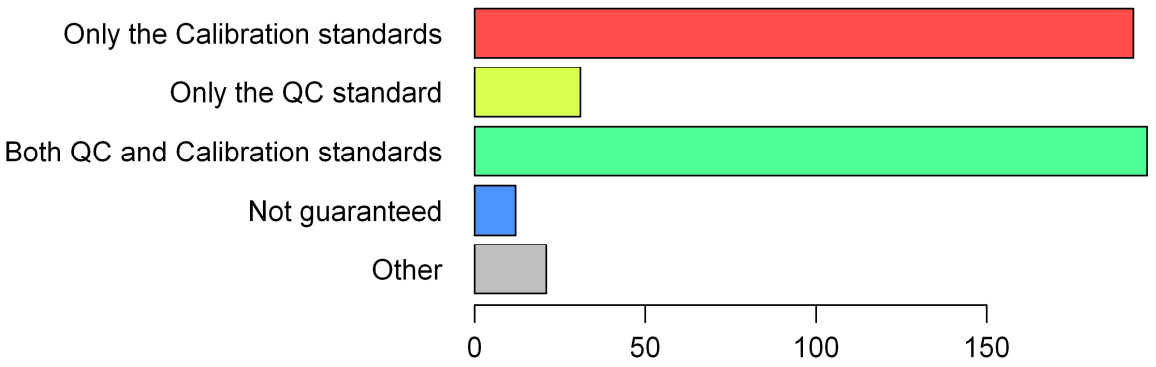
Scenario 2: Use of a certified check sample for quality control

Metrological Traceability [is to …]



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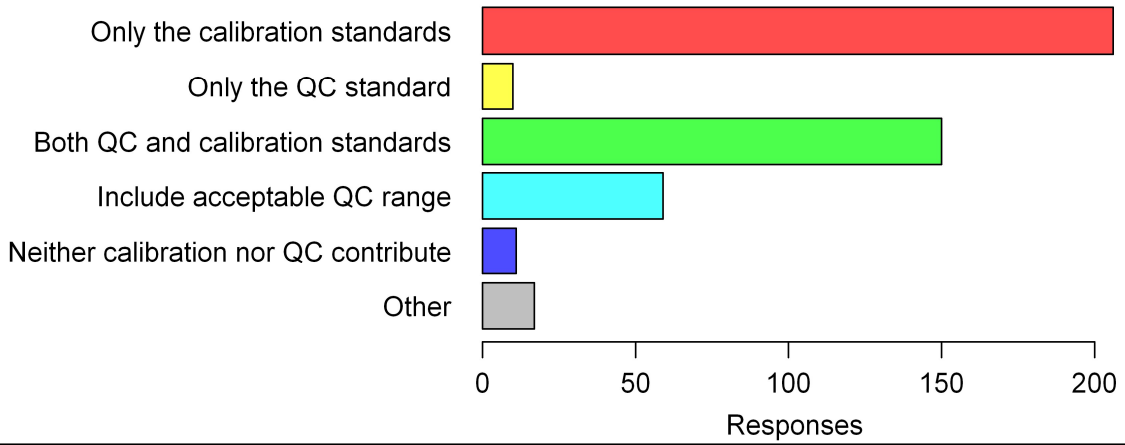
Scenario 2: Use of a certified check sample for quality control

Measurement uncertainty [should include …]



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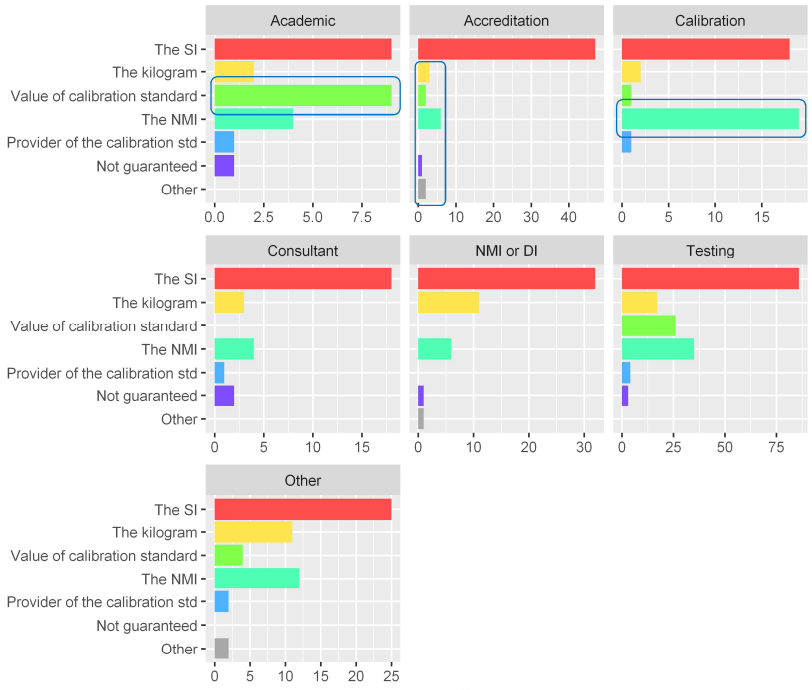
See online for
more summaries

http://bit.ly/EUCHM_TRC_2019_SUMMARY

Responses by Organisation Type
[Significant only]

Scenario 1: Traceability



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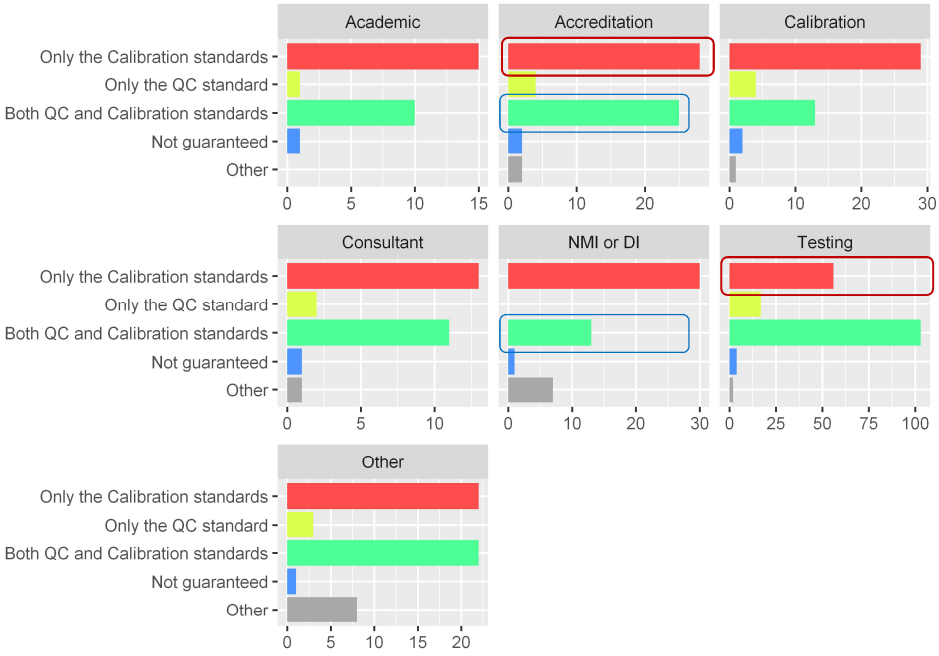
Scenario 2: Traceability



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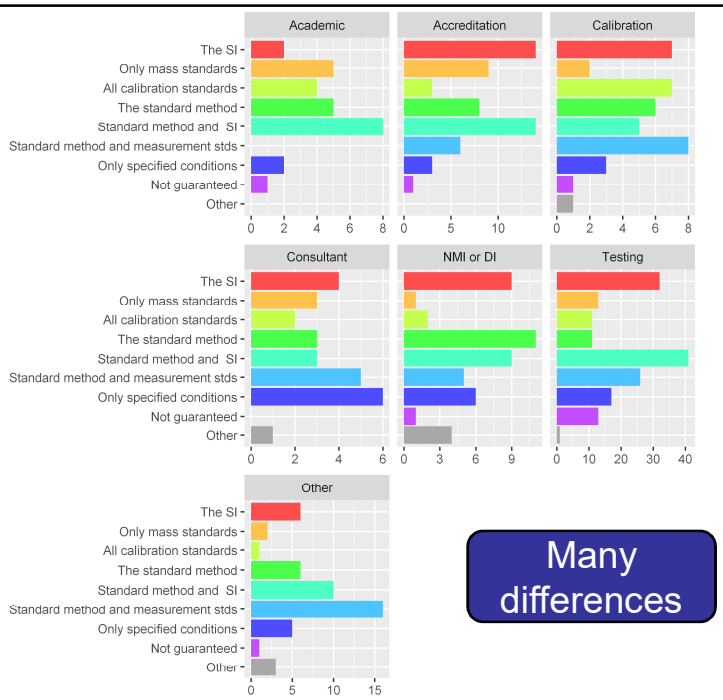
Scenario 4: Operationally defined measurand - Traceability



Many differences

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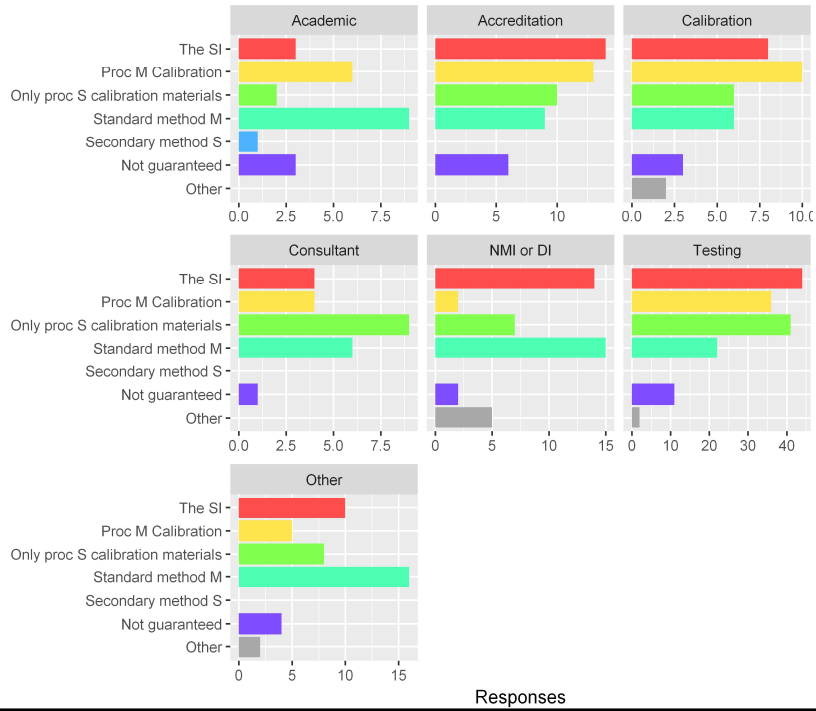
Scenario 5: Operationally defined/ Secondary procedure - Traceability



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What have we learned?

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Metrological traceability

- All groups represented offered a range of responses
  - Little consensus on the ‘best’ description except in simple cases
- Traceability “to the NMI” is still a common – but not dominant – concept
- Traceability to local calibration standards is often not interpreted as implying higher traceability
- The role of QC checks in establishing traceability is not clear

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Measurement uncertainty

- The great majority of respondents correctly expect standards to contribute to uncertainty
- Many labs expect QC material uncertainties and/or QC limits to contribute to uncertainty
- Doubts or misconceptions about metrological traceability may be impeding understanding of contributors to uncertainty
  - Or vice versa!

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Interlaboratory certification

- Traceability chains are not clear to respondents
  - Accreditation body respondents appeared more likely to identify results as SI traceable when participants are accredited
- Operationally defined measurands and methods showed by far the least consensus

Traceability statements are difficult!

Acknowledgements

I Leito, E Sahlin, B Magnusson, R Bettencourt da Silva
Eurachem Measurement Uncertainty and Traceability Working Group

Thanks for your attention!