

Estimates of measurement uncertainty using data from participation in External Quality Assessment Schemes for trace elements in biological fluids



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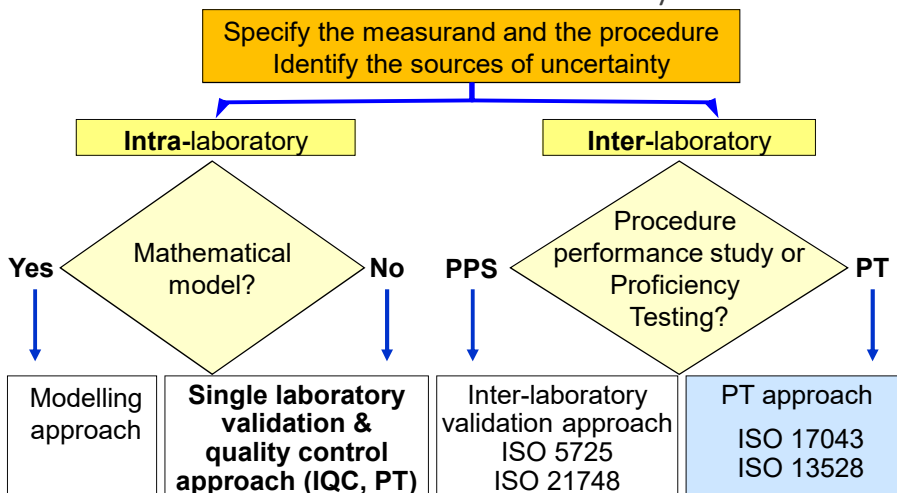
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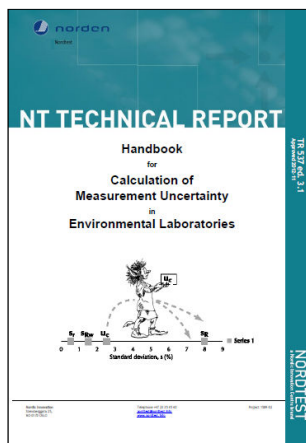
Approaches to the evaluation of measurement uncertainty*



*Graph outline from: EUROLAB Technical Report No. 1/2007

www.eurolab.org

The Nordtest approach main equations



$$u_c = \sqrt{u(R_w)^2 + u(bias)^2}$$

Within-laboratory
reproducibility

Uncertainty of the
estimate of the
laboratory and the
procedure bias

$$u(bias) = \sqrt{RMS_{bias}^2 + u(C_{ref})^2}$$

Bias variability

Average uncertainty of
the reference value

<http://www.nordtest.info/index.php/technical-reports/item/handbook-for-calculation-of-measurement-uncertainty-in-environmental-laboratories-nt-tr-537-edition-3.html>

Nordtest approach

ADVANTAGES

Based on **real working data**

Assessment of bias **over a range of matrices / levels** (scope of the method)

Simplified approach, less rigorous statistics

LIMITATIONS

It requires:
- a **large amount** of data
- collected over a **period of time**

Ideally **CRMs / reference measurements** should be used to estimate bias

“Rough” approach
→ **it overestimates MU**

PT items for MU estimate: pros / cons

Availability

Covering the range of concentrations / matrices

Closer to real samples

Limited cost

Assigned values often not traceable but

when considerable experience exists, consensus values are a good estimate of reference values

In many areas of testing, most laboratories participate in PT not more than once a year....!

Laboratory Medicine External Quality Assessment Schemes

Typically:

- Covering the range of matrices / levels
- High frequency, e.g. once a month
- Estimates of precision included

Can this information be used by the provider to estimate a participant's measurement uncertainty with the Nordtest approach?

EQA Schemes involved in this project

The Federate EQAS for trace elements in biological fluids

- A joint EQAS sharing the same PT items and database among 6 different countries (Australia, Belgium, France, Italy, Spain, The Netherlands)

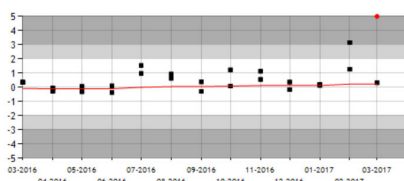
UK TEQAS

- A UK-based EQAS for trace elements with world-wide participation

Both part of the Network of Organizers of EQAS
in Environmental and Occupational Laboratory Medicine
www.trace-elements.eu



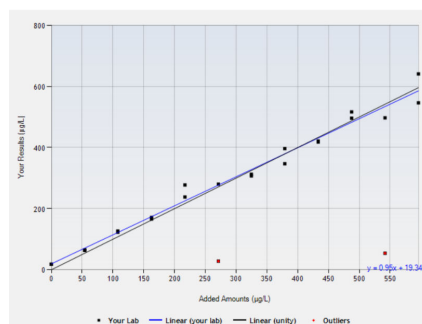
Features of the Federate OELM EQAS (1)



24 PT items, including 12 duplicates

Two PT items analysed each month
in a cycle of 12 months

- Assigned values: robust means, x^*
- Uncertainties of assigned values calculated from the robust SD, s^* as described in ISO 13528
- z-scores against pre-set criteria
- Annual evaluation of laboratory intermediate precision based on differences between duplicates, excluding «outliers», i.e. data with $|z\text{-score}| > 5$



Features of the Federate OELM EQAS (2)

Performance score

Z-score	Performance score
≤ 1	3
$> 1 - 2$	2
$> 2 - 3$	1
> 3	0
No result submitted	0

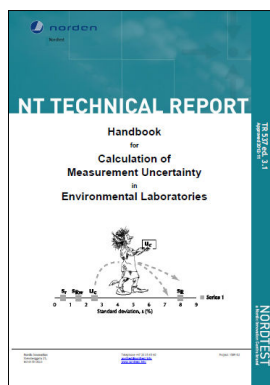
Performance score includes:

- «outliers», i.e. data with $|z\text{-score}| > 5$
- not reported results

Cumulative Performance score

Analyte	Submissions		Performance	
	Your Lab	Max	Your Lab	Min Pass
Cd Blood	24	24	62	48
Co Blood	24	24	67	48
Cu Blood	24	24	62	48
Hg Blood	24	24	61	48
Mn Blood	24	24	61	48
Pb Blood	24	24	54	48

Example



Preliminary assessment using only data from the Federate OELM EQAS

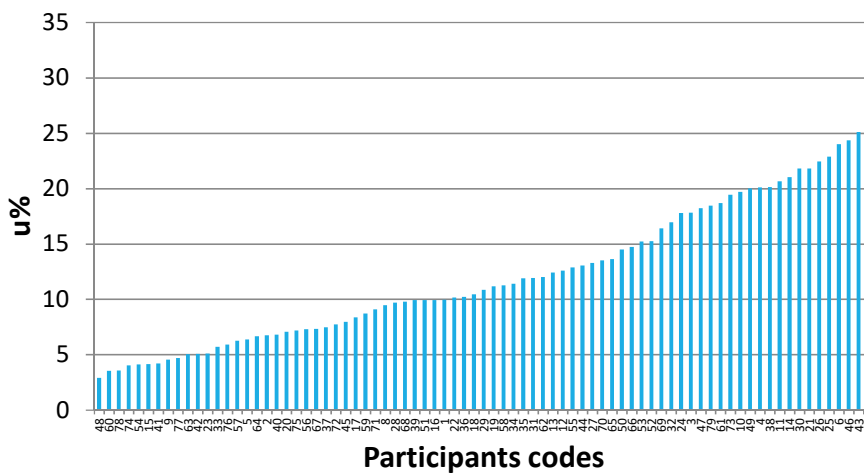
- Pb in blood
- Cycle: 2016-2017
- 102 participants
- Different analytical techniques: ETAAS, ICP-MS, FAAS
- Conc range: 20 – 600 $\mu\text{g/L}$

79 sets > 12 results, at least 3 pairs

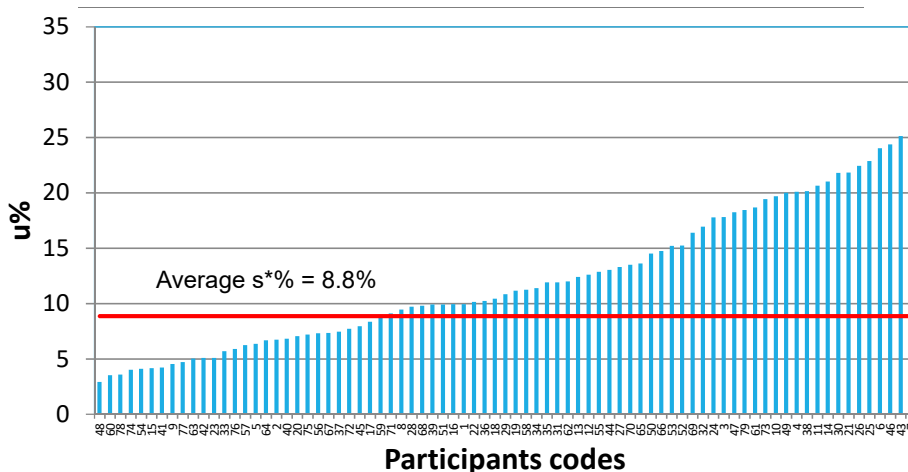
Exclusions:

- «Outliers» (i.e. data with $|z\text{-score}| > 5$).
Where possible, obvious blunders (such as wrong units, transcription errors, decimal errors) corrected
- Data reported as «0»: excluded

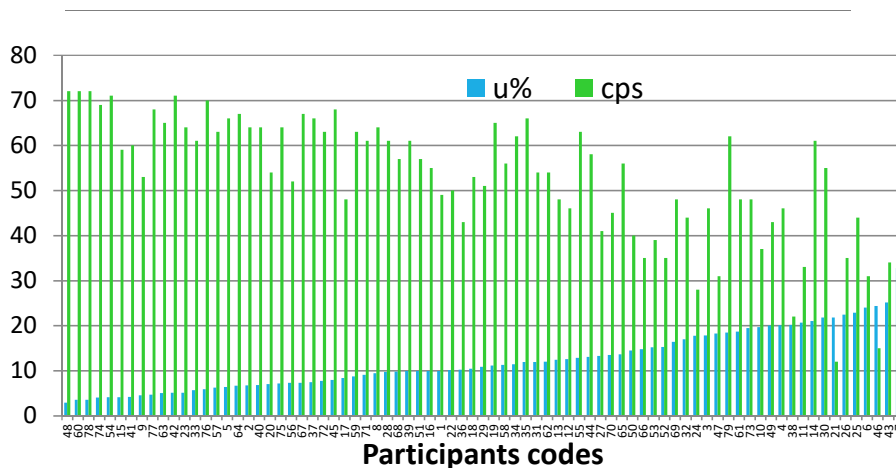
Participants' measurement uncertainty estimated from their EQAS data: Pb in blood, 2016-2017



Participants' measurement uncertainty estimated from their EQAS data: Pb in blood, 2016-2017



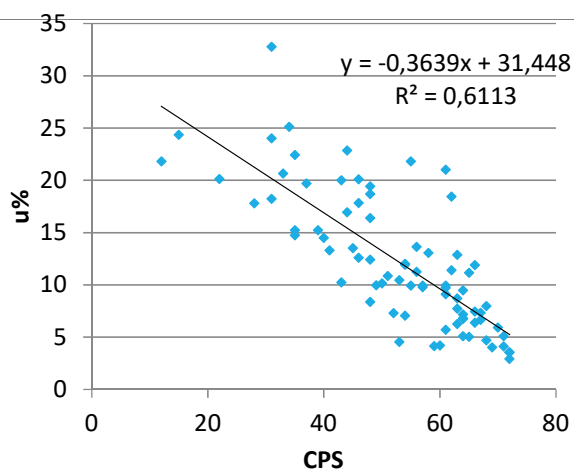
Participants' MU vs Cumulative Performance Score: Pb in blood, 2016-2017



EURACHEM WORKSHOP ON PROFICIENCY TESTING IN ANALYTICAL CHEMISTRY, MICROBIOLOGY AND LABORATORY MEDICINE
PORTOROZ (SLOVENIA), 9 - 12 OCTOBER 2017

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Participants' MU vs Cumulative Performance Score: Pb in blood, 2016-2017



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Are these MU estimates plausible?

Use of PT to check measurement uncertainties

The ζ (zeta)-score can help to check the plausibility of the laboratory's measurement uncertainty estimate. It is calculated as follows:

where x is the laboratory's result, X the assigned value, and their

$$\zeta = \frac{(x - X)}{\sqrt{u_x^2 + u_X^2}}$$

Evaluation:

- 0 < |z| ≤ 2 : satisfactory
- 2 < |z| ≤ 3 : *questionable*
- |z| > 3 : unsatisfactory

respective standard uncertainties (u_x and u_X).

From the Eurachem leaflet
«How can proficiency testing help my laboratory?»



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- ✱ Lab 65

Conclusions

- It looks promising!
- It is based on independent tests of the performance of the laboratory
- It is «taylored» to the individual participant!
- It requires no additional work from participants!



Application over wide ranges must consider constant vs proportional MU

The skilful assistance of Irene de Graaf is gratefully acknowledged