• MU ESTIMATION FROM TECHNICAL, MATRIX AND DISTRIBUTIONAL UNCERTAINTIES
• MU EXPRESSION IN TEST REPORTS

EURLs *Campylobacter*, CPS & *Lm* webinar on MU
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Combined and Expanded Standard Uncertainty

Combined standard uncertainty

- 2 options provided in ISO 19036 (8.1.3)
  - Option 1: A combination of separately estimated:
    - ✓ technical standard uncertainty
    - ✓ matrix standard uncertainty
    - ✓ distributional standard uncertainties
  - Option 2: reproducibility standard deviation alone (technical standard uncertainty)

➢ Recommendation of EURLs guide (2.1): to use option 1 and not option 2

⮰ Values of matrix uncertainty are provided

Combined standard uncertainty based on separate technical, matrix and distributional standard uncertainties (option 1) (1)

- Estimate technical uncertainty as a reproducibility standard deviation
  - $u_{\text{tech}} = s_R$

- Estimate matrix uncertainty
  - $u_{\text{matrix}} = s_r$

Combined standard uncertainty based on separate technical, matrix and distributional standard uncertainties (option 1) (2)

- Estimate any relevant distributional uncertainties from the data underlying the reported results
- Derive the combined standard uncertainty $u_c(y)$

$$u_c(y) = \sqrt{u_{tech}^2 + u_{matrix}^2 + u_{Poisson}^2 + u_{conf}^2} \quad \text{(example)}$$

- For a given method, not all the terms will be included in the calculation of combined standard uncertainty

E.g., a CCT without partial confirmation: $u_c(y) = \sqrt{u_{tech}^2 + u_{matrix}^2 + u_{Poisson}^2}$

Expanded uncertainty

- Calculate the expanded uncertainty *U* from the combined standard uncertainty $u_c(y)$, with a coverage factor *k*:

$$U = k \times u_c(y)$$

- In ISO 19036 , *k* is chosen as a value of 2
  - To correspond approximately to a confidence level of 95%
  - Therefore

$$\boldsymbol{U = 2u_c(y)}$$

Expression of Measurement Uncertainty in test reports

Reporting Measurement Uncertainty (1)

- MU reported in same unit as test result
- Number of figures in reported MU
  - To reflect practical measurement capability
  - And the same than for the test result
    - ➢ It is recommended that expanded uncertainty be rounded to 2 significant figures

Reporting Measurement Uncertainty (2)

Three options to express MU in test report:

- Using $\log_{10}$ scale
  - Option 1: $\log_{10}$ result ± *U* : $y \pm U \log_{10}$ cfu/g
  - Option 2: $\log_{10}$ result with limits : $y \log_{10}$ cfu/g $[y - U; y + U]$
- Using natural values (anti-log)
  - Option 3: natural result value with limits : *x* cfu/g $[10^{y-U}; 10^{y+U}]$

Example

Result (x) = 1,00 x10^5 cfu/g, therefore y = $\log_{10}$ result (x) = 5,00, and U = 0,31 $\log_{10}$

- Report using $\log_{10}$ scale
  - $\log_{10}$ result ± U : $y \pm U$ $\log_{10}$ cfu/g

    5,00 +/- 0,31 $\log_{10}$ cfu/g
  - $\log_{10}$ result with limits : y $\log_{10}$ cfu/g [$y - U$; $y + U$]

    $y - U$ = 5,00 – 0,31 = 4,69

    $y + U$ = 5,00 + 0,31 = 5,31

    5,00 $\log_{10}$ cfu/g [4,69; 5,31]
- Report using natural values (anti-log)
  - Natural result value with limits : x cfu/g [10^{y-U} ; 10^{y+U}]

    $10^{y-U} = 10^{4,69}$ = 48977 (rounded to 4,90 x 10^4)

    $10^{y+U} = 10^{5,31}$ = 204173 (rounded to 2,04 x 10^5)

    1,00 x10^5 cfu/g [4,90 x 10^4 ; 2,04 x 10^5]

Results below Limit of Quantification (LOQ)

- Can arise:
  - for a CCT, when the number of counted colonies is zero, $\Sigma C = 0$
  - for a CCT with partial confirmation, when the number of confirmed colonies is zero, $n_c = 0$
- Not covered today, see ISO 19036, clause 9.2, including examples

Reporting Measurement Uncertainty

Include in the test report an explicit statement:

- the indicated MU is an expanded uncertainty
- the confidence level (95%)
- MU has been estimated in accordance with EN ISO 19036

"The reported expanded measurement uncertainty has been estimated in accordance with ISO 19036 and is based on a standard uncertainty multiplied by a coverage factor of $k = 2$, providing a level of confidence of approximately 95 %."