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## Handling high uncertainty using the uncertainty factor

B. Magnusson

Eurachem on-line workshop  
25-26 October 2022  
Measurement uncertainty evaluation  
based on in-house validation data

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## Scope

How to report result with  
confidence interval when  
measurement uncertainty is high

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## Reporting result – 50 mg/kg

Low uncertainty $U = 10 \%$	High uncertainty $U \approx 70 \%$
Result is $50 \text{ mg/kg} \pm 5 \text{ mg/kg}$ <b>Symmetric interval</b>	Results is 50 mg/kg $U_{\min} = 25 \text{ mg/kg}$ $U_{\max} = 100 \text{ mg/kg}$ <b>Asymmetric interval</b>

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## What does GUM say

GUM proposes mostly symmetric interval, but annex G.5.3 states in case of high asymmetry:

*“The alternative is to give  
**an interval that is symmetric in probability**  
(and thus asymmetric in U):  
the probability that Y lies below the lower limit  
 $y - U_-$  is equal to the probability  
that Y lies above the upper limit  $y + U_+ \dots$ ”*

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## Reporting result – 50 mg/kg Intervals symmetric in probability

Low uncertainty* $U = 10 \%$	High uncertainty* $U \approx 70 \%$
Result is $50 \text{ mg/kg} \pm 5 \text{ mg/kg}$ <b>Symmetric probability</b>	Results is 50 mg/kg $U_{\min} = 25 \text{ mg/kg}$ $U_{\max} = 100 \text{ mg/kg}$ <b>Symmetric probability</b>
*Assuming a normal distributions	*Assuming a lognormal distribution

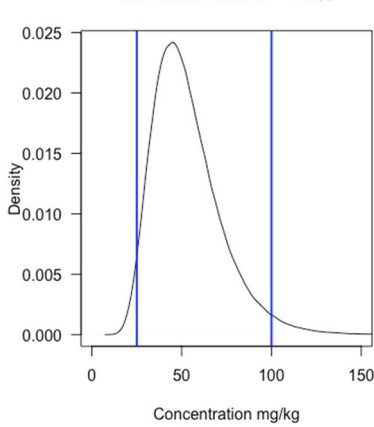
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## High uncertainty – skewed distribution


Result 50 with  $U = 72 \%$



$U_{\min} = 25$   
 $U_{\max} = 100$   
Results  
50 [25,100] mg/kg

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**How to calculate  $U_{\max} = 100$  and  $U_{\min} = 100^*$**


We use an **Uncertainty Factor = 2.0**  
by which the measured value is multiplied and  
divided to get the uncertainty interval.

$$U_{\min} = x / {}^F U = 50 / 2.0 = 25 \text{ mg/kg}$$
$$U_{\max} = x \times {}^F U = 50 \times 2.0 = 100 \text{ mg/kg}$$

\*Source Eurachem Guide on Measurement  
uncertainty arising from sampling

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**How to calculate  ${}^F U = 2.0^*$**

1. Calculate the the standard uncertainty  $u'$  in RSD  
 $u' = \frac{1}{2} * U/100$  for  $U \approx 70\%$  we get  $u' = 0.35$
2. Calculate the natural log standard deviation  $s_g$   
 $s_g \approx u' = 0.35$
3. Calculate the uncertainty factor  
 ${}^F U = \exp(2s_g) = \exp(2 \times 0.35) = 2.0$

\*Source Eurachem Guide on Measurement  
uncertainty arising from sampling

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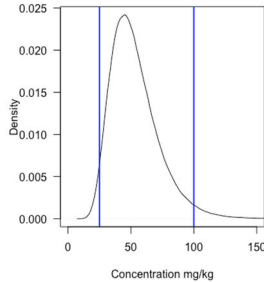
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**The approximation  $s_g \approx u' = 0.35$**

Assuming a lognormal distribution with a  $\log s_g = 0.35$  and a simulation the calculated


$u' = 0.36\%$  so  
the exact  $U = 72\%$

**Result 50 with U = 72 %**



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**A result of 50 mg/kg with  $U \approx 70\%$**

Results can be reported with a confidence interval with a **symmetric probability** using the uncertainty factor

**Result**  
**50 [25,100] mg/kg**  
or  
**50 (-25,+50) mg/kg**

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**THANKS FOR LISTENING**

Now open for questions!