

Using z'-scores with an assigned value obtained by consensus: a new possibility in ISO 13528:2015



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Introduction

The organization of proficiency tests (PT) for National Reference Laboratories (NRLs) is one of the duties of the European Union Reference Laboratory (EURL) according to the Directive no 96/23/EC. The participation in these PTs allows NRLs and official control laboratories (OCLs) to assess their competence and to prove the reliability of their results.

The organization and statistical analysis of this proficiency study were performed according to ISO/IEC 17043 and ISO 13528:2015 standards. The assigned value (x_{pt}) was determined as the consensus of the results of all participants using robust statistics with the algorithm A. The robust standard deviation (s^*) and the uncertainty ($u(x_{pt})$) were also calculated. The assessment of laboratory performance according to the decision 657/2002/EC is performed using z-scores, only when the uncertainty of the assigned value was below 0.3 times the standard deviation for performance assessment ($u(x_{pt}) \leq 0.3 \hat{\sigma}_{pt}$). The standard deviation value for the proficiency test ($\hat{\sigma}_{pt}$) derived from predictive general models, such as the Horwitz equation or the complementary Thompson model. Whenever $u(x_{pt}) > 0.3 \hat{\sigma}_{pt}$ the uncertainty of the assigned value has to be taken into account (quadratically) by expanding the denominator of the performance score, resulting in the use of the z'-score. The new ISO 13528:2015 does allow the use of the z'-score even when the assigned value is determined as the consensus of the reported results.

Scope:

In our PT, to confirm and quantify dyes, chloramphenicol and nitrofurantoin residues the ratio $u(x_{pt})/\hat{\sigma}_{pt}$ of 0.684 corresponds to an $u(x_{pt})$ contributing to 47 % of $\hat{\sigma}_{pt}$, instead of the 9 % recommended by ISO 13528 standard. Consequently PT provider decided to report the z'-scores values as indicative values.

However, up to which value of this ratio can the proficiency of participants be evaluated? Without given warning signals or action signals, whereas the corresponding z'-scores do not exceed critical values and so do not give signals.

Two different possibilities:

➔ $u(x_{pt}) \leq 0.3 \sigma_{pt}$

➔ $u(x_{pt}) > 0.3 \sigma_{pt}$

• Performance assessment

z-score

$$z = \frac{(x_i - x_{pt})}{\sigma_{pt}}$$

z'-score

$$z' = \frac{(x_i - x_{pt})}{\sqrt{\sigma_{pt}^2 + u^2(x_{pt})}}$$

• Interpretation of the score

$|z| \leq 2.0$ Acceptable
 $2.0 < |z| < 3.0$ Give a warning signal
 $|z| \geq 3.0$ Unacceptable

$|z'| \leq 2.0$ Acceptable
 $2.0 < |z'| < 3.0$ Give a warning signal
 $|z'| \geq 3.0$ Unacceptable

With z'-score always smaller than z-score by a factor f

• Factor (f)

$$f = \frac{\sigma_{pt}}{\sqrt{\sigma_{pt}^2 + u^2(x_{pt})}}$$

• Range of the factor (f)

$0,96 < f < 1,00$

$0,74 < f < 0,93$

Z-scores	u(xpt)/σ pt				
	0	0.3	0.5	0.7	0.9
0.10	0.10	0.10	0.09	0.08	0.07
0.50	0.50	0.48	0.45	0.41	0.37
0.75	0.75	0.72	0.67	0.61	0.56
1.00	1.00	0.96	0.89	0.82	0.74
1.50	1.50	1.44	1.34	1.23	1.11
2.00	2.00	1.92	1.79	1.64	1.49
2.50	2.50	2.39	2.24	2.05	1.86
3.00	3.00	2.87	2.68	2.46	2.23
3.50	3.50	3.35	3.13	2.87	2.60
4.00	4.00	3.83	3.58	3.28	2.97

Table1: z' values for different ratio u(xpt)/σ pt compared to z values

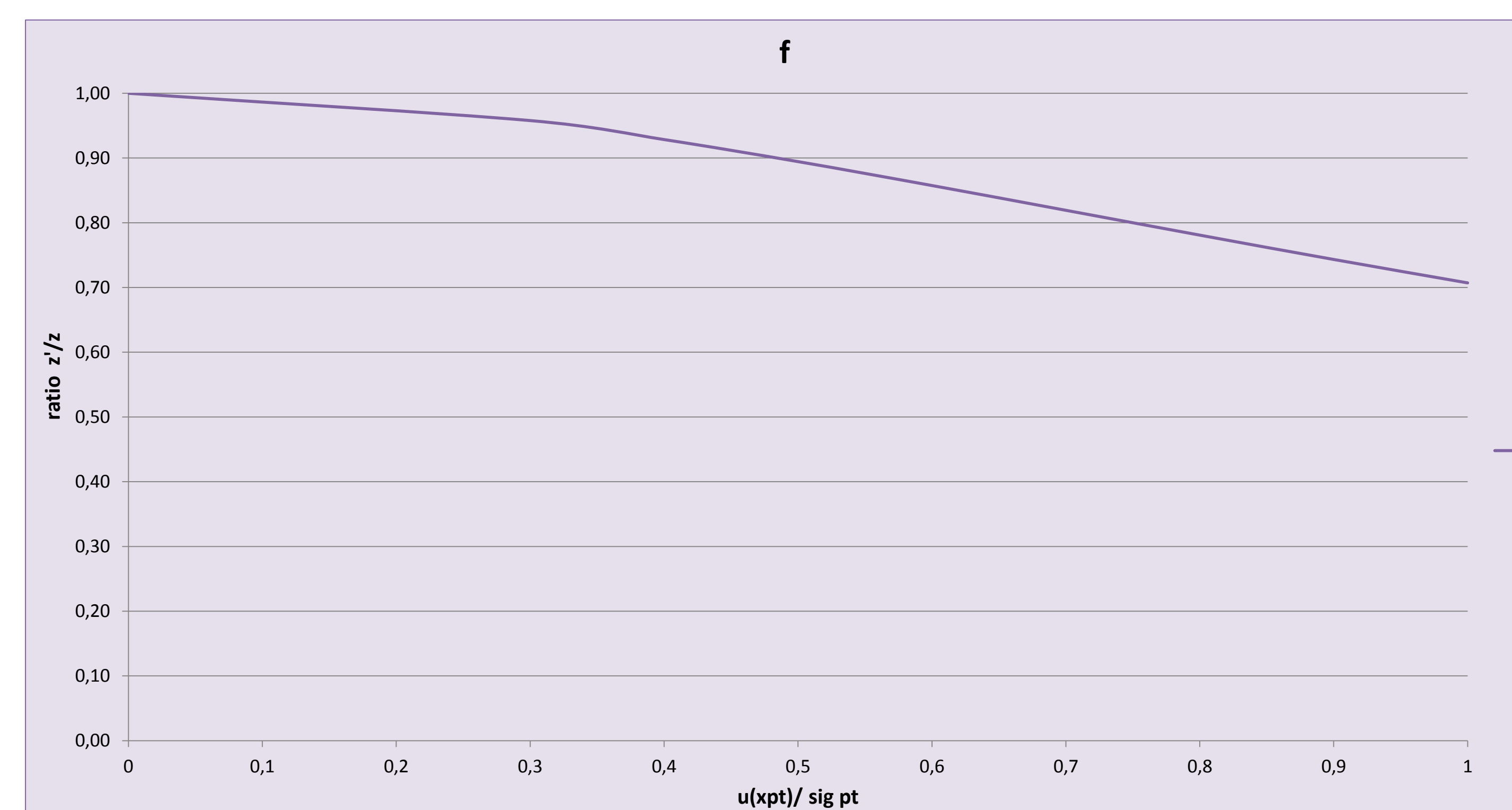


Fig1. Graphical representations of the ratio Z'-score /z-score depending of u(xpt)/σ pt

Conclusion:

When the uncertainty is not negligible it is recommended to calculate the z'-score in order to evaluate the proficiency of the participant. This z'-score give less actions signal.

References

- Council Directive (EC) No 96/23 of 29 April 1996 on measures to monitor certain substances and residues, Off. J. Eur. Communities
- ISO 17043: 2010 (E): Conformity assessment, General requirements for proficiency testing
- ISO 13528: 2005 (E): Statistical methods for use in proficiency testing by interlaboratory comparisons
- European Commission Decision 2002/657/EC of 12 August 2002. Off J Eur Commun. L221: 8-36.

