

**PTB statement regarding systematic errors
to be taken into account in the calculation of the uncertainty in measurement
– Revised version –**

Basic principle: Correction of systematic errors

The Guide to the expression of uncertainty in measurement (GUM) describes in 3.2.3 and 3.2.4 how systematic errors have to be taken into account¹. The GUM assumes, *that the result of a measurement has been corrected for all recognized significant systematic effects* (GUM, 3.2.4). The result is presented in the normal way

$$Y = y \pm U = y \pm k \cdot u_c(y)$$

where U denotes the expanded uncertainty and $u_c(y)$ the combined standard uncertainty, which in both cases includes the uncertainty of the correction performed, as described in (2).

Exception, that is not suitable for traceability: uncorrected measured value as best estimate of the measurand

If, contrary to the recommendations of the GUM, the uncorrected estimate $y' = y + b$ is used, the estimate of the not corrected systematic error b has to be taken into account, when calculating the measurement uncertainty associated with y' . It is calculated according to

$$u_c(y') = \sqrt{u_c^2(y) + b^2} \quad (1)$$

where

$u_c(y)$: denotes the combined standard uncertainty associated with the corrected measurement result, see equation (2)

b : denotes the estimate of the systematic error

(cf. [1]). The combined standard uncertainty $u_c(y)$ associated with the estimate y of measurand Y (model: $Y = f(X_1 + \dots + X_N) - B$, X_i : input quantities, B : systematic error) is determined (for uncorrelated input quantities) according to

$$u_c(y) = \sqrt{(c_1 \cdot u(x_1))^2 + \dots + (c_N \cdot u(x_N))^2 + (u(b))^2} \quad (2)$$

where

$u(x_i)$: denotes the standard uncertainty of the estimate x_i associated with measurand X_i ,
 $i = 1, \dots, N$

c_i : denotes the sensitivity coefficient according GUM, 5.1.3

$u(b)$: denotes the standard uncertainty of the estimate b of systematic error B

The uncertainty $u_c(y')$ is not a standard uncertainty and shall not be used for uncertainty propagation (see [2]). Reporting uncorrected estimates is thus unsuitable, e.g., for calibration certificates.

Literature:

[1] Lira I, Wöger W 1998 Evaluation of the uncertainty associated with a measurement result not corrected for systematic effects; *Meas. Sci. Technol.* 9 1010–1011

[2] Klauenberg K, Wübbeler G, Elster C 2019 About not correcting for systematic effects; *Measurement Science Review* 19(5) 204–208

¹ GUM, F.2.4.5 is not relevant.