Uncertainty Type B

Type B

- If all influence quantities varied to the fullest possible extent, a designed experiment, statistical means sufficient
- Limited time, resources
- Mathematical model
- Law of propagation

Available information:

- Previous measurement data
- Knowledge of materials and instruments
- Manufacturer's specifications
- Data provided in calibration and other certificates
- Uncertainties assigned to reference data taken from handbooks

Type B requires skill!

- Can be as reliable as Type A, especially where only a small number of independent observations are available

Estimate available as a multiple

- taken from a manufacturer's specification, calibration certificate, handbook, or other source
- Quoted uncertainty is a multiple of the standard deviation
- Standard uncertainty is the quoted value divided by the multiplier

Example

- A calibration certificate states that the mass of a stainless steel mass standard of nominal value one kilogram is 1000.000325g and that "the uncertainty of this value is $240\mu g$ at the three standard deviation level". What is the standard uncertainty of the mass standard?
- Solution: $\frac{240}{3} = 80\mu g$

Estimate available as interval

- Quoted uncertainty is an interval having a 90, 95 or 99 percent level of confidence
- Unless otherwise indicated, assume a normal distribution
- Recover the Standard uncertainty by dividing the quoted uncertainty by the appropriate factor, 1.64, 1.96 or 2.58

Example

- A calibration certificate states that the resistance of a standard resistor of nominal value ten ohms is 10.000742Ω +/-129μΩ at 23°C and that "the quoted uncertainty of 129μΩ defines an interval having a level of confidence of 99%". What is the standard uncertainty?
- Solution: $129/2.58=50\mu\Omega$

Upper and lower bounds avble

- Measurand lies within the interval -a to +a with probability 1.0, probability outside 0.
- No specific knowledge about distribution within interval
- Assume a uniform distribution
- Standard uncertainty $u = \frac{a}{\sqrt{3}}$

Example

- A handbook gives the value of the coefficient of linear thermal expansion of pure copper at 20°C as $16.52X10^{-6}{}^{o}C^{-1}$ and simply states that "the error in this value should not exceed $0.4X10^{-6}{}^{o}C^{-1}$"
- What is the standard uncertainty of the coefficient?
- Solution: $u(\alpha_{20}) = \frac{0.4X10^{-6}}{\sqrt{3}} = 0.23094X10^{-6}{}^{o}C^{-1}$

Triangular distribution

- Measurand lies within the interval -a to +a with probability 1.0, probability outside 0.
- Measurand has a triangular distribution
- Standard uncertainty

$$u = \frac{a}{\sqrt{6}}$$

Example

- The dimension of an object is known to be triangularly distributed between 12.52 and 12.57mm. Determine the standard uncertainty.
- Solution:

$$\frac{0.025}{\sqrt{6}} = 0.01026mm$$

Other distributions

- See books on statistics