Expanded Uncertainty

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- Multiply the combined standard uncertainty by a coverage factor k
- $U = ku_c(y)$
- The result of measurement
- Y = y +/- U
- y - U <= Y <= y + U

Also,

- State the level of confidence p
- associated with the interval

Realise that,

Intervals are only approximate
No sense of difference between 95 & 94%

Choice of coverage factor k

- Based on the required confidence p
- If measurand is normally distributed,

p	k
68.27	1
90	1.645
95	1.96
95.45	2
99	2.576
99.73	3

Central Limit Theorem

- If $Y=c_1X_1+c_2X_2+\ldots+c_NX_N$,
  even if the distributions of X_i are not normal,
  the distribution of Y will be approximately normal, Detailed
  if the X_i are independent
  and the uncertainty of Y is much larger than any single component from a non-normally distributed X_i

t-distribution

- May be used when the degrees of freedom are less
- Approximates the sum of a linear combination of two or more variables
- where the degrees of freedom is given by Welch Satterthwaite formula

Welch Satterthwaite formula

$$\nu_{eff} = \frac{u_c^4(y)}{\sum_{1=1}^{N} \frac{u_i^4(y)}{\nu_i}}$$

- For a type B evaluation ν_i may be assumed ∞

Example: Venturimeter

- Problem
- Data from earlier soln

$$\nu_{eff} = \frac{1.11^4}{0.282^4/50 + 0.844^4/4}$$

$$= 11.95$$

Practical recommendation

- Adopt k=2 and assume that $U=2u_c(y)$ defines an interval having a level of confidence of approximately 95%
- For more critical applications, adopt k=3 and assume that $U= 3u_c(y)$ defines an interval having a level of confidence approximately 99%