Manual of Codes of Practice for the Determination of Uncertainties in Mechanical Tests on Metallic Materials

SECTION 2

Glossary of definitions and symbols

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2.1 DEFINITIONS

Coverage factor

A number that, when multiplied by the combined standard uncertainty, produces the expanded uncertainty. It is dependent on the confidence level (e.g. 95% probability).

Error of measurement

The result of a measurement minus the true value of the measurand (not precisely quantifiable because the *true value* is unknown and lies somewhere within the range of uncertainty).

Level of confidence

The probability that the value of the measurand lies within the quoted range of uncertainty.

Measurand

The specific quantity being reported as the measurement result. A measurand can be a direct test reading or an estimate of a material property from other readings.

Measurement

A set of operations having the object of determining a value of the measurand.

Result of a measurement

Value attributed to the measurand, obtained by measurement.

Uncorrected result
Result of a measurement before correction for systematic error.

Corrected result
Result of a measurement after correction for systematic error.

Standard deviation

The positive square root of the variance.

Uncertainty of measurement

A parameter, associated with the result of a measurement, that defines the range within which the true value of a measurand is estimated to fall (within a given confidence).

Standard uncertainty
The estimated standard deviation.

Combined standard uncertainty
The result of the combination of standard uncertainty components.

Expanded uncertainty
The value obtained by multiplying the combined standard uncertainty by a coverage factor.

Variance

A measure of the dispersion of a set of n measurement results. It is the sum of the square of the deviation of the measurement result from the average, divided by $n-1$.

2.2 SYMBOLS

c_i	Sensitivity coefficient.
d_v	Divisor used to calculate the standard uncertainty = 1 (for normal probability distribution) = 2 (for normal probability distribution, $k = 2$) = $\sqrt{3}$ (for rectangular probability distribution) = $\sqrt{6}$ (for triangular probability distribution) = $\sqrt{2}$ (for U-shaped probability distribution)
f	Functional relationship between the estimated value of the measurand, y, and the input parameters x_i.
k	Coverage factor used to calculate expanded uncertainty U for a normal distribution.
k_p	Coverage factor used to calculate an expanded uncertainty for a specified level of confidence p where a normal probability distribution cannot be assumed (see table in Section 2.4).
n	Number of repeat measurements.
m	Number of input parameters on which the measurand depends.
p	Probability or level of confidence expressed in percentage terms or in the range 0 to 1.
q	Random variable.

$\bar{q}$	Arithmetic mean or average of n repeated measurements of randomly varying quantity q. [Eq. (2)]
$s(q_j)$	Experimental standard deviation of a random variable q determined from n repeat measurements, when n is a relatively small number. [Eq. (3)]
$s(\bar{q})$	Experimental standard deviation of arithmetic mean $\bar{q}$. [Eq. (4)]
$u(x_i)$	Standard uncertainty of input parameter x_i. [Eq. (5)]
$u_c(y)$	Combined standard uncertainty of the measurand, y. [Eq. (6)]
U	Expanded uncertainty of the measurand, y. [Eq. (8)]
V	Value of the measurand.
x_i	Estimate of input quantity X_i.
y	Estimate of the measurand V ($V = y \pm U$). [Eq. (1)]
ν_i	Degrees of freedom of standard uncertainty $u(x_i)$ of input parameter, x_i.
ν_{eff}	Effective degrees of freedom of $u_c(y)$ used to obtain k_P (t- distribution). [Eq. (7)]

2.3 EQUATIONS FOR UNCERTAINTY CALCULATIONS

$$y = f(x_1, x_2, \ldots\ldots\ldots\ldots, x_m) \tag{1}$$

$$\bar{q} = \frac{1}{n}\sum_{j=1}^{n} q_j \tag{2}$$

$$s(q_j) = \sqrt{\frac{1}{(n-1)}\sum_{j=1}^{n} (q_j - \bar{q})^2} \tag{3}$$

$$s(\bar{q}) = \frac{s(q_j)}{\sqrt{n}} \tag{4}$$

$$u(x_i) = s(\bar{q}) \qquad [\textit{Type A} \text{ uncertainty}] \tag{5a}$$

$$u(x_i)=\frac{tolerance}{d_v} \qquad [Type\ B \text{ uncertainty}] \tag{5b}$$

$$u_c(y)=\sqrt{\sum_{i=1}^{m}\ [c_i u(x_i)]^2} \tag{6}$$

$$\nu_{eff}=\frac{u_c^4(y)}{\sum_{i=1}^{m}\ \frac{u_i^4(y)}{\nu_i}} \tag{7}$$

$$U=ku_c(y) \tag{8}$$

2.4 Student's t-Distribution Table

ν_{eff}	1	2	3	4	5	6	7	8	10	12	14	14
k_{95}	13.97	4.53	3.31	2.87	2.65	2.52	2.43	2.37	2.28	2.23	2.20	2.17

ν_{eff}	18	20	25	30	35	40	45	50	60	80	100	∞
k_{95}	2.15	2.13	2.11	2.09	2.07	2.06	2.06	2.05	2.04	2.03	2.02	2.00

NOTE: The above values are for a level of confidence of 95%. Values for other levels of confidence can be found in the Guide.