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

SECTION 3

Typical sources of uncertainty in materials testing

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Uncertainty values associated with standard instruments used in mechanical testing

Important Note

The following uncertainty values are typical and given for guidance only to the authors of the UNCERT Codes of Practice. The uncertainty values relating to the instruments actually used in the measurement must be obtained from either valid calibration certificates, Standards specification, manufacturer's information or other means approved by the laboratory's accreditation authority.

3.1 Uncertainty in force measuring devices (for static and low cycle fatigue testing machines)

Class of Machine †	Expanded uncertainty, U, % ‡
0.5	±0.44
1	±0.88
2	±1.75
3	±2.61

† According to ISO 7500/1 "Metallic materials - Verification of static uniaxial testing machines - Part 1: Tensile testing machines", First edition, 1986.

‡ Assuming:
(a) normal distribution with a coverage factor, k, of 2,
(b) no temperature effect,
(c) no significant drift, and
(d) no end-loading effects.

3.2 Uncertainty in strain measurement using extensometers

Class of extensometer †	Expanded uncertainty, U, ‡	
	Relative, %	Absolute, µm
0.2	±0.2	±0.6
0.5	±0.5	±1.5
1	±1.0	±3.0
2	±2.0	±6.0

† According to EN 10002-4: 1994 "Tensile testing of metallic materials - Part 4. Verification of extensometers used in uniaxial testing", CEN, November 1994.

‡ Assuming:
(a) normal distribution with a coverage factor, k, of 2,
(b) whichever value is the greater of the relative and absolute errors, and
(c) relative errors on the gauge length are not exceeding the limits specified in the standard.

3.3 Typical errors in length measuring devices

Instrument used	Resolution, mm †	Accuracy
Micrometer (mechanical)	±0.01	±0.002 mm
Micrometer (digital)	±0.001	±0.002 mm
Vernier caliper (digital)	±0.01	±0.02 mm
Steel rule (up to 1000 mm)	±0.5	±0.5 mm or 0.1% ‡

† Resolution is defined as follows:

For an analogue scale, the resolution is the centre-to-centre distance between two adjacent scale graduation marks (scale interval).

For a digital scale, the resolution is considered to be one increment on the numerical indicator, provided that the indication does not fluctuate by more than one increment.

‡ Whichever value is greater.

3.4 Uncertainty in thermocouple readings

Type of thermocouple	Temperature range, ^{o}C	Uncertainty †
K	-40 to +375 375 to 1000	± 1.5^{o}C ± 0.004 T
T	-40 to +125 125 to +350	± 0.5^{o}C ± 0.004 T
J	-40 to +375 375 to 750	± 1.5^{o}C ± 0.004 T
N	-40 to +375 375 to 1000	± 1.5^{o}C ± 0.004 T
E	-40 to +375 375 to 800	± 1.5^{o}C ± 0.004 T
R	0 to +1100 1100 to 1600	± 1.0^{o}C ± [1 + 0.003 (T -1100)]
S	0 to +1100 1100 to 1600	± 1.0^{o}C ± [1 + 0.003 (T -1100)]

† For Class 1 thermocouples according to IEC 584.2, 1982 (BS EN 60584.2:1993). The uncertainty tolerance is expressed either as a deviation in degrees Celsius or as a function of the actual temperature assuming (a) no drift, and (b) no effects related to wire diameters and conductor insulating materials.