Blanes **PRESSURE SOLUTIONS**

C101: Calibration Introduction (VL)

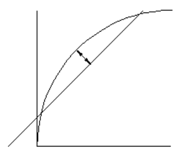
Calibration means checking one unit against a reference, and determining and perhaps minimising the difference.

Pobody's nerfect right?

Let's consider the important definitions in any calibration setup.

Best Straight Line Non-Linearity:

The results when the instrument is set up with a linear response which minimises departure from the straight line, but does not necessarily result in zero and full scale being true.



Hysteresis:

This is the difference in reading the same point when the direction of movement is reversed. This is often mechanical in origin.

Non-Linearity:

This is the departure of the calibration curve from a straight line. The reading Y = aX + b in a linear system where X is the true reading, a is the slope and b is the zero error or offset.

Precision:

Often used in place of accuracy . It is more correctly a measure of "Instrument Uncertainty". It does not take account of the various uncertainties involved in its calibration. In other words, it shows the agreement with the reference standard used, without stating the uncertainty in the reference standard.

Reference Standard:

Calibration is a comparison process, and the reference standard is the "unit that is right". The reference is seldom perfect, and is an approximation to the ideal.

Repeatability:

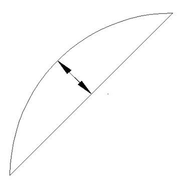
A measure of how closely the instrument can repeat readings of the same true input. This can be likened to a good group in target shooting, which is not necessarily on the bull.

Resolution:

A measure of the smallest change in reading that can be read. Obvious in digital instruments where it equates to the least significant digit, it can be subjective in analogue instruments where the eye of the reader has to decide the position of the pointer. It is usually limited to 1/5 of a division in analogue instruments.

Terminal Based Non-Linearity:

The departure from a straight line which is true at zero and full scale.



P.O.Box 3357, Benoni 1500. 169, Elston Ave, Benoni, 1501, Gauteng, South Africa
Phone 422-1749/1840 Fax 421-5379 Dial code international +2711 local 011
E-mail: rod@pressuresolutions.co.za Web: www.pressuresolutions.co.za

Test Uncertainty Ratio (TUR):
The ratio of the UUT uncertainty to the reference uncertainty, in absolute terms, not percentage.

Uncertainty:
This is what metrologists talk about rather than accuracy. It covers possible errors from the ideal.

Unit-under-test UUT:
Also device (DUT) or sensor (SUT). Self explanatory.

Uncertainty Budget:
Metrologists talk about an “uncertainty budget”. This is a list of factors which have an influence on the measurement. Each factor needs to have an uncertainty associated with it, and then the summation of the various factors generates a value of uncertainty for the measurement. These factors are usually combined using the root sum square method, rather than algebraic or arithmetical addition.

Uncertainty Combination:
We mentioned the root sum square method. In this method, the various component uncertainties are squared, then added together, and the total uncertainty is the square root of that sum. Algebraically, if the total uncertainty is U, and the components are A, B, C……, then $U = \sqrt{(A^2 + B^2 + C^2 \ldots\ldots)}$.

What this means in practice is that only the large uncertainties are statistically significant.

Example:
Lets consider a mass measurement of a solid object. Slap it on the scale and take the reading, right!
No.

The scale, being electronic, might have a certificate claiming an accuracy of 100 parts per million at 20ºC.

Firstly, does this mean the reading of the scale agreed with the reference within 100 ppm? In this case, the uncertainty of the reference has to be added in.

Next, if our reading is not taken at 20ºC, we have to determine what uncertainty is caused by operating the scale at temperatures other than 20ºC.

Nothing in life is stable, so we have to consider the time delay since the scale was last calibrated. The longer the period, the greater the uncertainty.

Now we have to consider what else can contribute uncertainty to our reading. The scale was calibrated at a particular gravity. What uncertainty is incurred by operating at another value of gravity. What uncertainty is allocated to our local gravity value.

What uncertainty is created by the buoyancy of the air? What air density was the scale calibrated at? How do we measure air density, and to what uncertainty can we measure it?
Big fleas and little fleas!

Some-one, and it often must be us, has to do an analysis of the customers needs, and show how our proposal meets those needs.

Multiple References:
Sometimes, as when calibrating a pressure transmitter, you need two references, a pressure reference and a current reference. These uncertainties need to be combined.