What can a calibration certificate tell you?

What should I do when the correction terms on the certificate are for temperatures that aren't the ones I want to use? What measurement uncertainty is associated with interpolations? What about extrapolating? Many questions arise when calculating measurement uncertainty and interpreting calibration certificates.

A calibration certificate which bears the SWEDAC logo, (or e.g. DKD, UKAS) the registration number of the laboratory, and a reference to the ISO/IEC 17025 standard indicates that a calibration has been done under accreditation (See Figure 1). This means that an independent third party is carefully monitoring the laboratory to ensure that it maintains its level of quality. This accreditation system will soon be accepted all over the industrial world.

BASIC INFORMATION

The contents and layout of the calibration certificate are largely governed by the ISO/IEC 17025 standard, but the certificate also contains additional information of use to customers. The certificate gives the date of calibration, which is important for ensuring that the stipulated calibration intervals are followed. There is also a short description of the device(s) being tested and the resolution of the indicating instrument. The condition of the test devices on arrival should also be noted, as this can indicate damage during shipment. It is particularly important to identify the test devices by their serial numbers or a similar type of individual labelling system. The calibration only applies to these individual devices and/or to the linkage between them. The certificate should also specify the calibration work that was done and the temperature levels involved.

Specifying the calibration method, measurement environment, preparatory work

Figure 1: The SWEDAC logo at the top left of the calibration certificate indicates that the calibration has been done under accreditation. Other countries' accredited calibration certificates are valid in Sweden and vice versa.

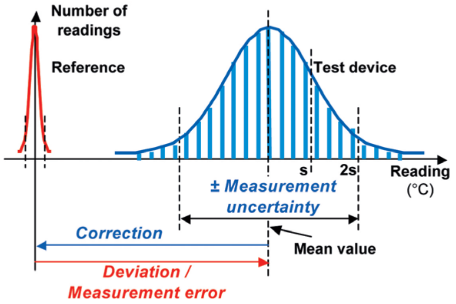

Figure 2: A graphic representation of measurement error and measurement uncertainty. The measurement error can be corrected but the measurement uncertainty remains.

and equipment used is helpful to the client because this makes it possible to compare repeated calibrations done over a long period of time.

The results page of the certificate gives the correction terms (see Figure 2) at the various temperatures. The deviations are not precise. If there is sufficient resolution, repeated readings taken on the same equipment will show a spread in the values read both on the reference system and on the device being calibrated. [ref 1] The true value does not change; it is our inability to measure correctly which is at work. Uncertainties present in the entire calibration setup affect the result. After calculating in accordance with the stipulated standardised methods, [ref 2] we obtain a total measurement uncertainty which, with about 95% probability, will apply to all the measurement results. In other words, in principle we allow an even greater deviation in 5% of the measurement results. Because this calibration method is standardised, everyone measures in the same way and the measurement uncertainty – the indicator of quality – is therefore comparable. See Figure 2.

SUBSEQUENT ANALYSIS

When you want to analyse deviation and measurement uncertainty in your own subsequent calibrations, sometimes the calibration certificate stipulates temperatures other than the ones you want to use. If, for example, the deviations stated on the calibration certificate are 0.4 at 500 °C and 0.8 at 600 °C and you want to know the deviation at 550 °C, you can do a linear interpolation and use 0.6 there. See Figure 3.

Of course, the best solution would be to do a new calibration at 550 °C. In this case, the uncertainty at the interpolated point should be recalculated upwards by 50% compared with the closest calibrated point. If there are several calibrated points with varying ΔT, this recalculation should be done to a higher percentage as you deem appropriate. Normally, thermocouples exhibit significantly greater variation between their extreme values than Pt100 sensors do.

One basic rule is never to extrapolate to values that lie outside the highest and lowest calibration temperatures. If you cannot predict exactly how your measurement equipment will be used, it can be wise to request the calibration of a few extra equidistant temperature points. This can be a useful procedure for your company's secondary reference thermometers.

Because the rule is to round off measurement uncertainty upwards in accordance with the test device's resolution, measurement uncertainty often has relatively large margins. For example, 0.3123 is rounded up to 0.4 at a resolution of 0.1 of a degree. An exception to this rule says that if the value exceeds the decimal of resolution by less than 5% (here: 0.05 x 0.1), you can round down. In this case, that would mean that uncertainty figures up to 0.305 should be rounded down to 0.3. If the result is to be used immediately in a subsequent calibration, no rounding off is necessary. For a more complete understanding of estimating measurement uncertainty and the traceability of calibration, consult the references given below or, even better, attend Pentronic's courses.

[Ref 1] Pentronic News 09-3
[Ref 2] Search EA-4/02 via Google

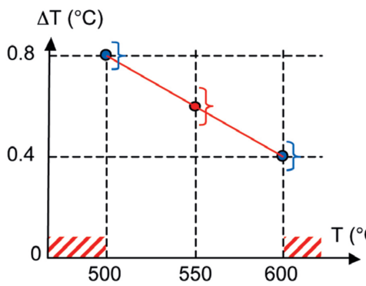

Figure 3. A deviation of ΔT at 500 and 600 °C can be used to linear interpolate a value, e.g. for 550 °C. Extrapolation outside the interval of 500-600 °C is not permitted. The measurement uncertainty (shown here as braces) increases as the distance of the interpolated (red) point from the (blue) calibration points increases.

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