This edition of Pentronic's temperature school now concludes with quality assurance and calibration. In eight issues over two years, we have reviewed fundamental aspects of temperature measurement, theory and methods. Back in Lesson 3 we discussed traceable temperature measurement, and we will now return to quality assurance with a focus on systemic calibration.

LESSON 8 QUALITY ASSURANCE AND CALIBRATION

ALL THE LESSONS ARE NOW available at our website: www.pentronic.se All the lessons are based on Pentronic's popular courses Traceable Temperature Measurement 1 and 2, which are offered regularly in Västervik and which can also be tailored for a specific industry or technology. The courses give a deeper theoretical insight into temperature measurement but also include practical lab work and guides for calculations as well as for documenting your own measurements.

You are welcome to contact us for more information about our courses.

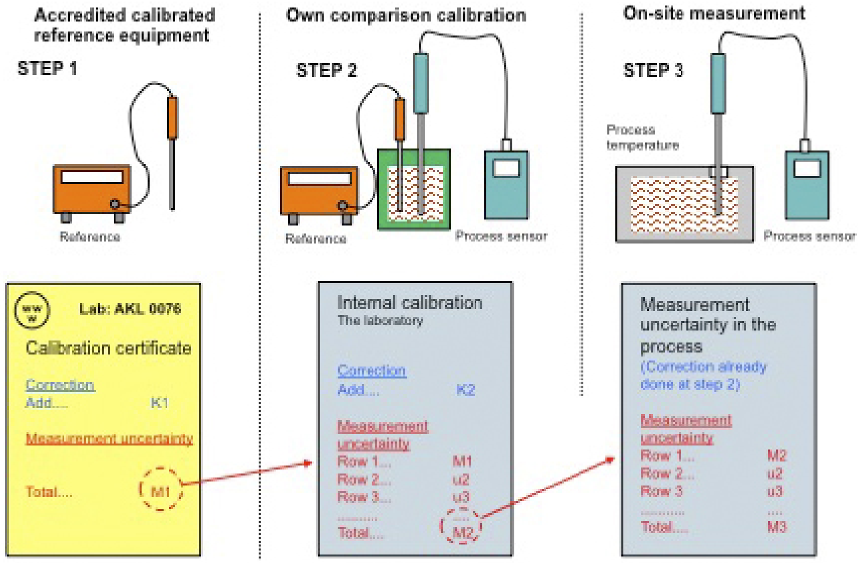
TAKE STOCK OF THE NEED FOR CALIBRATION

If you lack routines for calibration, your first action should be to carefully take stock of your needs. Often there will be many temperature measuring points at varying temperature intervals and requiring different measurement equipment, both new and old. One way to do such an assessment is to use the headings in the table below.

When doing the survey, you need to be extremely careful to document the the measurement uncertainties required by each specifier from the temperature measurement process (based on e.g. standards, quality or regulations).

MEASUREMENT UNCERTAINTY

Often the permitted measurement uncertainties are large enough that you can personally make comparisons to calibrated reference equipment.



However, remember that the measurement uncertainty increases quickly with every comparison. The images above illustrate how measurement uncertainty is added to the chain at each step you take away from the accredited reference calibration.

The measurement uncertainty increases with the number of calibration steps away from the accredited laboratory. Normally, the increase amounts to a factor of 3 to 5 in controlled environments. In industrial environments, it is easy to multiply the measurement uncertainty by a factor of 10. Once again, the choice of type and quality of sensors and equipment has a major effect on the measurement uncertainty along the chain.

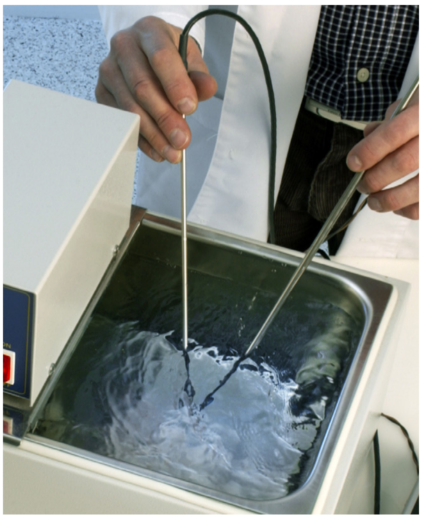
CALCULATING TOTAL MEASUREMENT UNCERTAINTY

The total measurement uncertainty must be calculated based on the values stipulated for your equipment and on your calibration certificates, as well as based on assumptions about error sources. To do this correctly, it is often necessary to have experience of temperature measurement, statistics and calculation tools, experience that suppliers of sensors and instruments can provide.

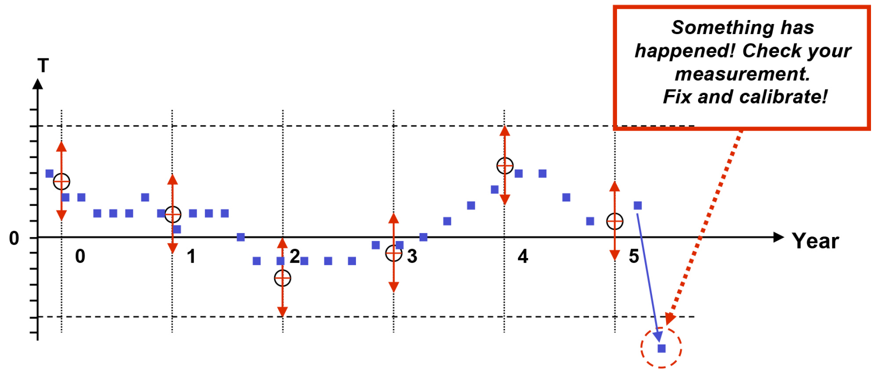
On the next page is an example of what a table of calculated total measurement uncertainty might look like.

	Survey table	Examples of tasks
1	Measuring point	Furnace 1, position A, hanging through the roof
2	Sensor type	Type K thermocouple in an outer protection tube
3	Temperature range	0 – 1000 °C
4	Measurement chain	Directly connected to the temperature indicator, model…
5	Critical temperatures	630 and 870 °C
6	Stipulated maximum measurement uncertainty	+/- 10 and +/- 5 °C respectively
7	Representative measuring point	In the air near the goods in process. Yes until further notice.
8	Special control methods	Temperature consistency at nine points at 630 and 870 °C
9	Suspected error sources	Radiant heat from a radiator?

An example of what may need to be done when calibration routines are introduced.



ui	Uncertainty description, sources	Size (C)	Distribution
	Calculated measurement uncertainty		
	Basic uncertainties		
1	Reference equipment, from the calibration certificate k=2	0.2	Normal
2	Operation with the time after the calibration occasion	0.1	Rectangle
3	Resolution & reading errors, reference indicator	0.1	Rectangle
4	Stability in the reference indicator's measurement series	0.1	Range
5	Gradients in the bath or furnace	0.15	Rectangle
6	Resolution & reading errors, the measurement object	0.1	Rectangle
7	Stability in the measurement object's measurement series	0.1	Range
	Other uncertainties		
8a	Temperature operation, reference system, ± x °C	0.01	Rectangle
8b	Temperature operation, measurement object ± x °C	0.014	Rectangle
8c	Gradients over contact	0.01	Rectangle
	± Total measurement uncertainty: 0.3374		**± Rounded off: 0.4**



Calibration deviation ± measurement uncertainty (the circles with a red cross ± red arrows). The short-term stability is made clear on the calibration occasion. The long-term stability, the operational stability, only becomes apparent after the passage of some time and several calibrations. The blue squares indicate the self-inspection values, which can be offset from the calibrations. However, the trend line of the series of self-inspections should follow that of the calibrations. Major deviation is a warning signal that something has happened.

The procedure for calculating the total measurement uncertainty can be demanding, but remember it is only done once, as long as nothing in your process is dramatically altered. For cases that involve many measuring points, one calculation of total measurement uncertainty can apply to a number of points.

HOW OFTEN DO YOU NEED TO CALIBRATE?

Once a year is a simple rule if nothing else is stipulated. This annual interval presumably has no other reason than that it is easy to remember. Otherwise, the stipulated measurement uncertainty requirements plus the operation experienced between the calibrations should form the basis for the length of the calibration interval. ISO 9001-9002 permits such variations in procedure.

By documenting "experiences", for example by doing regular self-inspections, you acquire a good knowledge basis for making any changes to the calibration interval. The short-term stability is made clear on the calibration occasion. The long-term stability, the operational stability, only becomes apparent after the passage of some time and several calibrations. The self-inspection values can be offset from the calibrations. However, the trend line of the series of self-inspections should follow that of the calibrations fairly closely. Major deviation is a warning signal that something has happened and a spur to start investigating. See the figure on the left.

If you would like to discover even more about temperature measurement, Pentronic offers courses in traceable temperature measurement in Västervik or at your own premises if required. For more information visit www.pentronic.se

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