

## **Evaluation of measurement data — Guide to the expression of uncertainty in measurement.**

### **Practical considerations**

If all of the quantities on which the result of a measurement depends are varied, its uncertainty can be evaluated by statistical means. However, because this is rarely possible in practice due to limited time and resources, the uncertainty of a measurement result is usually evaluated using a mathematical model of the measurement and the law of propagation of uncertainty. Thus implicit in this *Guide* is the assumption that a measurement can be modelled mathematically to the degree imposed by the required accuracy of the measurement.

Because the mathematical model may be incomplete, all relevant quantities should be varied to the fullest practicable extent so that the evaluation of uncertainty can be based as much as possible on observed data. Whenever feasible, the use of empirical models of the measurement founded on long-term quantitative data, and the use of check standards and control charts that can indicate if a measurement is under statistical control, should be part of the effort to obtain reliable evaluations of uncertainty. The mathematical model should always be revised when the observed data, including the result of independent determinations of the same measurand, demonstrate that the model is incomplete. A well-designed experiment can greatly facilitate reliable evaluations of uncertainty and is an important part of the art of measurement.

In order to decide if a measurement system is functioning properly, the experimentally observed variability of its output values, as measured by their observed standard deviation, is often compared with the predicted standard deviation obtained by combining the various uncertainty components that characterize the measurement. In such cases, only those components (whether obtained from Type A or Type B evaluations) that could contribute to the experimentally observed variability of these output values should be considered.

Although this *Guide* provides a framework for assessing uncertainty, it cannot substitute for critical thinking, intellectual honesty and professional skill. The evaluation of uncertainty is neither a routine task nor a purely mathematical one; it depends on detailed knowledge of the nature of the measurand and of the measurement. The quality and utility of the uncertainty quoted for the result of a measurement therefore ultimately depend on the understanding, critical analysis, and integrity of those who contribute to the assignment of its value.