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# "Guide to the Expression of Uncertainty in Measurement" by the International Organization for Standardization

(advertised by G. D'Agostini)

**Abstract**

The ISO has recently published a *Guide* containing the recommendations of the Comité International des Poids et Mesures about the expression of experimental uncertainties, as well the motivations, a detailed description of the procedures and practical examples. This note is simply intended to be an an invitation to a critical reading of the *Guide*.

## Introduction

After 15 years of work by the most authoritative organizations of metrology, a *Guide* has been published[1], in order to establish general rules for evaluating and expressing uncertainty. These rules are intended to be applicable to a broad spectrum of measurements - "from the shop floor to fundamental reaserch". The goal is to achieve a worldwide consensus which, "like the nearly universal use of the SI has brought coherence to all measurements, would permit the significance of a vast spectrum of results in science (...) to be readily understood and properly interpreted".

As this note is not intended to be a summary or a scholium of the *Guide*, I have just picked up some information and citations ( within " " ) which should provoke enough the people sensitive to the subject.

## What there was before?

Essentially the chaos.
Many contradictory cooking recipes can be found in text books, with - to my knowledge - the remarkable exception of the DIN norms[2].

## Organizations which supported the development of the Guide

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| BIPM | Bureau International des Poids et Mesures |
| IEC | International Electrotechnical Commission |
| IFCC | International Federation of Clinical Chemistry |
| ISO | International Organization for Standardization |
| IUPAC | International Union of Pure and Applied Chemistry |
| IUPAP | International Union of Pure and Applied Physics |
| OIML | International Organization of Legal Metrology |

## Picked up for you from the Guide

- **Error or uncertainty?**
  - "error: result of a measurement minus a true value of the measurand";
  - "uncertainty: parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand".
- **'Random' and 'systematic' uncertainty?**
  "The uncertainty in the result of a measurement generally consists of several categories according to the way in which their numerical value is estimated:
  - A. those which are evaluated by statistical methods,
  - B. those which are evaluated by other means.

  These categories (...) are not substitutes for the words 'random' and 'systematic'. The term *systematic uncertainty* can be misleading and should be avoided".
- **What is probability?**
  "(...) In contrast to this frequency-based point of view of probability an equally valid viewpoint is that probability is a measure of the *degree of belief* that an event will occur.
  (...) Recommendation INC-1 (...) implicitely adopts such a viewpoint of probability (...)" .

- **"Safe" estimate of uncertainties?**
"(...) the best evaluation of the uncertainty (...) must be given (...)
The method stands, therefore, in contrast to certain older methods that have the following two ideas in common:

  - The first idea is that the uncertainty reported should be 'safe' or 'conservative' (...) In fact, because the evaluation of the uncertainty of a measurement result is problematic, it was often made deliberately large.
  - The second idea is that the influences that give rise to uncertainty were always recognizable as either 'random' or 'systematic' with the two being of different nature; (...)"

- **Uncertainty as "maximum error bounds"?**
"The combined uncertainty and its components should be expressed in the form of standard deviations.
(...) if the 'maximum error bound' ( the largest conceivable deviation from the putative best estimate) is used (...) the resulting uncertainty (...) will be unusable by anyone wishing to incorporate it into subsequent calculations (...)".

- **How to report category B uncertainties?**
"(...) should be characterized by quantities (...) which may be considered as approximations to the corresponding variances, the existence of which is assumed."

- **Combining the uncertainties?**

  - "Any detailed report of the uncertainty should consist of a complete list of the components, specifying for each the method used to obtain its numerical value";
  - "the combined uncertainty should be characterized by the numerical value obtained by applying the usual method for combination of variances".

- **Correlated results?**
"Where appropriate, the covariance should be given".

## Conclusions

Let us conclude with a last citation from the *Guide*:

"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".

# References


[1] *Guide to the Expression of uncertainty in measurement*, ISO, Geneva, Switzerland, 1993 ( ISBN 92-67-10188-9 ).

[2] DIN Deutsches Institut für Normung, DIN 1319 Teile 1-4 ( only parts 1-3 are available in english ), Beuth Verlag GmbH, Berlin, Germany, 1985.