GENERAL APPROACH TO THE EVALUATION OF MEASUREMENT UNCERTAINTIES

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ABSTRACT

Since 1995 with the first edition of the GUM by Joint Committee Guide for Metrology, (JCGM) expression of uncertainty in measurement takes a large part in measurement activities. To be able to give a measurement result with a sound uncertainty expectation, different approaches exist that were covered in several linked documents depending of the available measurement model. In this presentation, we will give an overview of the main methods based on physical model and show that each available method addresses a corresponding model situation.

KEYWORDS

Uncertainty measurement, measurement model, measurement result

1 INTRODUCTION

The Joint Committee for Guides in Metrology (JCGM) provides us with invaluable material such as the GUM (JCGM 100:2008) and other related documents. A very short description of uncertainty in measurement could be seen as: measurement model definition, uncertainty components and propagation. Starting from measurand definition, we will through key questions discuss the available uncertainty assessment methods.

2 GENERAL APPROACH

The definition of a measurand is fully detailed in International Vocabulary in Metrology (JCGM 200:2012). The main difficulty is : does a good corresponding measurement model exist ?

2.1 What is a measurement model ?

A measurement model could be seen as the right depiction of the measurement process corresponding to a targeted uncertainty. International Vocabulary in Metrology (JCGM 200:2012)defines it as a : "mathematical relation among all quantities known to be involved in a measurement..." (§2.48)

Three cases are identified:

- a physical measurement model is unavailable or too complex
- a physical measurement model is available
- a complex physical measurement model is available

2.2 Physical measurement model unavailable or too complex

This case could be addressed through the use of global model (statistical approach).
A good example is interlaboratory comparison, for which a statistical model is described in ISO 5725. This presentation will not cover this type of model.

2.3 Physical measurement model available

From a simple measurement model describing a direct measurement with influence quantities (like direct pressure measurement or direct temperature measurement) to a more complex measurement model using a mathematical relation combining several simple measurements (like for example the measurement of gas flow through an orifice plate), GUM (JCGM 100:2008) is the reference document and its application could be done relatively easily.

An example will be provided during the presentation.

2.4 Complex Physical measurement model available

When model is too complex or non linear, JCGM 101:2008 addresses the issue through propagation of distributions using Monte Carlo method. This numerical approach is interesting for three reasons :

1. no more need to calculate partial derivatives,
2. this approach addresses non linear models which are difficult to treat using GUM (JCGM 100:2008),
3. this method could be used to validate GUM approach choice in showing that there are no significant differences between both approaches.

An example will be provided during the presentation.

3 CONCLUSIONS

The main conclusion of this presentation is that every method of uncertainty assessment is corresponding to a particular state of availability of the measurement model. Each method is completing others and should be seen as a tool responding to the available information.

4 REFERENCES

JCGM 100:2008. Evaluation of measurement data - Guide to the expression of uncertainty in measurement (GUM)

JCGM 101:2008. Evaluation of measurement data - Supplement 1 to the Guide to the expression of uncertainty in measurement - Propagation of distributions using a Monte Carlo method

JCGM 104:2009. Evaluation of measurement data An introduction to the Guide to the expression of uncertainty in measurement and related documents

JCGM 200:2012. International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (also known as "VIM 3")