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PEOPLE'S REPUBLIC OF CHINA**

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**Guide to the evaluation and expression of uncertainty in
measurement -- Supplement 1: Propagation of distributions
using a Monte Carlo method**

(English Translation)

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Foreword

This standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This standard uses the translation method equivalent to ISO /IEC Guide 98-3/Suppl.1.2008 "Measurement uncertainty - Part 3. Measurement

Guide to Uncertainty Representation (GUM..1995) Supplementary Document 1. Distribution Propagation Based on the Monte Carlo Method.

This standard has the following editorial changes compared to ISO /IEC Guide 98-3/Suppl.1.2008.

--- Modified the standard name.

This standard is proposed and managed by the National Certification and Accreditation Standardization Technical Committee (SAC/TC261).

This standard was drafted. China Metrology University, China Institute of Metrology, Zhejiang Institute of Metrology, Shanghai Metrology and Testing

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0.1 Overview

This standard is a supplement to the "Guidelines for the Expression of Measurement Uncertainty" (GUM), mainly through the establishment of measurement models, using Monte Carlo

The method (abbreviation. MCM) performs probability distribution propagation and evaluates the measurement uncertainty [ISO /IEC Guide 98-3:2008, 3.1.6]. The

The method is applied to models with multiple inputs and a single output.

In the following two cases, it is valuable to use MCM instead of GUM uncertainty framework for uncertainty evaluation [ISO /IEC

Guide98-3:2008, 3.4.8].

a) a nonlinear model;

b) The probability density function (PDF) of the output clearly deviates from the normal distribution or the t-distribution, such as a significant asymmetry in the distribution.

In a), the estimation of the output and its standard uncertainty using the method in the GUM uncertainty framework may be unreliable;

In b), use the method in the GUM uncertainty framework to get the inclusion interval of the output (ie, the extension in the GUM uncertainty framework)

The degree of certainty" may not be practical.

GUM [ISO /IEC Guide 98-3:2008, 3.4.8] "provides a method for assessing uncertainty" based on uncertainty

Degree propagation law [ISO /IEC Guide 98-3:2008, Chapter 5] and characterization of output with normal distribution or t-distribution [ISO /IEC Guide98-

3:2008, G.6.2, G.6.4]. In this method, the uncertainty propagation law provides a method for propagation uncertainty through the model. specifically,

It gives the best estimate of the output and the standard uncertainty under the following conditions.

a) the best estimate of each input;

b) the standard uncertainty of the estimated values of each input;

c) the degree of freedom associated with these standard uncertainties, where possible;

d) Non-zero covariance between inputs.

In this method, the inclusion interval under the specific inclusion probability of the output is given by the PDF of the output.

The best estimate, standard uncertainty, covariance, and degrees of freedom are the information available for the input. The method in this standard, the input amount

The information available is the input quantity PDFs, which is the PDF of the output volume obtained by the transmission of the input quantity PDFs.

Given the limitations of the GUM uncertainty framework, distributed propagation always yields output consistent with the input PDFs.

PDF. The input quantity of PDFs describes the knowledge of the input quantity, and the output quantity PDF determined by the input quantity knowledge describes the output quantity.

knowledge. Once the output PDF is obtained, the output can use its expectation, its best estimate, and its standard deviation, ie the standard

The quasi-uncertainty is summarized; and the inclusion interval of the output with the given probability can be obtained from the PDF.

The use of PDFs in this standard is consistent with the concept implicit in GUM. A quantity of PDF indicates the knowledge state of the quantity, ie

It quantitatively reflects the degree of credibility that is given to the quantity based on the available information. These available information usually include raw statistics, measurements

Volume results or other relevant scientific descriptions and professional judgments.

In order to construct a quantity of PDF, Bayesian theory can be applied based on a series of observations of this quantity [27, 33];

For proper information about system effects, an appropriate PDF can be determined using the principle of maximum information entropy [51, 56].

Distribution propagation has a wider range of applications than the GUM uncertainty framework. It takes advantage of the best estimate and standard uncertainty

(More effective degrees of freedom and covariance, as appropriate).

Decimal point symbol. The decimal point symbol is represented by the dot in the English version of the text, and is indicated by the period in the French version. (see 4.12)

Appendix A gives some perspectives based on history.

Note 1: GUM gives a method when linearization is insufficient [ISO /IEC Guide 98-3:2008, 5.1.2 Note]. The drawback of this method is. only used

The main nonlinear term in the model Taylor series expansion, and the input is considered to be a normal distribution.

Note 2: Strictly, GUM characterizes the statistical properties of the variable $(Yy)/u(y)$ with a t-distribution, where Y is the output, y is the estimated value of Y, and $u(y)$ is the estimate.

The standard uncertainty of the value y [ISO /IEC Guide 98-3:2008, G.3.1]. This feature is also applicable in this standard. [Actually, GUM

The medium variable is $(yY)/u(y)$.]

Note 3: A quantity of PDF cannot be understood as frequency density.

Note 4: "Uncertainty assessment is neither procedural nor purely mathematical. It depends on the properties being measured, the measurement methods and procedures used, etc.

Detailed knowledge. Therefore, the quality and utility of the uncertainty quoted by the measurement depends on the understanding of the information contributing to the assessment, a rigorous analysis and

Its integrity. "[17]

0.2 JCGM Background Information

Since 1993, the "Guide to Measurement Uncertainty" has been developed (Guide to the expression of uncertainty in measure-

ment, GUM) and "International vocabulary basic terms" (International vocabulary of basic and general terms in

Metrology, VIM), seven international organizations, founded the Joint Commission on Metrology Guidelines in 1997 (Joint Committee for

Guides in Metrology, JCGM), by the Bureau of International Bureau of Metrology (Bureau International des Poids et Mesures, BIPM)

The long-term chairman. JCGM took over the development of these two standards from ISO's Fourth Technical Advisory Group (TAG4).

The Joint Commission is composed of BIPM and the International Electrotechnical Commission (IEC).

International Federation of Clinical Chemistry (International Federation of Clinical Chemistry and Laboratory Medicine,

IFCC), International Laboratory Accreditation Cooperation (ILAC), International Standard

International Organization for Standardization (ISO), International Union of Theoretical and Applied Chemistry (Interna-

tion Union of Pure and Applied Chemistry, IUPAC), International Union of Theoretical and Applied Physics (International U-

nion of Pure and Applied Physics, IUPAP) and the International Organization of Legal Metrology (International Organization of

Legal Metrology, OIML) and other organizations.

JCGM has two working groups. The first working group is the "Measurement Uncertainty Representation Working Group", and the task is to promote the use and system of GUM.