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ASSESSMENT OF MEASUREMENT UNCERTAINTY IN CALIBRATION OF MEASURING INSTRUMENTS USED IN INFORMATION-MEASUREMENT SYSTEMS

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Abstract

Classification of measuring instruments is given in article used for calibration, an assessment of uncertainty of measurements, calibration by a method of a direct assessment, in particular, carrying out an assessment with use of basic algorithm developed on the documents GUM, VRACHEM and EA -4/02.

Keywords: Assessment, classification, ISOMEC standard, calibration, method, measurement.

INTRODUCTION

Currently, assessment of uncertainty of measurements in accredited calibration laboratories is one of the urgent issues in the activity of the state calibration system of Uzbekistan. Because the measurements are performed with guaranteed accuracy, and the measurement results must be evaluated in accordance with the international ISOMEC standard requirements. Accordingly, one of the metrological requirements is to assess the uncertainty of measurements in the calibration of measuring instruments used in information measurement systems.

RESEARCH METHODS

On the international level and in Europe, territorial regulatory documents on the assessment of measurement uncertainty have been developed and implemented in practice for various types of measurements. The ISOMEC 170252005 standard clarified the international recognition of measurement results of accredited calibration and testing laboratories. For calibration laboratories, the European Association for Accreditation of Laboratories has developed a manual EA-4/02, but this manual describes the procedure for estimating the uncertainty of measurements based on the “Guide to Expression of Measurement Uncertainty” and not the specification of calibration.

RESULTS AND DISCUSSIONS

It is known that accredited laboratories do not have a staff of metrologists who perfectly know the basics of mathematical statistics or understand the concept of measurement uncertainty. The complexity of estimating the uncertainty of measurements in the calibration of the measuring instruments used in the calibration of weighted information measurement systems and the fact that the calculations are large require a lot of laboratory resources. Accordingly, laboratory specialists need special methods, automated algorithms, programs that make calculations much easier and allow to present the results of measurements in the form of a table or graph. In addition, it is necessary to take into account the international standards of the GUM "Measurement Uncertainty Expression", in particular the ISOMEC 17025- "Requirements for the accreditation of testing and calibration laboratories" Standard. In order to estimate the cumulative uncertainty in the calibration of the measuring instruments in the measuring channels, an analysis of the main sources of uncertainty must be performed based on GVM. In general, the sources of uncertainty in the calibration of measuring instruments can include:

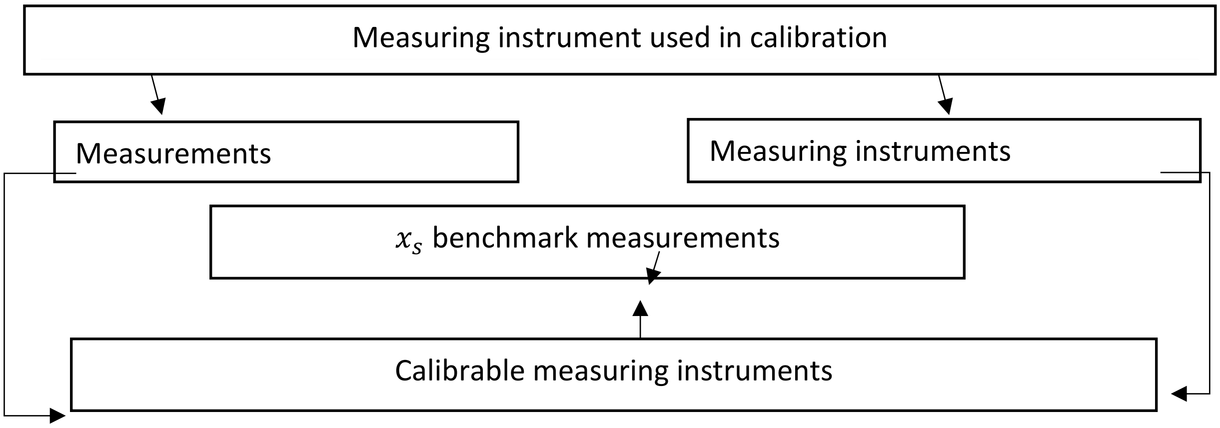
- It is possible to describe the object of measurement with the used measuring tool and their surrounding environment;
- Software for performing calculations and processing measurement results;
- The subject of measurement and the procedure he uses;
- Failure to determine the subjective system;
- The limit of conductivity and sensitivity of measuring instruments;
- Inaccuracy of the restored value of the standard sample or working standard;
- Absence of used mathematical models;
- Uncertainty budget should include all listed types of uncertainty;
- Since calibration is one of the most frequently performed metrological activities for measuring instruments used in information-measuring systems, Figure 1 presents the classification of measuring instruments used in calibration.

During the calibration, the reference *Xb* (measured with the standard measuring instrument) is compared with the *Xc* value (measured with the calibrable measuring instrument). It is known that the difference between these quantities is determined during the calibration process.

$$\Delta = x_c - x_s$$

From this expression, the systematic error of the measuring instrument to be calibrated is determined. This difference is then used to correct the measurement result. In this case, estimating the calibration uncertainty Δ concludes with an estimate of the uncertainty of .

$$\Delta = x_c - x_s$$



Picture 1. Classification of measuring instruments used in calibration.

The uncertainty estimation procedure depends on the measurement method used to transfer the unit size. There are many measurement methods used in calibration, below we present the estimation of the calibration uncertainty based on the method of direct measurement with a calibrated measuring instrument of the magnitude that repeats the standard measurement.

In this case, the model of the equation;

$\Delta = (x_c + \Delta_c) - (x_s + \Delta_s)$

will have an appearance.

Here:

x_c – value measured with a calibrated measuring instrument;

Δ_c - uncorrected systematic error of the calibrated measuring instrument;

x_s- the actual value of the standard measurement specified in the calibration certificate;

Δ_s – is the additional systematic error of the measurement, which is related to the drift of the repeated quantity value during the last calibration time interval; changes in the conditions of use of the measurement (changes in environmental parameters and supply voltage); the influence of the calibrating measuring instrument on the standard measurement parameters, the imprecise setting of repeated multi-valued measurement values and etc. The listed input quantities are subject to the following uncertainties:

u (X_c) – is the uncertainty associated with the dispersion of the readings of the calibrated measuring instrument, which is determined when performing multiple measurements according to language A;

u (Δ_c) – quantization uncertainty of a calibrated measuring instrument;

u (Xs) – calibration uncertainty of reference measurement;

u (Δ_s) – uncertainty of additional measurement errors.

The cumulative calibration uncertainty is equal to:

$$u(\Delta) = \sqrt{u^2(x_c) + u^2(\Delta_c) + u^2(x_s) + u^2(\Delta_s)}.$$

The expanded calibration uncertainty is defined by the following expression:

$$U = f_{0.95}\left\{(n-1)\left[\frac{u(\Delta)}{n(x_c)}\right]\right\}u(\Delta).$$

The results of the conducted research show that in general, the uncertainty of any measurement results, and in particular, the assessment of the uncertainty of measurements in the calibration of measuring instruments used in information-measuring systems, is based on the basic regulations of the GUM and EVRASCHEM "Manuals" and the measuring instrument developed on the basis of the EA-4/02 document. assessment of measurement uncertainty in calibration- is performed based on the basic algorithm (Figure 2).

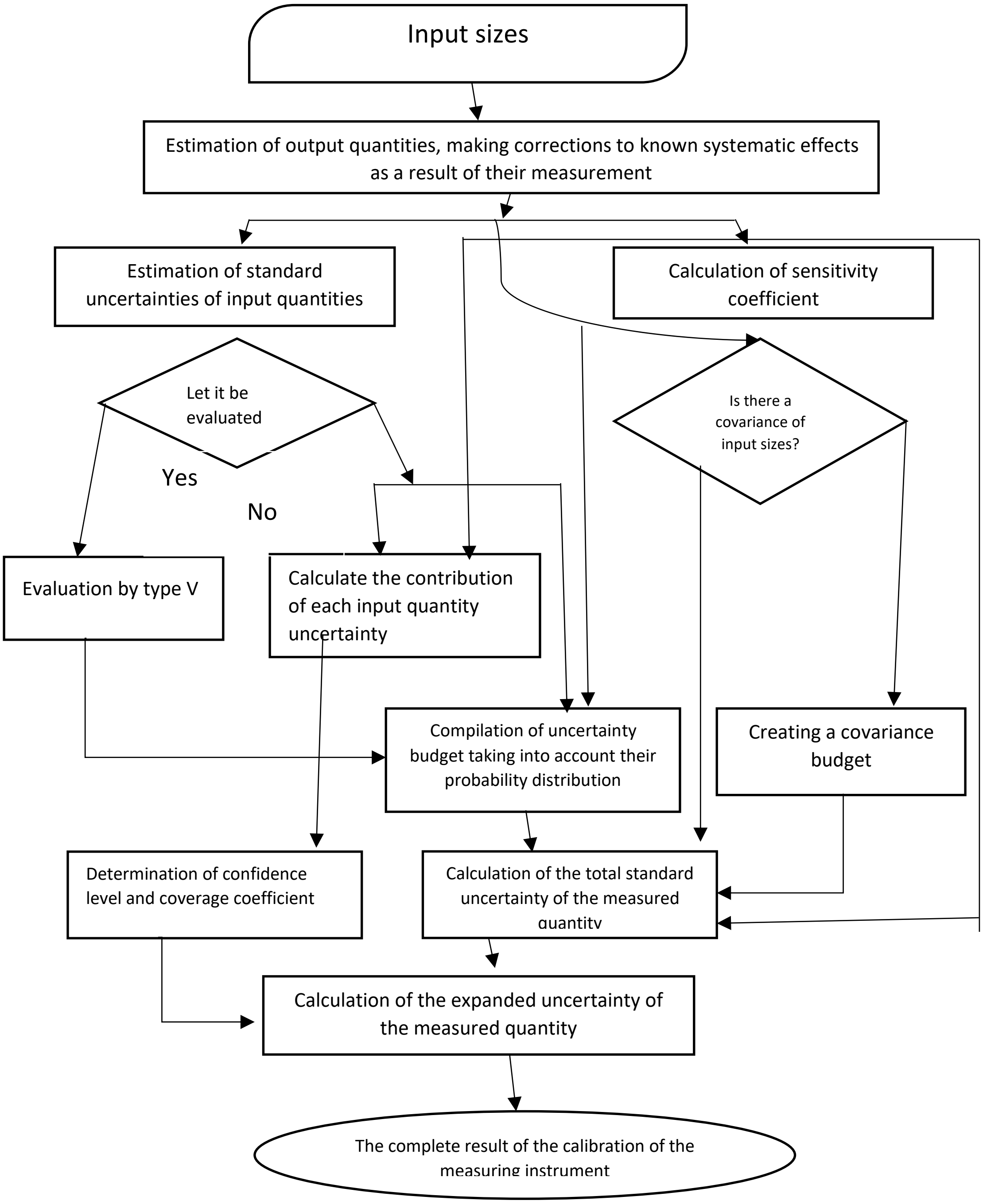


Figure 2. Uncertainty of measurements in the calibration of the measuring instrument

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