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POLICY ON EXPRESSION OF UNCERTAINTY OF MEASUREMENT RESULTS ISSUED BY ACCREDITED LABORATORIES

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This document defines the policy of the Republican Unitary Enterprise “Belarusian State Centre for Accreditation” (hereinafter referred to as BCCA) with respect to the expression of uncertainty in the measurement of results issued by accredited laboratories.

The policy applies to the activities of the BSCA and accredited laboratories.

Uncertainty of measurement result is a qualitative characteristic related to accuracy of measurement result and characterizing the dispersion of the values that are reasonably attributed to a measurand.

Calibration and testing laboratories shall know accuracy characteristics of their calibration/testing methods and apply evaluation procedures for the uncertainty of results of quantitative measurement methods covered by their scope of accreditation.

BSCA takes into consideration the following documents published by international accreditation organizations ILAC and EA while defining its policy on expression of uncertainty of measurement results issued by accredited laboratories:

ILAC-P14:01/2013, EA 4/02 M:2013 and ILAC-G8:03/2009 – for calibration laboratories,

ILAC-G17:2002, EA-4/16 G:2003 and ILAC-G8:03/2009 – for testing laboratories.

1. BSCA shall assess competence of its accredited calibration and testing laboratories in calculating uncertainty of measurement results for calibration and testing, covered by their scope of accreditation, except for non-quantitative methods.

2. While assessing competence, BSCA shall make sure that accredited calibration laboratories conduct assessment of uncertainty of measurement results in compliance with the Guide to the Expression of Uncertainty in Measurement (GUM), including its appendices, EA 4/02 M:2013 and/or ISO Guide 35.

3. Forming the scope of accreditation of calibration laboratories

3.1 The scope of accreditation of calibration laboratories accredited by BSCA shall include calibration and measurement capabilities (CMC) expressed in terms of:

- codes and names of the measurand */ reference material;*
- calibration objects (names of means of measurement / *material*, to be calibrated */ measured);*
- measurement range and, where applicable, additional parameters, (e.g. current frequency or voltage);
- expanded uncertainty of measurement result U with definite coverage factor and level of confidence;
- documents that establish calibration methods (techniques).

3.2 There shall be no ambiguity on the expression of the CMC on the scopes of accreditation and, consequently, on the smallest uncertainty of measurement that can be expected to be achieved by a laboratory during a calibration or a testing. Particular care should be taken when the measurand covers a range of values. This is generally achieved through employing one or more of the methods for expression of the uncertainty described in clause 3.3.

3.3 Uncertainty may be expressed as:

A single value, which is valid throughout the measurement range.

A range. In this case a calibration laboratory should have proper assumption for the interpolation to find the uncertainty at intermediate values.

A function of the measurand or a parameter.

A matrix where the values of the uncertainty depend on the values of the measurand and additional parameters.

A graphical form, providing there is sufficient resolution on each axis to obtain at least two significant figures for the uncertainty following the decimal point.

3.4 Open intervals (e.g., “U < x”) are not allowed in the specification of uncertainties.

3.5 The uncertainty covered by the CMC shall be expressed as the expanded uncertainty having a specific coverage probability of approximately 95 %. The unit of the uncertainty shall always be the same as that of the measurand or in a term relative to the measurand, e.g., percent.

3.6 Calibration laboratories shall provide evidence to the accreditation body that they can provide calibrations to customers in compliance with the scope applied for accreditation under 3.1, so that measurement uncertainties of the laboratory equal those covered by the CMC in the scope of accreditation. In the formulation of a list of CMC, laboratories shall take notice of the performance of the “best existing device” which is available for a specific category of calibrations.

3.7 A reasonable amount of contribution to uncertainty from repeatability confirmed by calibration shall be included and, if possible, contributions due to reproducibility should be included in combined uncertainty of CMC. There should, on the other hand, be no significant contribution to CMC uncertainty related to imperfections of “best existing device” under calibration or measurement.

3.8 It is recognized that for some calibrations a “best existing device” does not exist and/or contributions to the uncertainty attributed to the device significantly affect the uncertainty. If contributions to uncertainty from the sample can be separated from other contributions, then contributions resulting from the samples may be excluded from CMC. For such a case, however, the scope of accreditation shall clearly identify that the contributions to the uncertainty from the device are not included.

Note: The term “best existing device” is understood as an object to be calibrated that is available for customers, even ***if it has a special performance (stability) or has a long history of calibration.***

3.9 If the laboratory provides services related to calibration using standard samples, the uncertainty covered by the CMC should generally include factors related to the measurement procedure as it will be carried out on a sample, i.e., typical matrix effects, interferences, etc. shall be considered. The uncertainty covered by the CMC will not generally include contributions arising from the instability or inhomogeneity of the sample/material. The CMC should be based on an analysis of the *assigned* performance of the method for typical stable and homogeneous samples.

Note: The uncertainty covered by the CMC while calibrating with the use of the reference material is not identical with the uncertainty associated with a reference material provided by a reference materials producer.

4. BSCA Policy on Statement of Uncertainty of Measurement on Calibration Certificates

4.1 Calibration laboratories shall report, in the calibration certificate, the uncertainty of measurement and/or make a statement of compliance with an identified metrological specification in accordance with the requirements below.

4.2 The laboratory shall keep and maintain the measured quantity values and the uncertainty of measurement, in compliance with the requirements in GOST SO/IEC 17025 (clauses 7.5 and 7.8.4.1) and present this evidence upon the first demand of the client.

4.3 The measurement result shall normally include the measured quantity value **y** and the associated expanded uncertainty **U**. In calibration certificates the measurement result should be reported as **y ± U** associated with the units of **y** and **U**. Tabular presentation of the measurement result may be used and the relative expanded uncertainty **U/|y|** may also be provided if appropriate. The coverage factor and the coverage probability shall be stated on the calibration certificate. To this an explanatory note shall be added, which may have the following content:

"The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95 %."

Note: For asymmetrical uncertainties other presentations than y ± U may be needed. This concerns also cases when uncertainty is determined by Monte Carlo simulations (propagation of distributions) or with logarithmic units.

4.4 The numerical value of the expanded uncertainty shall be given to, at most, two significant figures. Further the following applies:

The numerical value of the measurement result shall in the final statement be rounded to the least significant figure in the value of the expanded uncertainty assigned to the measurement result.

For the process of rounding, the usual rules for rounding of numbers shall be used, subject to the guidance on rounding provided i.e. in Section 7 of the GUM.

Note: For further details on rounding, see ISO 80000-1:2009 [7]

4.5 Uncertainty stated on the calibration certificate shall include relevant contributions during calibration and contributions that can reasonably be attributed to the customer's device. Where applicable the uncertainty shall cover the same contributions to uncertainty that were included in the CMC uncertainty components, except that uncertainty components evaluated for the best existing device shall be replaced with those of the customer's device.

4.6 Therefore, reported uncertainties tend to be *larger than the uncertainty covered by the CMC*. Random contributions i.e. transport uncertainties, should normally be excluded in the uncertainty statement. If, however, a laboratory anticipates that such contributions will have significant impact on the uncertainties attributed by the laboratory, the customer should be notified at the stage of consideration of tenders and reviews of contracts.

4.7 As the definition of CMC implies, accredited calibration laboratories shall not report a smaller uncertainty of measurement than the uncertainty of the CMC for which the laboratory is accredited.

5 BSCA Policy on Expression of Uncertainty by Testing Laboratories

5.1 It is important for laboratories, their customers and all interested parties to know uncertainty value of measurement results, while these laboratories, their customers and the interested parties apply measurements that are obtained using quantitative methods within the conformity assessment of the testing object.

5.2 Statistical random and systematic factors effects contribute to the uncertainty of measurement of the results. If possible, systematic factors should be cut.

The degree of accuracy while estimating uncertainty depends on the following:

- requirements of testing/measurement methods;
- requirements of the customer;
- interpretation of results in case a decision is taken that the object of testing confirms with the requirements set.

5.3 Methods of uncertainty estimation for testing methods covered by the scope of accreditation are developed directly in the laboratory taking into account all uncertainty components.

5.4 Consideration should be given to the different factors which may contribute to the overall uncertainty of a measurement (not all are relevant in all cases).

Some examples are given below:

- definition of the measurand (parameter) of (testing/ measurement) object;
- sampling;
- transportation, storage and handling of samples;
- preparation of samples;
- environmental and measurement conditions;
- the personnel carrying out the tests;
- measurement methods;
- the measuring instruments;
- certified or reference materials;
- software applied within methods associated with the measurement;
- uncertainty arising from correction of the measurement results for eliminating systematic components.

5.5 According to ILAC-G17 only “well-recognised methods specifying limits of the major sources of uncertainty require no special action from the laboratory”;

Regarding the testing methods that do not specify limits to uncertainty values the above document states that “... testing laboratories must report uncertainty estimates if any of the factors in clause 5.4. occur. In any case testing laboratories should know the uncertainty associated with a measurement whether it is reported or not.”

5.6 Consequently, following accreditation criteria, a laboratory shall have and apply the concept of uncertainty of measurements and have the ability to estimate its numerical value for qualitative methods of testing/measurements if it is required by the interested parties.