UDC 006.86

Halchenko Y.M., assistant of the department of cyberphysical and information-measuring systems
(Dnipro University of Technology, Dnipro, Ukraine)

REQUIREMENTS FOR THE CONTENT OF CALIBRATION PROCEDURE FOR MEASURING INSTRUMENTS

Introduction. All instruments have errors that gradually increase over time, which leads to a loss of accuracy of the measurements performed. Calibration is one of the main processes used to establish the accuracy of an instrument. The main task of calibration is to establish a relation between the unknown value of the instrument being calibrated and a standard with a known value and its inherent measurement uncertainty [1]. Calibration is often confused with instrument setting, which is erroneously called "self-calibration". Settings are made to make the necessary changes to the operation of the instrument, and calibration is performed to determine the actual values of the instrument's metrological characteristics.

According to the Law of Ukraine On metrology and metrological activities, instrumentation control equipment (ICE), used outside the scope of legally regulated metrology, and secondary and working standards used for verification of ICE, and optional ICE used in the legally regulated area of metrology must undergo a calibration procedure [2]. DSTU ISO 17025 pt.6.4.6 states that in order to provide the metrological traceability of measurement results, the ICE used for measurements must be calibrated [3]. According to pt. 5.5 of DSTU ISO 17025, calibration laboratories must document the calibration procedures that they use in their work. References [4] provide recommendations on the expression of measurement uncertainty during calibration, and [3,5] contain general requirements for the content of a calibration certificate, but there are no requirements in regulatory documents for the content of calibration procedures. Because of the lack of a clear structure calibration procedures may differ in content in various bodies accredited to calibrate the ICE.

Objective. The paper introduces requirements for the structure and content of the calibration procedure.

Main part. The calibration procedure for the ICE should detail how the calibration is performed, the responsibilities for each task, and any other conditions or limitations on calibration. The following structure of the calibration procedure is proposed:

1. Purpose – states the reason why the calibration procedure was developed.
2. Sphere of application – to which instruments the developed calibration method can be applied.
3. Documentary standards – normative references that were used when writing the procedure.
4. Terms and definitions - definition of terms and abbreviations used in the procedure.
5. Safety - safeguards that must be observed when performing a calibration.
6. Employee qualification requirements – a list of competencies that the employee performing the calibration should have.
7. Used standards and auxiliary equipment – a list of equipment used for calibration and control of environmental conditions, indicating their metrological characteristics.
8. Performing calibration – step-by-step instructions for performing calibration and processing calibration results. It may consist of the following items:

8.1. Preparation for calibration – the application for calibration, normative technical documentation for the ICE is being studied. This stage also includes the preparation for operation of standards, auxiliary equipment and calibrated ICE, as per their operating manual.

8.2. Performing a Calibration:

a) visual analysis – the completeness of the device as per the passport for the device, availability of identification mark and clearness of superscriptions and symbols, zero mechanical damages to the gauge body of the device any damage that impairs or precludes the correct operation of the device are checked;

b) testing – secure mounting of instrument terminals, smooth motion and clear fixation of switches and the movement smoothness of the instrument pointer along the entire scale should be established;

c) measurements and determination of metrological characteristics – first select the points for which calibration will be carried out, based on the wishes of the client then for each calibration point, a series of measurements with multiple observations is performed (usually 10 measurements are taken for each calibration point, and the pointer is smoothly brought up to the mark 5 times from the side of the lower values and 5 times from the side of the higher values). The obtained readings of the standard and the calibrated ICE are recorded in the calibration protocol.

8.3. Processing of measurement results – a mathematical model for measuring the calibrated quantity is compiled, an average value is calculated for each calibration point, calculate the standard uncertainties for the components included in the mathematical model of the measurement, taking into account the influence of all components in accordance with the mathematical model for the measurements, calculate the expanded measurement uncertainty. After all calculations, an uncertainty budget is drawn up.

8.4. Presentation of the calibration results – execution of a protocol containing all data of the calibration process. According to the calibration protocol, a calibration certificate is issued in accordance with the requirements of DSTU ISO/IEC 17025. In case of negative calibration results, a protocol or an extract from the protocol is drawn up, which indicates the reasons for the nonconformance.

9. Storage of equipment – clarification regarding the handling of equipment after calibration.

10. Responsibility – who is responsible for the calibration results, the condition of the instrument being calibrated and the working standards.

Conclusion. Currently, there are no normative documents in Ukraine that regulate the requirements for the structure or content of ICE calibration procedure. Therefore, each body (laboratory) that provides equipment calibration services independently develops calibration procedures and sets the structure and content of the procedure at its own discretion, which does not contribute to the formulation of uniform requirements for calibration procedures. The paper introduces the content of the procedure, which can be applied to any type of equipment being calibrated.

References

1. ISO/IEC Guide 99:2007 International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM), 2007.

2. Про метрологію та метрологічну діяльність : Закон України від 05.06.2014 р. № 1314-VII. Дата оновлення: 01.01.2022 р. URL: https://zakon.rada.gov.ua/laws/show/1314-18 (дата звернення 02.05.2022).

3. ДСТУ EN ISO/IEC 17025. Загальні вимоги до компетентності випробувальних та калібрувальних лабораторій (EN ISO/IEC 17025:2019, IDT; ISO/IEC 17025:2017, IDT). Київ, 2019. 32 с.

4. EA. Expression of the uncertainty of measurement in calibration. Technical Report EA-4/02, European Cooperation for Accreditation, 2013.

5. Про затвердження порядку калібрування вторинних та робочих еталонів : наказ Міністерства розвитку економіки, торгівлі та сільського господарства України від 10.08.2020 р. № 1518. URL: https://zakon.rada.gov.ua/laws/show/z1000-20 (дата звернення 02.05.2022).