



STANDARDIZATION OF THE ACTIVITY OF TESTING LABORATORIES AND IMPROVEMENT OF THE LEVEL OF METROLOGICAL SUPPLY

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Annotatsiya

This article investigates the standardization of testing laboratory activities, the assurance of measurement uniformity, and the metrological reliability of measurement results. In the modern operation of testing laboratories, the accuracy, traceability, repeatability, and reproducibility of measurement results are among the key factors determining product quality, compliance with the requirements of technical regulations, and the reliability of conformity assessment processes. The results of the study can contribute to improving the quality of measurements in testing laboratories, reducing the risk of non-conforming results, and strengthening compliance with accreditation requirements.

Kalit soʻzlar: testing laboratory, standardization, metrological support, metrological traceability, measuring instruments, calibration, verification, measurement uncertainty, ISO/IEC 17025, quality management, accreditation, interlaboratory comparisons.

Annotatsiya. Mazkur maqolada sinov laboratoriyalari faoliyatini standartlashtirish, oʻlchashlarning birliligi va natijalarining metrologik ishonchliligini taʼminlash masalalari tadqiq etilgan. Sinov laboratoriyalarining zamonaviy faoliyatida oʻlchash natijalarining aniqligi, kuzatuvchanligi, takrorlanuvchanligi va qayta tiklanuvchanligi mahsulot sifati, texnik reglamentlarga muvofiqlik hamda muvofiqlikni baholash jarayonlarining ishonchliligini belgilovchi asosiy omillardan biri hisoblanadi. Tadqiqot natijalari sinov laboratoriyalarida oʻlchashlar sifatini oshirish, nomuvofiq natijalar xavfini kamaytirish va akkreditatsiya talablariga muvofiqlikni mustahkamlashga xizmat qilishi mumkin.

Kalit soʻzlar: sinov laboratoriyasi, standartlashtirish, metrologik taʼminot, metrologik kuzatuvchanlik, oʻlchash vositalari, kalibrlash, qiyoslash, oʻlchash noaniqligi, ISO/IEC 17025, sifat menejmenti, akkreditatsiya, laboratoriyalararo taqqoslash.

Аннотация. В статье исследуются вопросы стандартизации деятельности испытательных лабораторий, обеспечения единства измерений и метрологической достоверности результатов. В современных условиях деятельности испытательных лабораторий точность, прослеживаемость, повторяемость и воспроизводимость результатов измерений являются одними из

основных факторов, определяющих качество продукции, соответствие требованиям технических регламентов и достоверность процессов оценки соответствия. Результаты исследования могут способствовать повышению качества измерений в испытательных лабораториях, снижению риска получения несоответствующих результатов и укреплению соответствия требованиям аккредитации.

Ключевые слова: испытательная лаборатория, стандартизация, метрологическое обеспечение, метрологическая прослеживаемость, средства измерений, калибровка, поверка, неопределенность измерений, ISO/IEC 17025, менеджмент качества, аккредитация, межлабораторные сравнения.

INTRODUCTION

Today, testing laboratories are an important component of the infrastructure for assessing the conformity of products, raw materials, materials, and technological processes with established requirements. The reliability of test results obtained in laboratories is of great importance to manufacturers, consumers, regulatory authorities, accreditation bodies, and other interested parties. Therefore, the activities of a testing laboratory cannot be limited solely to the implementation of test methods. The organizational structure of the laboratory, personnel competence, test methods, measuring instruments, sample management, data recording, and result evaluation processes should be managed as integral components of a unified quality management system. ISO/IEC 17025:2017 establishes international requirements for the competence of testing and calibration laboratories. The standard places particular emphasis on laboratory competence, impartiality, and consistent operation. In Uzbekistan, the process of improving the systems of technical regulation, standardization, metrology, and accreditation in accordance with international requirements is also continuing. Under the existing system, public services are provided for the approval of the technical competence of testing laboratories, as well as for the accreditation of conformity assessment bodies and metrological services. According to the Government Portal of the Republic of Uzbekistan, the Presidential Decree No. PF-25 aimed at accelerating reforms in the field of technical regulation in 2026 establishes objectives such as developing the national quality infrastructure, expanding calibration capabilities, and increasing the share of internationally recognized accreditation services. Under these conditions, along with standardizing the activities of testing laboratories, assessing the actual level of metrological support, identifying existing problems, and systematically addressing them are among the important scientific and practical issues. The **purpose of the study** is to develop a methodological approach aimed at improving standardization and metrological support processes in testing laboratories as an interconnected system and increasing the reliability of measurement results.

The main **objectives of the study** are as follows:

1. to identify the main areas of standardization of testing laboratories;
2. to assess the role of metrological support in laboratory activities;
3. to identify significant risk factors in the management of measuring instruments;
4. to improve mechanisms for ensuring metrological traceability;

5. to systematize the assessment and control of measurement uncertainty;
6. to propose comprehensive indicators for assessing the level of metrological support of a laboratory;
7. to develop practical recommendations for improving laboratory activities.

MATERIALS AND METHODS

The study employed the methods of systematic analysis, comparative analysis, expert assessment, risk assessment, metrological analysis, and comprehensive indicator evaluation.

The normative and methodological basis of the study consists of ISO/IEC 17025:2017, ISO 10012:2026, as well as regulatory documents in the fields of metrology, standardization, technical regulation, and conformity assessment.

ISO/IEC 17025 is one of the principal international standards for assessing laboratory competence, and its requirements cover both organizational and technical aspects of testing and calibration activities.

From the perspective of measurement management, ISO 10012:2026 is of particular importance. The standard establishes requirements for a measurement management system aimed at ensuring reliable measurement results. It is focused on the systematic management and continual improvement of measurement processes and supporting activities.

The metrological support of a testing laboratory can appropriately be considered as a set of the following key elements:

1. availability and technical condition of measuring instruments;
2. identification of measuring instruments;
3. verification and calibration status;
4. metrological traceability;
5. evaluation of measurement uncertainty;
6. validation or verification of test methods;
7. metrological competence of personnel;
8. internal quality control;
9. interlaboratory comparisons;
10. maintenance of metrological documentation.

For the management of measuring instruments in a laboratory, each instrument should be assigned an individual identification number, and its metrological status should be recorded in an electronic or paper-based register. The register should include information on the name of the measuring instrument, manufacturer, model, serial number, measurement range, accuracy characteristics, date of the last calibration or verification, date of the next control, and the responsible employee.

One of the important aspects of metrological support is ensuring the traceability of measurement results to measurement standards or appropriate higher-level measurement standards. In this regard, merely having a certificate for a measuring instrument is not sufficient. The conditions of use, measurement range, accuracy requirements, and compliance of the instrument with the requirements of the relevant test method should also be assessed.

RESULTS

As a result of the study, a comprehensive approach was developed for assessing the level of standardization and metrological support of testing laboratories.

The overall level of metrological support of a laboratory can be expressed using the following generalized index:

$$M = w_1K_1 + w_2K_2 + w_3K_3 + w_4K_4 + w_5K_5 + w_6K_6$$

where:

M — integral indicator of the laboratory's metrological support level;

K₁ — metrological condition of measuring instruments;

K₂ — calibration/verification coverage;

K₃ — level of metrological traceability;

K₄ — level of measurement uncertainty evaluation;

K₅ — personnel competence;

K₆ — effectiveness of internal and external quality control;

w_i — weighting coefficient reflecting the importance of the respective indicator for the laboratory.

The values of these indicators can be normalized within the range from 0 to 1. In this case, the laboratory may determine the weighting coefficient of each component depending on the specific area of its activities.

For example, the level of metrological support can be conditionally assessed according to the following criteria:

Integral indicator value	Metrological support status	Assessment
0.90–1.00	Very high	Stable and well-developed
0.75–0.89	High	Generally compliant with requirements
0.60–0.74	Satisfactory	Improvement required
0.40–0.59	Low	Significant nonconformities exist
0–0.39	Very low	System restructuring required

This table is proposed not as a mandatory requirement of a regulatory document, but as a methodological assessment model that can be used within the laboratory's internal management system. Management of the Metrological Condition of Measuring Instruments

One of the most common risks in laboratory activities is incomplete maintenance of information regarding the metrological condition of measuring instruments. The fact that a measuring instrument has been verified or calibrated does not automatically mean that it is suitable for all types of testing.

1. For example, the following characteristics of a measuring instrument should be assessed separately:

2. measurement range;
3. maximum permissible error;
4. operating conditions;
5. accuracy class;
6. measurement uncertainty;
7. compliance with the test method.

Therefore, it is advisable for a laboratory to develop a compatibility matrix based on the relationship between the “**measuring instrument — test method — measured parameter**” triad. Ensuring Metrological Traceability Metrological traceability is one of the key elements ensuring the reliability of test results. The traceability of a

measurement result should be directly linked to the measuring instrument, calibration chain, measurement standards, and relevant documented evidence.

Traceability in the laboratory can be organized according to the following sequence:

test sample → measurement method → measuring instrument → calibration/verification → measurement standard → national or international measurement standards system.

A lack of documentation at any link in this chain may reduce the reliability of the measurement result. Evaluation of Measurement Uncertainty Assessing the quality of a test result merely as “accurate” or “inaccurate” is not sufficient. The uncertainty associated with the result should also be determined and, where appropriate, reflected in test reports.

The generalized expression for measurement uncertainty can be presented as follows:

$$u^c = \sqrt{(u_1^2 + u_2^2 + \dots + u_n^2)}$$

where u^c is the combined standard uncertainty, and $u_1, u_2, \dots, u_n$ are individual uncertainty components affecting the measurement result.

The expanded uncertainty is expressed as:

$$U = k \cdot u^c$$

where k is the coverage factor.

When developing an uncertainty budget under laboratory conditions, components related to the measuring instrument, calibration, repeatability, environmental conditions, operator influence, sample preparation, and other components of the test method may be taken into account.

Improving Personnel Competence

Metrological support is not limited to technical equipment. The competence of laboratory personnel directly affects the reliability of measurement results.

Therefore, it is advisable to establish a regular professional development system for personnel in the following areas:

1. fundamentals of metrology;
2. evaluation of measurement uncertainty;
3. requirements of ISO/IEC 17025;
4. validation and verification of test methods;
5. use of measuring instruments;
6. internal laboratory quality control;
7. interlaboratory comparisons;
8. risk management;
9. maintenance of technical documentation.

Assessment of personnel competence should not be limited to certificates confirming completion of training courses. Practical assignments, supervised tests, examinations, and the results of interlaboratory comparisons should also be taken into account.

DISCUSSION

The theoretical and methodological results obtained demonstrate that standardization and metrological support in testing laboratories should not be managed

as independent processes, but rather as interconnected elements of a unified quality management system.

The standardized operation of a laboratory is primarily characterized by the documentation of all essential processes. However, the mere existence of documents does not in itself guarantee laboratory competence. The practical implementation of established requirements, mechanisms for monitoring results, and processes for continual improvement are of critical importance.

ISO/IEC 17025:2017 is one of the principal international standards used to assess laboratory competence and is applied by accreditation bodies as a criterion for evaluating laboratories.

In Uzbekistan, the development of the accreditation system is also increasing the importance of international requirements in laboratory activities. The areas of activity of the Uzbekistan Accreditation Center are related to the accreditation of laboratories and conformity assessment bodies, with particular attention being paid to harmonization with the international accreditation infrastructure.

From the perspective of metrological support, one of the most important issues for a laboratory is to assess measuring instruments not merely according to the criterion of whether they “have a certificate or not,” but according to their **suitability for a specific test and their influence on the measurement result**. Therefore, it is advisable to introduce a risk-based management system for measuring instruments in laboratories. In this approach, a higher level of control should be established for measuring instruments that require high accuracy and have a significant impact on test results. In addition, interlaboratory comparisons and proficiency testing provide an opportunity for an objective external assessment of laboratory results. If a laboratory regularly compares its results with those obtained by other competent laboratories, it becomes possible to identify hidden problems in the test method or measurement system.

The comprehensive assessment model proposed as a result of the study enables laboratory management to allocate resources toward priority areas. For example, if the metrological condition of measuring instruments in a laboratory is high, but personnel competence assessment and interlaboratory comparison indicators are low, subsequent improvement measures should be focused specifically on these areas.

Furthermore, digitalization of metrological support can increase operational efficiency. An electronic metrological register, automatic monitoring of calibration due dates, identification of the metrological status of measuring instruments using QR codes, and an electronic register of nonconformities are modern tools for managing laboratory activities.

PROPOSED IMPROVEMENT MODEL

A five-stage model is proposed for improving the metrological support of testing laboratories.

Stage 1 — Diagnostics

An audit of the laboratory's current condition is conducted. Measuring instruments, test methods, personnel, documentation, and the quality control system are inventoried.

Stage 2 — Risk Identification

The main risks affecting measurement results are identified. Each risk is assessed according to probability and consequence criteria.

Stage 3 — Standardization of the Metrological System

A unified register of measuring instruments, calibration and verification schedules, metrological traceability documentation, uncertainty budgets, and control procedures are developed.

Stage 4 — Competence Development

The knowledge and practical skills of personnel are regularly assessed. Training programs are organized in areas where deficiencies are identified.

Stage 5 — Monitoring and Continual Improvement

The level of metrological support is periodically assessed using the proposed integral indicator. Corrective and preventive measures are developed based on the identified deficiencies.

The fundamental feature of this model is that metrological support is considered not as a one-time process of fulfilling accreditation requirements, but as a management system that requires continual improvement.

CONCLUSION

The results of the study demonstrate that standardization of testing laboratory activities and improvement of the level of metrological support are important prerequisites for increasing the reliability of laboratory results.

To ensure effective operation of testing laboratories, it is advisable to comprehensively develop the following areas:

1. standardization of laboratory processes based on international standards;
2. establishment of a unified electronic register of measuring instruments;
3. risk-based management of calibration and verification processes;
4. ensuring metrological traceability of measurement results;
5. improvement of validation and verification of test methods;
6. systematic evaluation of measurement uncertainty;
7. expansion of participation in interlaboratory comparisons and proficiency testing;
8. regular assessment of the metrological and technical competence of laboratory personnel;
9. strengthening internal quality control;
10. periodic assessment of the state of metrological support using an integral indicator.

The proposed comprehensive assessment model makes it possible to identify the strengths and weaknesses of a laboratory's metrological support, use available resources more effectively, and determine priority areas for improvement. Thus, the competitiveness of a testing laboratory and the international recognition of its results depend not only on the availability of modern laboratory equipment, but also on the metrological traceability of measurements, personnel competence, suitability of test methods, and effective operation of the quality management system. The reforms currently being implemented in Uzbekistan in the fields of technical regulation and metrology create new opportunities for further harmonization of these areas with international practice. Within the framework of the reforms implemented in 2026,

particular objectives have been established to expand calibration capabilities and develop internationally recognized accreditation services.

REFERENCES

1. ISO/IEC 17025:2017. *General requirements for the competence of testing and calibration laboratories*. International Organization for Standardization, Geneva, 2017.
2. ISO 10012:2026. *Quality management — Requirements for measurement management systems*. International Organization for Standardization, Geneva, 2026.
3. Law of the Republic of Uzbekistan “On Metrology”, No. O‘RQ-614, April 7, 2020.
4. Law of the Republic of Uzbekistan “On Standardization”, No. O‘RQ-800, November 3, 2022.
5. Law of the Republic of Uzbekistan “On Technical Regulation”, No. O‘RQ-819, February 28, 2023.
6. Law of the Republic of Uzbekistan “On Accreditation of Conformity Assessment Bodies”, February 27, 2023.
7. Presidential Decree of the Republic of Uzbekistan No. PF-25, “On Measures to Accelerate Reforms in the Field of Technical Regulation Based on Advanced International Practices”, February 16, 2026.
8. Agency for Technical Regulation under the Cabinet of Ministers of the Republic of Uzbekistan. *Accreditation System and Regulatory Framework*.
9. Agency for Technical Regulation under the Cabinet of Ministers of the Republic of Uzbekistan. *Register of Public Services: Accreditation of Conformity Assessment Bodies and Metrological Services; Approval of the Technical Competence of Testing Laboratories*.
10. Higher Attestation Commission of the Republic of Uzbekistan. *Requirements for Scientific Publications and Research Articles*.
11. ISO. ISO/IEC 17025 — *General requirements for the competence of testing and calibration laboratories*. International Organization for Standardization.