

**DEVELOPING A METHODOLOGICAL SYSTEM FOR EVALUATING  
THE IMPLEMENTATION OF ISO/IEC 17025 REQUIREMENTS  
IN CALIBRATION LABORATORIES FOR GEOMETRIC  
MEASURING INSTRUMENTS**

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**Abstract:** In the rapidly evolving landscape of industry and science, accuracy and reliability have become core values in every technical process. Calibration laboratories that work specifically with geometric measuring instruments play a key role in supplying these values, as the precision of measurement results impacts not only product quality but also the technological reputation of manufacturers at local and international levels. At the heart of guaranteeing this precision stands adherence to the ISO/IEC 17025 standard, a globally recognized benchmark for the competence of testing and calibration laboratories. However, merely declaring compliance with the standard is insufficient; there must be a well-developed methodological system to conduct regular, thorough evaluations of how well laboratories actually fulfill ISO/IEC 17025 requirements in their everyday actions and documentation.

**Keywords:** Geometric measuring instruments, calibration, laboratory, ISO/IEC 17025, international standards, evaluation system, methodology, quality management, process control.

**Аннотация:** В быстро меняющемся ландшафте промышленности и науки точность и надежность становятся основополагающими ценностями любого технического процесса. Калибровочные лаборатории, которые работают именно с геометрическими измерительными инструментами, играют ключевую роль в обеспечении этих ценностей, поскольку точность результатов измерений влияет не только на качество продукции, но и на технологическую репутацию производителей на местном и международном уровнях. В основе обеспечения этой точности лежит соблюдение стандарта ISO/IEC 17025 — признанного во всем мире эталона компетентности испытательных и калибровочных

лабораторий. Однако простого заявления о соответствии стандарту недостаточно; необходимо разработать методологическую систему, которая бы позволяла регулярно и всесторонне оценивать, насколько тщательно лаборатории выполняют требования ISO/IEC 17025 в своей повседневной практике и документации.

**Ключевые слова:** Геометрические измерительные инструменты, калибровка, лаборатория, ISO/IEC 17025, международные стандарты, система оценки, методология, управление качеством, контроль процессов.

**Annotatsiya:** Sanoat va fan sohasidagi tezkor rivojlanish sharoitida aniqlik va ishonchlik har qanday texnik jarayonning asosiy qadriyatlariga aylanmoqda. Aynan geometrik o'lchash vositalari bilan ishlaydigan kalibrlash laboratoriyalari ushbu qadriyatlarni ta'minlashda muhim ahamiyat kasb etadi, chunki o'lchov natijalarining aniqligi mahsulot sifati bilan bir qatorda, ishlab chiqaruvchilarning mahalliy va xalqaro miqyosdagi texnologik obro'siga ham bevosita ta'sir ko'rsatadi. Ushbu aniqlikni kafolatlashning asosi esa — sinov va kalibrlash laboratoriyalari malakasining butun dunyo bo'ylab tan olingan mezoni bo'lgan ISO/IEC 17025 standartiga amal qilishdir. Biroq, faqat ushbu standartga rioya qilinayotgani haqida bayonot berish yetarli emas; laboratoriyalarda ISO/IEC 17025 talablarining har kuni amalda va hujjatlarda qay darajada bajarilishini muntazam va chuqur baholashga imkon beradigan yaxshi ishlab chiqilgan metodik tizim mavjud bo'lishi kerak.

**Kalit so'zlar:** Geometrik o'lchash vositalari, kalibrlash, laboratoriya, ISO/IEC 17025, xalqaro standartlar, baholash tizimi, metodologiya, sifat menejmenti, jarayonlarni boshqarish.

### **Introduction**

The significance of this challenge grows even further given the range of instruments classified as geometric measuring devices. These include micrometers, calipers, coordinate measuring machines, angle measurement tools, surface flatness gauges, and others routinely used in manufacturing, construction, and various branches of engineering. Every one of these tools requires high precision, strict traceability, and regular confirmation of accuracy via calibration. Therefore, calibration laboratories working with geometric measuring instruments often act as critical nodes in the network of industrial quality control. Developing a methodological system for assessing ISO/IEC 17025 compliance begins with understanding the philosophy and structure of the standard itself. ISO/IEC 17025 requires laboratories to build a robust management system encompassing technical competence, organizational procedures, and objective documentation of all processes. The first fundamental aspect of a genuinely effective assessment methodology is therefore ensuring comprehensive documentation and transparency at every stage of calibration, from the initial receipt

and registration of a device to the issuance of the calibration certificate.

### **Materials and methods**

A methodological evaluation system should start by mapping all laboratory processes to each section and subsection of the ISO/IEC 17025 standard. This mapping allows for closer inspection of whether every aspect, such as staff qualification, environmental conditions, uncertainty management, calibration method validation, traceability of reference standards, IT infrastructure, and customer communication, meets the required level of quality and traceability. Every laboratory process, whether technical or administrative, should be cross-examined against concrete standard requirements—for example, the proper control of environmental factors such as temperature and humidity during calibration, or the presence and regular review of operational procedures. Another layer of assessment involves the competence and ongoing training of laboratory staff. In many laboratories, personnel are technically proficient, but knowledge of updates to ISO/IEC 17025 or modern calibration practices may be outdated. A truly effective methodological system periodically measures staff awareness of the latest developments in the field, provides ongoing training, and records the outcomes of these educational initiatives. Moreover, the evaluation system must check how skills and responsibilities are distributed in the laboratory, and whether all staff demonstrate a clear understanding of both their duties and the expectations set by ISO/IEC 17025. A substantial component of the methodology is focused on the measurement equipment and reference standards used within the laboratory. Equipment qualification, regular maintenance, calibration cycles, and traceability to national or international standards are all essential. The assessment system should require regular reviews of calibration certificates, maintenance logs, and performance check records. This ensures the entire laboratory apparatus meets required standards—and that the results can be confidently traced to recognized benchmarks, reducing the risk of errors in measurement and guaranteeing the reliability of the final calibration reported to customers [1].

### **Results and discussion**

Uncertainty management and risk assessment are increasingly recognized as pillars of modern laboratory practice. ISO/IEC 17025 places strong emphasis on the identification, evaluation, and documentation of all possible sources of uncertainty and error in the calibration process. A comprehensive methodology should therefore include detailed checks of uncertainty calculations for conformity with established guides, as well as validate that all significant influences on the measurement have been considered and properly documented. This not only improves the technical accuracy of the laboratory but provides customers with a clear understanding of the reliability and limitations of the reported measurements. Quality assurance and improvement processes constitute another essential element. Methodological evaluation of ISO/IEC

17025 implementation must verify that laboratories conduct regular internal audits, participate in interlaboratory comparisons or proficiency testing, and systematically address non-conformities when detected. Effective response mechanisms, documentation of corrective and preventive actions, and follow-up investigations are part of a “living” quality management approach that strengthens the laboratory’s ability to learn from incidents and elevate its overall performance [2].

In addition to these technical considerations, the evaluation methodology should not neglect record-keeping, document control, and data integrity. Laboratories must maintain well-organized records of every step in the calibration process, ensuring that data cannot be lost, tampered with, or misinterpreted at a later date. Modern laboratories increasingly depend on robust IT platforms for data management, and the methodological evaluation must extend to reviewing electronic records systems for reliability, security, and accessibility in audit scenarios. Environmental, health, and safety requirements form another crucial pillar of laboratory operations. The evaluation system must check compliance with relevant environmental and safety regulations, verify that all hazardous materials are properly stored and handled, and ensure that staff are regularly trained on emergency response protocols. By embedding these checks into the assessment process, laboratories reduce the risk of accidents and contribute to sustainable laboratory management [3].

To make the methodological system effective and actionable, clear indicators and criteria should be established for every stage and category of the laboratory’s activities. These indicators must allow for objective, reproducible judgments on whether the standard’s requirements are being fulfilled—and highlight both areas of strength and zones requiring further improvement. Furthermore, the system should support both internal self-assessment and external audits by national or international oversight bodies, establishing an open feedback loop for continuous enhancement. Periodic review and revision of the assessment methodology itself is essential to keep it aligned with developments in measurement science, changes in industry regulations, and evolution of ISO/IEC 17025 itself. Best practices from other countries, new technologies, and stakeholder feedback must be systematically incorporated. In practice, this means the laboratory’s methodological system should never remain static but should evolve side by side with the broader world of scientific measurement [4].

A laboratory applying such a methodological evaluation system stands to gain numerous benefits. First, its quality management becomes proactive rather than reactive, allowing issues to be anticipated and resolved before they impact results. Second, client trust increases, as reports and certificates issued by the laboratory are demonstrably based on rigorous adherence to international standards. Third, the lab’s reputation among regulatory agencies, accreditation bodies, and partner institutions

grows—facilitating greater participation in industry networks and mutual recognition arrangements. One practical aspect involves creating assessment checklists mapped directly to each subsection of ISO/IEC 17025, tailored to the specific workflows and equipment of geometric measuring instrument calibration. These checklists should be regularly updated based on audit findings, customer feedback, scientific literature, and standards updates. Staff should participate in periodic training and feedback sessions, addressing points raised in assessment rounds, and implementing practical improvements in laboratory workflows and documentation. The methodological system must also introduce clear documentation procedures for any deviations, corrections, or improvements identified during evaluation. Proper root cause analysis, corrective action plans, and follow-up reviews ensure that every non-conformity is converted into an opportunity for growth, not simply hidden or overlooked. Bringing in external, independent auditors at regular intervals adds another layer of credibility and objectivity to the internal evaluation cycle. Another important dimension is fostering a culture of continuous improvement and openness within the laboratory team. Methodical evaluation processes should be communicated as opportunities for learning and professional growth, not as obstacles or punitive exercises. Laboratory leadership has a vital role in building this culture, recognizing instances of excellent performance, and incentivizing creative solutions to technical and operational challenges [5].

The comprehensive methodological system, therefore, embraces both structure and adaptability. It should provide sufficient rigor to assure compliance and precision, but also allow enough flexibility to adjust to specific lab situations and incorporate innovative ideas. Over time, this combination of strictness and openness will embed ISO/IEC 17025 standards deeply into the fabric of laboratory operations. Lastly, developing effective stakeholder communication is an essential outcome of this work. The evaluation system must include feedback mechanisms that capture insights from laboratory clients, auditors, and regulatory bodies. Clear, well-documented responses to feedback should be systematically reviewed and, where necessary, incorporated into operating procedures, contributing to a virtuous circle of improvement [6].

### **Conclusion**

In conclusion, the methodological system for evaluating ISO/IEC 17025 implementation in calibration laboratories for geometric measuring instruments represents a synthesis of global best practices with everyday laboratory needs. It transforms the abstract principles of the standard into concrete actions, documentation, and measurable improvement. Implementing such a system is not only a regulatory necessity but a strategic tool for achieving technical excellence, customer satisfaction, and international recognition in the field of metrology. As industries continue to innovate and expectations for accuracy rise, well-calibrated laboratories—operating

with robust methodological systems—will remain essential pillars of trust and quality in modern technological society.

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