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THE IMPORTANCE OF STANDARDIZATION REQUIREMENTS IN THE ACCREDITATION OF NON-DESTRUCTIVE TESTING LABORATORIES



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Abstract: This article analyzes the importance of standardization requirements in the accreditation of non-destructive testing laboratories. Based on ISO/IEC 17025, ISO 9712, ISO 16810, ISO 16809, ISO 17635, and the O'z DSt ISO/IEC 17025 standard applied in Uzbekistan, the requirements for laboratory competence, personnel qualification, metrological traceability, and testing methods are considered. The main directions for harmonizing national standards with international requirements and improving the accreditation system are substantiated.

Keywords: non-destructive testing, standardization, accreditation, laboratory competence, metrological support, metrological traceability, measurement uncertainty, ultrasound, flaw detector, national standard, international standard.

Reliable assessment of the technical condition of industrial facilities is one of the critical tasks in industrial safety, energy, oil and gas, transportation, construction, and mechanical engineering. Timely detection of defects that may occur during the operation of metal structures, pipelines, pressure vessels, welded joints, storage tanks, and other technical assets is essential for ensuring their reliability and safety.

Annotatsiya: Ushbu maqolada buzmasdan nazorat qilish laboratoriyalarini akkreditatsiyadan o'tkazishda standartlashtirish talablarining ahamiyati tahlil qilingan. ISO/IEC 17025, ISO 9712, ISO 16810, ISO 16809, ISO 17635 hamda O'zbekistonda qo'llaniladigan O'z DSt ISO/IEC 17025 standarti asosida laboratoriya kompetentligi, xodimlar malakasi, metrologik kuzatuvchanlik va sinov usullariga qo'yiladigan talablar ko'rib chiqilgan. Milliy standartlarni xalqaro talablar bilan uyg'unlashtirish hamda akkreditatsiya tizimini takomillashtirishning asosiy yo'nalishlari asoslab berilgan.

Kalit so'zlar: buzmasdan nazorat qilish, standartlashtirish, akkreditatsiya, laboratoriya kompetentligi, metrologik ta'minot, metrologik kuzatuvchanlik, o'lchash noaniqligi, ultratovush, defektoskop, milliy standart, xalqaro standart.

Sanoat obyektlarining texnik holatini ishonchli baholash sanoat xavfsizligi, energetika, neft-gaz sohasi, transport, qurilish va mashinasozlikdagi muhim vazifalardan biridir. Metall konstruksiyalar, quvurlar, bosim ostida ishlaydigan idishlar, payvandlangan birikmalar, rezervuarlar va boshqa texnik obyektlardan foydalanish jarayonida yuzaga kelishi mumkin bo'lgan nuqsonlarni o'z vaqtida aniqlash ularning ishonchligi va xavfsizligini ta'minlashda muhim ahamiyatga ega.

Аннотация: В данной статье анализируется значение требований стандартизации при аккредитации лабораторий неразрушающего контроля. На основе ISO/IEC 17025, ISO 9712, ISO 16810, ISO 16809, ISO 17635 и стандарта O'z DSt ISO/IEC 17025, применяемого в Узбекистане, рассматриваются требования к компетентности лабораторий, квалификации персонала, метрологической прослеживаемости и методам испытаний. Обоснованы основные направления гармонизации национальных стандартов с международными требованиями и совершенствования системы аккредитации.

Ключевые слова: неразрушающий контроль, стандартизация, аккредитация, компетентность лаборатории, метрологическое обеспечение, метрологическая прослеживаемость, неопределенность измерений, ультразвук, дефектоскоп, национальный стандарт, международный стандарт.

Надежная оценка технического состояния промышленных объектов является одной из важнейших задач в области промышленной безопасности, энергетики, нефтегазовой отрасли, транспорта, строительства и машиностроения. Своевременное выявление дефектов, которые могут возникать в процессе эксплуатации металлических конструкций, трубопроводов, сосудов под давлением, сварных соединений, резервуаров и других технических объектов, имеет важное значение для обеспечения их надежности и безопасности.

INTRODUCTION.

Ensuring the structural integrity and operational safety of critical infrastructure is a cornerstone of modern industrial quality management. Industrial sectors such as energy, oil and gas, transportation, chemical processing, construction, and heavy engineering rely heavily on technical assets operating under severe conditions. Metal structures, pipelines, pressure vessels, storage tanks, and welded joints are continuously exposed to mechanical stress, thermal fluctuations, and corrosive environments. Consequently, the timely detection, characterization, and evaluation of internal and surface discontinuities are paramount to preventing catastrophic structural failures and minimizing economic losses.

Non-destructive testing (NDT) methodologies play an irreplaceable role in quality assurance by enabling the inspection of materials, components, and assemblies without impairing their future usefulness or serviceability. However, the reliability and accuracy of NDT inspections depend on a complex array of factors, including the technical performance of flaw detectors, the validity of applied testing methodologies, operator competence, environmental control, and metrological traceability. A high-specification instrument alone cannot guarantee precise results if operated by underqualified personnel or guided by ambiguous testing protocols.

To establish confidence in inspection outcomes, laboratory accreditation serves as a primary tool for verifying technical competence, impartiality, and operational consistency. While general accreditation frameworks—such as ISO/IEC 17025—define foundational management and technical criteria, their application in NDT laboratories requires comprehensive integration with method-specific international standards. Furthermore, the rapid advancement of NDT technologies and the periodic revision of international normative documents necessitate continuous harmonization within national standardization systems.

LITERATURE REVIEW.

The issues of improving non-destructive testing (NDT) laboratories and their accreditation systems have been widely studied by both local and foreign researchers.

Among foreign scholars, R. Guo et al. (2023) [14] conducted a comparative analysis of the requirements of ISO/IEC 17025 (testing and calibration laboratories) and ISO/IEC 17020 (inspection bodies), highlighting the impartiality of test results and criteria for assessing technical competence. Modern NDT methods and uncertainty evaluation were thoroughly examined in a study published in *Progress in Materials Science* (2023) [15], which demonstrated the importance of standardized methods and digital technologies in detecting small-scale defects. N. Abdelazim et al. (2026) [16] analyzed the integration of sensor-based smart NDT systems, digital diagnostics, and artificial intelligence-based testing methods with standardization requirements.

Additionally, documents from international bodies such as ISO and ILAC (JCGM 100:2008 [12], ILAC G24:2022 [13]) address measurement uncertainty and metrological traceability, while ISO 9712:2021 [3] provides a unified international framework for NDT personnel qualification and certification.

In national practice, the activities of laboratories are regulated under O'z DSt ISO/IEC 17025:2019 [2] and national accreditation system requirements. However, most existing studies examine the general organizational and technical requirements of ISO/IEC 17025 in isolation, without fully integrating specific NDT methods (such as ultrasonic or radiographic testing) within their sectoral context.

The novelty and distinctive aspect of this study compared to previous works lie in presenting the general accreditation requirements of ISO/IEC 17025 as an integrated, multi-level, and systematic mechanism combined with the latest revisions of NDT-specific international standards (ISO 16810:2024, ISO 16809:2025, ISO 17635:2025, and ISO 16827:2025) and personnel competence requirements (ISO 9712:2021).

RESEARCH METHODOLOGY.

This article was prepared using systematic analysis of regulatory and technical documentation, comparative technical analysis, and structural classification, with artificial intelligence tools used as an auxiliary resource for up to 10% of the text preparation process.

Comparative Analysis and Harmonization Method: The requirements of ISO/IEC 17025:2017 and O'z DSt ISO/IEC 17025:2019 were comparatively analyzed. Previous and updated editions (2024–2025) of international standards on ultrasonic testing, thickness measurement, and weld inspection were compared to identify key revisions needed for national standardization.

Systematic and Logical Analysis Method: The accreditation process and the factors influencing testing reliability (personnel, equipment, methodology, metrological traceability) were structured as an interconnected sequence.

Classification and Tabulation Method: International and national standards, criteria for defining the

scope of accreditation, and 10 key factors influencing NDT results were categorized and presented in structured tables.

ANALYSIS AND RESULTS

This methodological approach provided a scientific and practical foundation for shifting the scope of NDT laboratory accreditation from general descriptions to precise technical parameters (object, method, range, and standard).

Non-destructive testing (NDT) methods are distinguished by their ability to obtain information about the internal and external condition of an object without causing significant damage. However, the reliability of inspection results depends not only on the technical performance of the flaw detector. Results are influenced by the applied methodology, operator qualification, characteristics of the object being tested, metrological state of the equipment, reference samples and standard blocks, environmental conditions, and evaluation criteria for interpreting results.

Therefore, accreditation serves as an essential tool for objectively evaluating the technical competence of non-destructive testing laboratories. ISO/IEC 17025:2017 specifies the general requirements for the competence, impartiality, and consistent operation of testing and calibration laboratories.

In Uzbekistan, the O'z DSt ISO/IEC 17025:2019 standard is applied to laboratories and is identical to ISO/IEC 17025:2017.

From this perspective, a comprehensive analysis of standardization requirements during the accreditation of non-destructive testing laboratories, evaluation of the harmonization between national and international standards, and improvement of mechanisms for ensuring laboratory competence represent an urgent scientific and practical task.

The objective of the research is to analyze the importance of standardization requirements in the accreditation of NDT laboratories based on international and national normative documents, systematize the core elements ensuring laboratory competence, and substantiate key directions for improving the standardization system.

Standardization is necessary to establish uniform technical requirements in NDT processes, ensure the comparability of inspections performed across different laboratories, and define a common approach to evaluating results.

At the international level, standardization in non-destructive testing is carried out within Technical Committee ISO/TC 135. The committee standardizes NDT methods, terminology, and functional requirements for testing equipment relating to construction materials, components, and assemblies.

ISO/TC 135 includes separate subcommittees for surface testing methods, ultrasonic testing, eddy current testing, radiographic testing, leak testing, personnel qualification, thermographic testing, and acoustic emission. This reflects the multi-tiered structure of standardization in the field of non-destructive testing.

Table 1
Selected Core International Standards for Non-Destructive Testing Laboratories and Their Roles

No	Standard	Main direction	Importance in Laboratory Activity
1	ISO/IEC17025:2017	Laboratory competence	General management and technical requirements of the laboratory
2	ISO 9712:2021	Qualification and certification of NDT personnel	Ensuring specialist competence
3	ISO 16810:2024	General principles of ultrasonic testing	Standardizing UT inspection processes
4	ISO 16809:2025	Ultrasonic thickness determination	Standardizing thickness measurement processes
5	ISO 17635:2025	General NDT rules for welded joints	Selecting methods and acceptance levels
6	ISO 16827:2025	Characterization and sizing of discontinuities in ultrasonic testing	Evaluating detected discontinuities/ defects

As shown in the table, relying on a single standard is insufficient to ensure laboratory competence. While general accreditation requirements are defined by ISO/IEC 17025, specific NDT standards for testing methods, ISO 9712 for personnel, and relevant normative documents for metrological matters are applied in combination.

The ISO/IEC 17025 standard focuses on ensuring the competence, impartiality, and consistent operation

of laboratories. The significance of standardization in laboratory accreditation can be conditionally represented through the following relationship:

Standard requirements → Methodology → Qualified personnel → Technical equipment → Metrological traceability → Testing → Result evaluation → Reliable conclusion

Every element in this chain directly affects the reliability of the subsequent stage. For instance, even if a laboratory possesses a modern flaw detector, if the testing methodology is not clearly defined or the operator lacks sufficient competence, the reliability of the obtained results cannot be fully guaranteed.

Therefore, accreditation must focus not merely on evaluating a laboratory's level of equipment but on its capability to perform specific types of work competently.

The scope of accreditation for an NDT laboratory must be grounded in precisely defined testing methods and their corresponding normative documents.

For example, ISO 16810 establishes general principles for ultrasonic testing of industrial products. It indicates that supplementary conditions based on product type may be specified in product standards, technical specifications, codes, contract documents, or written procedures. The standard does not independently define the extent of testing, scanning plans, or acceptance criteria.

This aspect holds significant methodological importance when defining the scope of accreditation. Rather than limiting a laboratory's scope to a general field like "ultrasonic testing," it is appropriate to specify the exact object, method, range, and normative document under which work is conducted.

In 2025, the ISO 16809:2025 standard was published. It defines the principles for ultrasonic thickness determination of metallic and non-metallic materials using contact or immersion methods based on pulse time-of-flight. Simultaneously, the 2017 edition was withdrawn in 2025.

Consequently, it is essential for national accreditation and standardization systems to account for new editions of international standards in a timely manner.

Welded joints are critical elements determining the reliability of industrial facilities. Ultrasonic, radiographic, penetrant, and magnetic methods are widely used to detect internal and external defects in them.

ISO 17635 establishes general rules for selecting NDT methods and evaluating results for quality control purposes in welded joints. It demonstrates that selecting methods, techniques, and acceptance levels depends on factors such as material, weld thickness, welding process, quality requirements, and testing volume.

Thus, during laboratory accreditation, replacing generic phrases such as "weld inspection" with specific testing methods and their respective standards allows for precise definition of laboratory competence.

In Uzbekistan, one of the primary standards for laboratory accreditation is O'z DSt ISO/IEC 17025:2019. It is applied as an identical standard to ISO/IEC 17025:2017.

In the scope of accreditation documentation, standard practice involves clearly specifying elements such as the test item, parameter/characteristic to be determined, test method, and normative document. This approach is equally applicable to NDT laboratories.

Table 2
System of Core Requirements for the Accreditation of Non-Destructive Testing Laboratories

Requirement Area	Core Content	Relevant Normative Basis
Laboratory competence	Impartiality, organizational and technical competence	O'z DSt ISO/IEC 17025:2019
Personnel	Qualification, knowledge, and certification	ISO 9712:2021
Testing methodology	Testing procedure and technical parameters	ISO 16810:2024 and specific standards
Thickness measurement	Ultrasonic thickness determination	ISO 16809:2025
Weld inspection	Selection of method and acceptance levels	ISO 17635:2025
Defect evaluation	Characterization and sizing of discontinuities	ISO 16827:2025
Equipment	Technical condition and metrological traceability	ISO/IEC 17025
Quality of results	Monitoring and evaluating results	ISO/IEC 17025
External quality control	Interlaboratory comparisons and proficiency testing	ISO/IEC 17025, ISO/IEC 17043

In NDT laboratories, the reliability of measurement results is intrinsically linked to metrological support. The technical and metrological condition of flaw detectors, ultrasonic thickness gauges, radiation detection devices, reference blocks, transducers, and other equipment must be systematically controlled.

ISO/IEC 17025 attaches great importance to establishing the metrological traceability of measurement results to guarantee the reliability of laboratory outputs. Consequently, the status, identification, and calibration state of measuring instruments and reference materials used by the laboratory must be formally documented.

The use of standard and reference blocks in ultrasonic testing is also vital. ISO 16810:2024 sets out general principles regarding instruments, transducers, couplants, standard and reference blocks in ultrasonic testing.

From this perspective, standardization and metrology should not be treated as separate processes but as a single, unified technical competence system for the laboratory.

In non-destructive testing, result reliability depends on several interconnected factors.

Table 3
Key Factors Influencing Non-Destructive Testing Results

No.	Factor	Requirement Provided in the Laboratory
1	Personnel competence	Qualification and proper training
2	Equipment	Technical serviceability and metrological control
3	Methodology	Current standard or validated procedure
4	Inspection object	Considering material and object characteristics
5	Inspection conditions	Specified environment and technological conditions
6	Reference sample	Suitable reference block/standard for calibration and verification
7	Interpretation of results	Specified evaluation criteria
8	Documentation	Complete recording of results
9	Quality monitoring	Internal and external quality control
10	Metrological traceability	Traceability to calibration and measurement standards

If any of these factors are inadequately addressed, the reliability of the inspection result may be negatively impacted. Therefore, during the accreditation process, it is necessary to evaluate not only the technical capabilities of the laboratory but also the interplay between these factors.

Based on the source analysis, the following key issues merit special focus within the NDT laboratory accreditation system:

Firstly, national standards must be regularly harmonized with new editions of international standards. For instance, timely adoption of new documents such as ISO 16810:2024 (ultrasonic testing), ISO 16809:2025 (ultrasonic thickness determination), and ISO 17635:2025 (welded joints) into the national standardization system is critical.

Secondly, scopes of accreditation should be defined around specific technical tasks rather than general terms. It is recommended to specify the inspection object, method, parameter, measurement range, and applied normative documents.

Thirdly, ISO 9712:2021 requirements must be factored into personnel competence evaluations. This is especially important for ultrasonic, radiographic, penetrant, and magnetic testing methods.

Fourthly, laboratory metrological support must be strengthened, ensuring metrological traceability of instruments and clearly defining procedures for using reference materials and test blocks.

Fifthly, expanding interlaboratory comparisons and proficiency testing programs in the NDT sector will enable better assessment of result comparability.

Sixthly, developing standardization requirements for digitized and automated NDT systems represents a key direction for future growth.

CONCLUSION AND SUGGESTIONS

Standardization requirements in the accreditation of non-destructive testing laboratories serve as an essential element in ensuring laboratory competence, result reliability, and comparability.

The analysis yields the following key conclusions:

Accreditation of NDT laboratories should not be restricted solely to ISO/IEC 17025 requirements but should be carried out comprehensively in conjunction with specific NDT method standards.

Personnel competence directly impacts the reliability of laboratory results; incorporating ISO 9712:2021 requirements is essential.

Updating national systems to account for modern standards—such as ISO 16810:2024 for ultrasonic

testing, ISO 16809:2025 for ultrasonic thickness determination, and ISO 17635:2025 for welded joints—is a priority task for standardization.

Explicitly defining the test item, method, parameter, range, and normative documents within the scope of accreditation enhances the objective assessment of laboratory competence.

Metrological traceability, the technical and metrological condition of equipment, and the proper use of standard and reference blocks are crucial prerequisites for result reliability.

Continuous harmonization of national standards with international revisions and the development of interlaboratory comparisons and proficiency testing for NDT laboratories are strongly recommended.

The advancement of automated, digital, and AI-driven NDT technologies will require future updates to accreditation and standardization requirements.

Overall, advancing standardization alongside accreditation, metrology, and personnel competence within a unified system is a fundamental requirement for ensuring reliability when evaluating the technical condition of industrial facilities.

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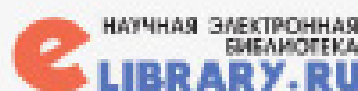
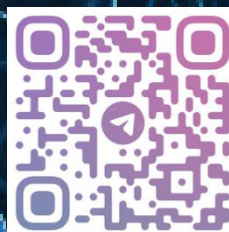
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