Technoeconomics. 2023, Vol. 2, No. 2 (5). Pp. 76–84.
Техноэкономика. 2023, Том 2, № 2 (5). С. 76–84.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2023.2.2.5.7

# RISK-BASED APPROACH IN TESTING LABORATORIES ACCORDING TO THE REQUIREMENTS OF GOST ISO/IEC 17025-2019

**Polina Belova, Sofia Kalyazina, Boris Lyamin** ✉

Peter the Great St. Petersburg Polytechnic University,
St. Petersburg, Russia

✉ lyamin.bm@gmail.com

**Abstract.** At present, in the context of digital transformation, the issues of improving quality of management at enterprises on the basis of a risk-based approach are vastly considered. The enterprise is affected, on the one hand, by macroeconomic instability and consequent international resource constraints, and, on the other, by the growing need to adopt information technologies that enable sustainable development. In such an environment, a risk orientation ensures the sustainability of all operations. Sustainability in testing laboratories is essential, as it represents exactly what guarantees the validity and accuracy of the overall performance and output. The updated revision of GOST ISO/IEC 17025-2019 introduces requirements for a risk-based approach in testing labs. This study focuses on the changes in standards and innovations regarding risk management. As a result of this research, the authors come to the conclusion that it is a matter of fundamental importance to introduce risk-oriented thinking in the quality management system of the labs' testing.

**Keywords:** quality management system, laboratory, quality management, risk and opportunity assessment, risk-based approach

**Citation:** Belova P.D., Kalyazina S.E., Lyamin B.M. Risk-based approach in testing laboratories according to the requirements of GOST ISO/IEC 17025–2019. Technoeconomics. 2023. 2. 2 (5). 76–84. DOI: https://doi.org/10.57809/2023.2.2.5.7

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2023.2.2.5.7

# РИСК-ОРИЕНТИРОВАННЫЙ ПОДХОД В ИСПЫТАТЕЛЬНЫХ ЛАБОРАТОРИЯХ СОГЛАСНО ТРЕБОВАНИЯМ ГОСТ ISO/IEC 17025–2019

**Полина Белова, София Калязина, Борис Лямин** ✉

Санкт-Петербургский политехнический университет Петра Великого,
Санкт-Петербург, Россия

✉ lyamin.bm@gmail.com

**Аннотация.** В настоящее время в условиях цифровой трансформации, вопросам совершенствования системы менеджмента качества предприятий на основе риск-ориентированного подхода уделяется большое внимание. На предприятие оказывают влияние, с одной стороны, макроэкономическая нестабильность и, как следствие, международные ресурсные ограничения, с другой, необходимость внедрения информационных технологий, позволяющих предприятию устойчиво развиваться. В таких условиях ориентация на риск обеспечивает устойчивость операционной деятельности. Устойчивость деятельности в испытательных лабораториях крайне необходима, так как именно это позволяет гарантировать достоверность и точность полученных результатов. В новой редакции стандарта ГОСТ ISO/IEC 17025-2019 впервые появляются требования к риск-ориентированному подходу для испытательных лабораторий. В работе проанализированы изменения в стандарте и нововведения относительно менеджмента риска. В результате проведенного анализа сделаны выводы о необходимости внедрения риск-ориентированного мышления в системе менеджмента качества испытательной лаборатории.

**Ключевые слова:** система менеджмента качества, лаборатория, управление качеством, оценка рисков и возможностей, риск-ориентированное мышление

**Для цитирования:** Белова П.Д., Калязина С.Е., Лямин Б.М. Риск-ориентированный подход в испытательных лабораториях согласно требованиям ГОСТ ISO/IEC 17025–2019 // Техноэкономика. 2023. Т. 2, № 2 (5). С. 76–84. DOI: https://doi.org/10.57809/2023.2.2.5.7



## Introduction

One of the main tasks of testing laboratories today is to convince the customer in the reliability of test results and, consequently, promote and justify the competence of the lab itself. Accuracy and trustworthiness of laboratory tests play a key role in industry and trade decision-making.

The main problem, however, is that not all laboratory tests can produce reliable results due to errors occurring at different stages of testing, as each stage is inevitably exposed to risks. In order to obtain reliable test results, labs must establish an analytical system aimed at studying, preventing and managing risks. In this regard, risk management implies performing actions to identify risks, assess and differentiate them, and establish a risk register with a detailed plan to eliminate or minimize the impact, monitor changes and control the potential risk probability.

The risk management system functions and rests on documenting procedures aimed at eliminating emerging risks, and assessing the impact of existing and potential risks. Competent risk management staff of the laboratory is a prerequisite for a reliable and impeccable process of development and operation of the lab. Each laboratory must first assess the likelihood of risks and outline the actions required to detect and prevent them before they lead to any undesirable

outcome. Undoubtedly, this can be achieved via risk management, as required by ISO 17025.

**Materials and Methods**

Throughout the course of this research, an in-depth analysis of international and domestic standards, in particular GOST ISO/IEC 17025-2019 was carried out. What is more, the work of leading standardization researchers and the management risks were considered. The information obtained was processed with due consideration of modern trends in management of state institutions, in particular, labs based on quality management tools such as the PDCA and PDPC chart, and general scientific methods:

– analysis and synthesis;
– comparison;
– classification.

**Results and Discussion**

For several years now, ISO/IEC 17025 has been the basis for testing and calibration laboratories worldwide, and has allowed laboratories to guarantee their customers the ability to provide reliable results (Kalra, 2004).

By the rule of the International Board for Standardization, Metrology and Certification, in 2019, ISO/IEC 17025–2009 GOST was replaced by ISO/IEC 17025–2019 GOST. The updated version of this standard outlines significant innovations that improve e-document management, and introduces a risk-based approach to quality management. The introduction to the new standard clarifies that the changes will allow laboratories to achieve the desired quality standard via the implementation of control measures, prevention and minimization of negative consequences (Gusarova, et.al., 2020; Ilin, 2022).

Risk arises in any activity because no one can guarantee exactly what will happen and what implications might occur in the future. The ISO 31000–2019 GOST defines risk as the impact of uncertainty on the achievement of goals. Risk always brings specific results that can be negative, positive or negligible. Interest in exploring ways to manage uncertainty and its consequences has grown significantly over the past decade. This has led to the development and application of tools, methods, processes and methodologies, collectively known as risk management. Risk management is one of the most studied topics among researchers and managers. The purpose of risk management is to increase the probability and impact of positive outcomes and to reduce the likelihood and impact of adverse events on the project (Latfullina, 2019).

There are many approaches to structuring risk management. Behm proposed an option consisting of two main phases: the first phase, risk assessment, comprising identification, analysis, differentiation; and the second phase of control, comprising planning and monitoring of risk management. A broader approach consisting of nine phases of risk management is proposed by Chapman and Ward. The approach described by the Kremljak consists of four steps (fig. 1): planning, evaluation, processing and monitoring. This process coincides with Deming's cycle of consistent improvement in quality management (PDCA - Plan, Do, Check, Act). The author stresses that risk management is a continuous process, not a random sequence of events.

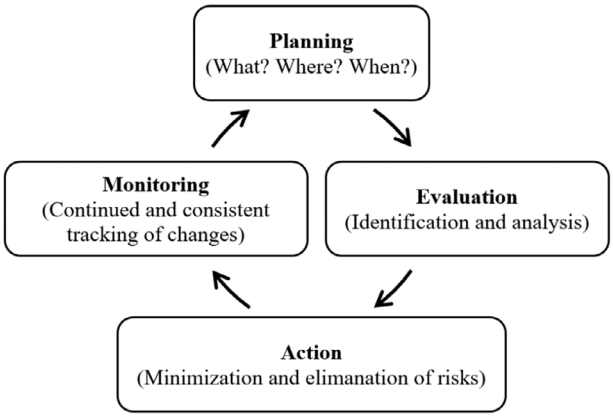



Fig. 1. Elements of Risk Management

It is important to consider separately the elements of risk management in the Kremljak's approach (Kremljak, 2016):

1) Planning. Risk planning is acontinuous process of developing an integrated approach to risk management in general. This phase begins with the development and documentation of a risk management strategy. It includes strategy design, outlining goals and objectives, and development of a risk and impact assessment methodology, together with the identification of resources, methods of documentation related activities, and staff training.

2) Evaluation. This stage entails, in addition to directly assessing the risk itself, an analysis of the effects and risk tolerance, as well as ways to suppress them or minimize their impact. Quantitative or qualitative methods, or a combination of these, are used for evaluation. The quantitative method determines the practical significance and cost of the consequences, their probability, and assigns the value of the risk level in the established units. Qualitative assessment establishes the relationship between impact, probability and risk level on a given scale.

A risk matrix is often used to assess risk, which allows prioritization and direction. Based on a risk and process efficiency matrix, a decision diagram (PDPC) can be constructed enabling each identified risk to develop a corrective action plan to avoid the risk.

3) Action. This stage is a so-called risk treatment, and includes methods of dealing with existing risks, their classification, performance of tasks to minimize the impact or eliminate the risk. This also includes scheduling, responsibility and cost estimation. The main objective of this phase is to reduce the impact of effects on the target. There are many methods for this, but they can be grouped into four main categories: risk prevention, risk control, risk acceptance and risk transfer.

4) Monitoring. Risk monitoring and control – a continuous process of tracking changes in both, already established risks, and identifying new ones, as market conditions and other circumstances affecting the target tend to be very fluid.

Many technologies exist to implement the second phase. Detailed description of risk assessment technologies includes GOST R 58771-2019. The choice of technology is determined by adaptability, scope of application, and the scale of the problem. It was also important to consider resource constraints, alternative solutions and the possibility of providing information to stakeholders (Boehm, 1991). The presented step-by-step risk assessment process allows the successful implementation of a risk-based approach. The main complexity of this process is the choice of risk assessment technology, as it will be individual for each specific lab and each specific risk register.

The 2019 version of the standard emphasizes the use of a risk-based approach that drives

QMS performance growth, leading to better results and minimizing negative impacts (Vikulov, 2020). It is important to note, that it is up to labs to decide whether they should develop a better and more sophisticated risk management methodology using a different standard, or not. Testing laboratories now need to carefully analyse the current situation and decide for themselves how to develop and implement a risk-based approach in specific settings that will ensure that the laboratory operates in accordance with the new criteria for accreditation. It is also essential to document the procedure developed before implementation (Viktorova, 2023).

Risk identification is a key step in risk management practice that is critical to an effective risk management process. Through the identification process, we record risks that directly affect the achievement of the goal. The results of the identification become later inputs to the risk and impact analysis process. At the same time, identification is a major step in risk management. It is also the most complex, as its goal is to create a comprehensive risk register, that would allow identifying as many uncertainties as possible that might affect the outcome (Fukayama, et.al., 2008).

The already mentioned GOST R 58771-2019 contains a set of tools for risk identification, including data collection methods and data analysis. The new version of the standard aims to minimize risks even before they occur. This is why a well-informed and thorough risk identification process is needed, as this is what minimizes risks before they even occur. In our opinion, the best method for identifying risks is the expert method, as experts with experience in the field are involved (Uglanova, 2019). Most importantly, they can take a broader look at the problem and assess even the smallest and most non-obvious risks by analyzing the big picture. The updated version of the standard defines supplier relations more strictly to minimize risk, assigns duties and responsibilities to staff, establishes the need for verification and validation, and so on.

The new version of the standard revised supplier relations and introduced new requirements, including the ones aimed at mitigating of external risks. It also clarified the need for a system and processes to evaluate external suppliers. The lab must identify and inform the supplier on the requirements it places on the products and services provided, acceptance criteria, and competence (Dmitrieva, Kopylova, 2020). The standard obliges the laboratory to have procedures and records in place, and ensure that products and services from external suppliers comply with those before they are used in the operation or handed over to the customer, allowing the laboratory to share the risk between itself and the external supplier. The reduction of the risk of non-performance of contractual obligations faced by any enterprise in the modern environment is reduced by the innovations in this section of the standard (Glukhova, 2017).

A more structured and concise staff-related section enshrines the responsibilities of all personnel in competence, impartiality and working in accordance with the management system. Whereas the previous version of the standard placed full responsibility on laboratory management. The new paragraphs and requirements of the standard oblige the laboratory to have procedures and records for defining competency requirements, selecting, training and supervising personnel, monitoring competencies, etc., which reduces internal laboratory risks. In order for laboratories to obtain reliable results and achieve customer satisfaction, errors must be minimized at all stages of the process. This requires all staff engaged in laboratory activities to understand the importance of considering the risks associated with their performance. In this way, each individual lab worker will be able to assess the possible risks associated with their actions and will be able to make uncertainty management decisions (Chapman, 1997).

Accreditation to the testing laboratory standard guarantees impartiality and confidentiality of activities and results. For its own impartiality on an ongoing basis, the laboratory must identify risks, including those arising from relationships that are based on ownership, management,

staff, resources, finances, and others. If the analysis reveals these risks, the laboratory must demonstrate how it eliminates or minimizes them (Raz, et.al., 2005).

The 2019 version of the standard introduces the terms "method verification" and "method validation" for the first time, making them mandatory. According to studies, 46% to 68% of laboratory errors occur during the preliminary phase, which is the sampling process. At this stage, most laboratory errors occur, including sample manipulation problems before samples reach the lab. Serious errors can be made in the transport, handling and identification of samples. The preliminary phase should therefore invite strict controls to avoid problems (Afanasyeva, Mokeeva, 2021).

One of the main differences between the old and the new version of the standard is the inclusion of the sampling in a laboratory process that is equivalent to testing and calibration, which means that it is subject to the requirements of the standard. The sampling procedure is becoming more controlled and accurate. Although the inclusion of sampling in the laboratory process increases the workload, it makes the test results more reliable. Recording documentation for sampling reduces the risk of claims from the customer (Lima-Oliveira, et.al., 2017). In the post-analysis phase, 18.5% to 47% of errors occur. Post-analysis activities within the laboratory include: checking the results, processing them in the information system and communicating with clients. Clear requirements for handling complaints and inappropriate work have therefore been included in the new standard.

The complaints section has been completely redesigned to include expanded requirements for the process of receiving, handling and resolving complaints. All interested parties should be familiar with the claims procedure. Upon receipt of the complaint, the laboratory must send the complainant the results of the investigation, which was prepared and approved by a person who did not participate in the activity complained of, in other words, the investigation into the causes must be independent (Fedchenko, et.al., 2019). Complaint assessment and documented consumer feedback is the evidence base for risk-based thinking.

It is important not to lose sight of the fact that since the date of introduction of the previous version of the standard, technology has come a long way. The standard now requires the information management system to be thoroughly tested before implementation. It is necessary to maintain a system that will guarantee data integrity and record system failures and corrective actions (Plebani, 2006). It is necessary to revisit the system and continuously improve it. The new version of the standard now divides the quality management system requirements into options (fig. 2).

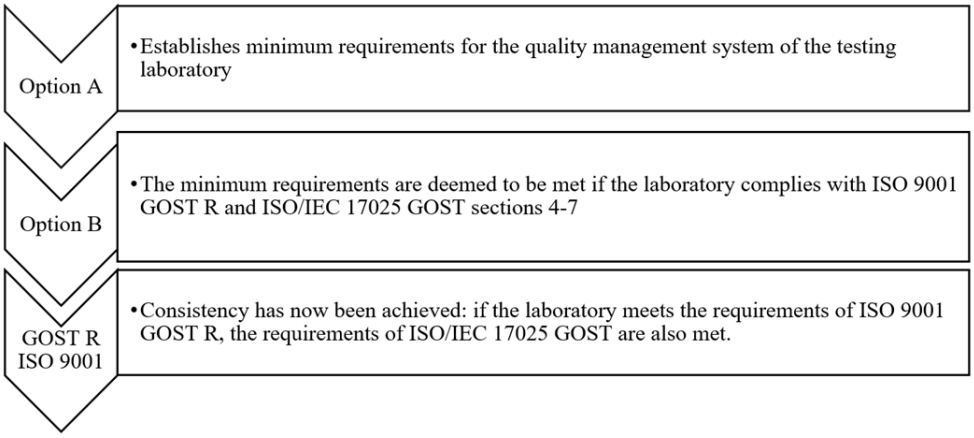
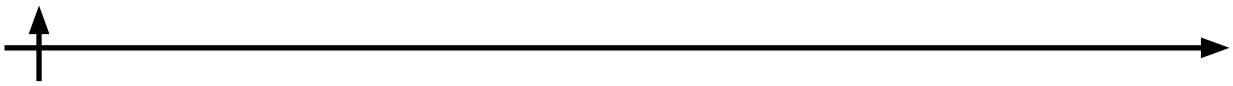



Fig. 2. Options for Quality Management System Requirements



The proposed options make it much easier for laboratories to develop a management system, since now they have the right to choose which path to follow. The updated version of the standard has achieved consistency that was not previously achieved: it can now be said that if the laboratory meets the requirements of ISO 9001 GOST R, it automatically meets the requirements of ISO/IEC 17025-2019 GOST.

**Conclusions**

Based on the comparative analysis, it can be concluded that the new version of GOST ISO/IEC 17025 is more concise, with clear and precise requirements. The updated version of the standard is more risk-based and less procedure-based.

The risk-based approach is not new, but it first appears applicable to testing and calibration laboratories in ISO/IEC 17025-2019 GOST, which sets out requirements for planning and assessing risks and opportunities, although it does not involve a full risk management system, as in ISO 31000 GOST R. The new version requires laboratories to implement a risk-based approach and demonstrate commitment to risk management in one form or another: definition of authority, mechanism for resolving conflict issues (complaints), improvements, etc.

The previous version of the standard refers only to the need to consider risks in decision-making. The standard now requires laboratories to include a documented risk and opportunity management procedure in the quality management system. Thus, there has been a shift from risk management to the creation of a fully fledged risk-centred procedure.

GOST ISO/IEC 17025-2019 does not contain specific and explicit requirements, thus providing the laboratory with an independent decision-making in terms of methodology. It is important to bear in mind that the laboratory makes the notion of "risk" more tangible, so that the staff involved in all laboratory activities understand what it means to analyse and consider risks in their activities, thus helping them to spread a culture of risk-based thinking not only within the laboratory, but throughout the field.

All the main processes of the lab must be described in the organization standards (STO), which regulates the requirements for the process in the form of a description of the sequence of operations, definition of areas of responsibility and methods of execution, as well as controlled indicators. At the same time, the requirements of GOST ISO/IEC 17025-2019 are aimed at describing the activities as they are.

The processes are developed in accordance with ISO/IEC 17025-2019 GOST 7 "Process Requirements", which defines the core processes of the laboratory, and ISO 9001-2015 GOST R 4.4.1, which states that the organization must define the processes, their application and interaction to maintain and continuously improve the QMS. The need for implementation in QMS laboratories arises from the necessity to obtain valid and reliable results through the creation of stable, reproducible test conditions.

ISO/IEC 17025-2019 GOST provides laboratories with the flexibility to develop a quality management system, provided they can provide proof of compliance and stability of application of the selected process. The current standard requires laboratories to consider, assess and act on both risks and opportunities associated with their operations. In addition, the laboratory needs to take into account the risks of impartiality.

In introducing a risk-based approach, the laboratory should consistently consider the following aspects:

– define the impediments to achieving the goal: establishment of a risk register;
– identify events that will enable the laboratory to achieve its goals faster or at lower cost;
– establish an inventory of ways to minimize the likelihood of undesirable consequences;
– create an action plan to reduce the impact of undesirable consequences on the achieve-

ment of goals;

– realize the opportunities for improvement that arise from the beneficial effects of risk.

Improving these areas altogether makes the risk assessment process more efficient, thereby, contributing to the development of a risk-based approach. When building a quality management system based on ISO/IEC 17025-2019 GOST, laboratories work on these areas, document the results and successfully implement risk management and an effective quality management system. As a result, it is possible to conclude that the accreditation to GOST ISO/IEC 17025-2019 demonstrates that the laboratory guarantees the validity of its results, besides making its activities more sustainable, as this is what the risk-based approach is aimed at. The use of ISO/IEC 17025-2019 by GOST laboratories makes research results not only valid worldwide, but also better and more reliable than similar laboratories that do not implement the standard.

## REFERENCES


**Afanasyeva E.V., Mokeeva A.A.** 2021. Comparative Analysis of Two Editions of GOST R 58771-2019. Risk Management and Risk Assessment Technologies, 105–108.

**Boehm B.W.** 1991. Software Risk Management: Principles and Practices. IEEE Software 1 (8), 32–41.

**Chapman C.** 1997. Project Risk Analysis and Management—PRAM the Generic Process. International Journal of Project Management 5 (15), 273–281.

**Dmitrieva A.S., Kopylova E.V.** 2020. Risk Management in the Testing Laboratory According to GOST ISO/IEC 17025-2019.

**Fedchenko A.S., Romanova L.A., Sorochkina O.Yu.** 2019. Analysis of the Requirements for the Competence of the Testing Laboratory in Accordance with GOST ISO / IEC 17025-2019.

**Fukayama H., Fernandes E., Ebecken N.F.F.** 2008. Risk Management in the Aeronautical Industry: Results of an Application of Two Methods.

**Glukhova L.V.** 2017. Features of the Practical Implementation of the Requirements of GOST R ISO 9001-2015 for Managing QMS Processes. Bulletin of the Volga University 1, 141-147.

**Gusarova S.N., Erokhina Yu.M., Kramok D.I., Khunuzidi E.I.** 2020. Recommendations for Test Lab Regarding Transition to New Requirements GOST ISO/IEC 17025–2019. Industrial Laboratory. Diagnostics of Material 86(2), 69-78. doi: 10.26896/1028-6861-2020-86-2-69-78

**Ilin I.V.** 2022. Integration of information and management technologies. Technoeconomics 1 (1). 24–32. DOI: https://doi.org/10.57809/2022.1.1.2

**Kalra J.** 2004. Medical Errors: Impact on Clinical Laboratories and Other Critical Areas. Clinical Biochemistry 12 (37), 1052–1062. doi: 10.1016/j.clinbiochem.2004.08.009

**Kremljak Z.** 2016. Risk Analysis of Specific Project Problems. Annals of DAAAM & Proceedings, 27. doi: 10.2507/daaam.scibook.2011.10

**Latfullina R.R.** 2019. Comparative Analysis of Standards GOST ISO/IEC 17025-2009 and ISO/IEC 17025-2019. My Professional Career 1 (4), 55-59.

**Lima-Oliveira G., Volanski W., Lippi G., et.al.** 2017. Pre-analytical Phase Management: a Review of the Procedures from Patient Preparation to Laboratory Analysis. Scand J. Clin Lab Invest 77(3), 153-163. doi: 10.1080/00365513.2017.1295317

**Plebani M.** 2006. Errors in Clinical Laboratories or Errors in Laboratory Medicine?. Clin Chem Lab Med 44(6), 750-9. doi: 10.1515/CCLM.2006.123. PMID: 16729864

**Raz T., Hillson D.** 2005. A Comparative Review of Risk Management Standards. Risk Management 7, 53–66. doi: 10.1057/palgrave.rm.82402272005

**Uglanova A.A.** 2019. Quality Management System of the Testing Laboratory in accordance with GOST ISO/IEC 17025-2019. World Science 10 (31), 198-204.

**Viktorova N.G.** 2023. Instrumental Methods for Ensuring the Socially Safe Development of Regional Socio-economic Systems of the Russian Federation 2023. Polytech-Press.

**Vikulov V.V., Tarasova E.Yu.** 2020. Introduction of GOST ISO/IEC 17025-2019 into the Practice of Testing Laboratory.

## СПИСОК ИСТОЧНИКОВ


**Афанасьева Е.В., Мокеева А.А.** 2021. Сравнительный анализ двух редакций ГОСТ Р 58771-2019. Менеджмент риска. Технологии оценки риска, 105–108.

**Boehm B.W.** 1991. Software Risk Management: Principles and Practices. IEEE Software 1 (8), 32–41.

**Chapman C.** 1997. Project Risk Analysis and Management—PRAM the Generic Process. International Journal of Project Management 5 (15), 273–281.

**Дмитриева А.С., Копылова Е.В.** 2020. Управление рисками в испытательной лаборатории согласно ГОСТ ISO/IEC 17025-2019.

**Федченко А.С., Романова Л.А., Сорочкина О.Ю.** 2019. Анализ требований к компетентности испытательной лаборатории в соответствии ГОСТ ISO/IEC 17025-2019.

**Fukayama H., Fernandes E., Ebecken N.F.F.** 2008. Risk Management in the Aeronautical Industry: Results of an Application of Two Methods.

**Глухова Л.В.** 2017. Особенности практической реализации требований ГОСТ р ИСО 9001-2015 для управления процессами СМК. Вестник Волжского университета им. В. Н. Татищева 1, 141-147.

**Гусарова С.Н., Ерохина Ю.М., Крамок Д.И., Хунузиди Е.И.** 2020. Рекомендации для испытательных лабораторий по переходу на новые требования ГОСТ ISO/IEC 17025–2019. Заводская лаборатория. Диагностика материалов 86(2), 69-78. doi: 10.26896/1028-6861-2020-86-2-69-78

**Ильин И.В.** 2022. Интеграция информационных и управляющих технологий. Техноэкономика 1 (1). С. 24–32. DOI: https://doi.org/10.57809/2022.1.1.2

**Kalra J.** 2004. Medical Errors: Impact on Clinical Laboratories and Other Critical Areas. Clinical Biochemistry 12 (37), 1052–1062. doi: 10.1016/j.clinbiochem.2004.08.009

**Kremljak Z.** 2016. Risk Analysis of Specific Project Problems. Annals of DAAAM & Proceedings, 27. doi: 10.2507/daaam.scibook.2011.10

**Латфуллина Р.Р.** 2019. Сравнительный анализ стандартов ГОСТ ИСО/МЭК 17025-2009 и ИСО/МЭК 17025-2019. Моя профессиональная карьера 1 (4), 55-59.

**Lima-Oliveira G., Volanski W., Lippi G., et.al.** 2017. Pre-analytical Phase Management: a Review of the Procedures from Patient Preparation to Laboratory Analysis. Scand J. Clin Lab Invest 77(3), 153-163. doi: 10.1080/00365513.2017.1295317

**Plebani M.** 2006. Errors in Clinical Laboratories or Errors in Laboratory Medicine?. Clin Chem Lab Med 44(6), 750-9. doi: 10.1515/CCLM.2006.123. PMID: 16729864

**Raz T., Hillson D.** 2005. A Comparative Review of Risk Management Standards. Risk Management 7, 53–66. doi: 10.1057/palgrave.rm.82402272005

**Угланова А.А.** 2019. Система менеджмента качества испытательной лаборатории в соответствии с ГОСТ ISO/IEC 17025-2019. Мировая наука 10 (31), 198-204.

**Викторова Н.Г.** 2023. Инструментальные методы обеспечения социально безопасного развития региональных социально-экономических систем Российской Федерации 2023. Политех-пресс.

**Викулов В.В., Тарасова Е.Ю.** 2020. Внедрение ГОСТ ISO/IEC 17025-2019 в практику испытательной лаборатории.

## INFORMATION ABOUT AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

**BELOVA Polina D.** – student.
E-mail: belova.pd@edu.spbstu.ru
**БЕЛОВА Полина Дмитриевна** – студент.
E-mail: belova.pd@edu.spbstu.ru

**KALYAZINA Sofia E.** – Senior Lecturer.
E-mail: kalyazina_se@spbstu.ru
**КАЛЯЗИНА София Евгеньевна** – старший преподаватель.
E-mail: kalyazina_se@spbstu.ru
ORCID: https://orcid.org/0000-0003-1455-8534

**LYAMIN Boris M.** – Associate Professor, Candidate of Economic Sciences.
E-mail: lyamin_bm@spbstu.ru
**ЛЯМИН Борис Михайлович** – доцент, к.э.н.
E-mail: lyamin_bm@spbstu.ru
ORCID: https://orcid.org/0000-0002-5153-7727

*Статья поступила в редакцию 07.06.2023; одобрена после рецензирования 13.06.2023; принята к публикации 20.06.2023.*

*The article was submitted 07.06.2023; approved after reviewing 13.06.2023; accepted for publication 20.06.2023.*