

### Institute of Energy and mechanical engineering named after A. Burkitbayev Department of Standardization, certification and metrology

## EDUCATIONAL PROGRAM 7M07502 Metrology (by industry)

Code and classification of the field of education: 7M07 Engineering, manufacturing and construction industries

Code and classification of training directions: 7M075 Standardization, certification and metrology (by branches)

Group of educational programs: M130 Standardization, certification and metrology (by industry)

Level based on NQF: 7 Level based on IQF: 7 Study period: 2 y. Number of credits: 120

Educational program 7M07502 - Metrology (by industry) was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

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Educational program «7M07502 Metrology (by industry) » was developed by Academic committee based on direction 7M075 Standardization, certification and metrology (by branches)

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	title	•		
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## List of abbreviations and designations

- EP Educational program
- EO Education outcome
- NQF national qualifications framework
- IQF industry qualification framework
- BD basic disciplines
- PD profile disciplines
- UC University component
- CC Component of choice
- SDG Sustainable Development Goals

## 1. Description of educational program

Master's educational program 7M07502 – "Metrology (by industry)" includes fundamental, natural science, general engineering and professional training of undergraduates in the field of metrology, who have theoretical knowledge and practical skills in professional training in the field of industrial metrology, quality management systems, verification and calibration. It is an educational program in the scientific and pedagogical direction of training and is designed for 2 years of study. The study lasts four semesters, culminating in a Master of Engineering degree, which imparts in-depth knowledge and develops advanced skills for use in a changing and competitive environment.

This EP trains competitive personnel in the field of metrology, focused on ensuring the reliability of measurement results, quality and safety of products and services, with indepth professional competencies in the development and implementation of regulatory and technical documentation, quality management systems, and testing of measuring instruments.

## 2. Purpose and objectives of educational program

**Purpose of EP:** Training competitive personnel in the field of metrology, focused on ensuring the reliability of measurement results, quality and safety of products and services, with in-depth professional competencies in the development and implementation of regulatory and technical documentation, quality management systems, as well as in testing measuring instruments, contributes to the development of scientific and technical potential, increased confidence in measurement results, harmonization with international standards and the achievement of Sustainable Development Goals by increasing the efficiency and sustainability of production processes, as well as creating an inclusive environment that provides equal opportunities for professional growth and development for everyone, including vulnerable groups.

## Tasks of EP:

1. To develop the student's competencies in managing material and information flows in the production of products and provision of services under conditions of universal metrological control;

2. To develop the student's competence to carry out the actions necessary for effective workin the field of metrology;

3. To develop in students teamwork skills, production and ethical responsibility, the ability to work and communicate with various specialists and the need to improve their knowledge and skills;

4. To develop in the student the ability to carry out control and testing during the production process;

5. To develop the student's ability to carry out metrological support activities.

6. To develop the student's competencies in the application of modern digital technologies and innovative methods of measurement and control, as well as in adaptation to the rapidly changing conditions of digitalization of industry and service industries, which contributes to increasing the accuracy and reliability of measurements, the efficiency of production processes, integration with international standards and the achievement of the Sustainable Development Goals (SDG 4) through the introduction of advanced technological solutions that ensure inclusive access to knowledge and technology for all, including vulnerable groups and people with disabilities.

### 3. Requirements for evaluating the educational program learning outcomes

At the final stage of master's preparation, it is envisaged to complete and defend a master's thesis.

The academic disciplines in which a master's thesis is to be defended are determined by the current state compulsory standards of higher professional education.

The master's thesis is the result of independent research under the guidance of a supervisor. The master's thesis is defended at a meeting of the State Attestation Commission.

The final state certification of students is carried out in accordance with the Rules for ongoing monitoring of academic performance, intermediate and final state certification of students in educational organizations. Persons who have fully completed the curriculum for the educational and professional program of higher basic education with the completion of at least 120 academic credits of theoretical training and a final master's thesis, who have successfully defended a master's thesis, are issued a diploma of higher education with the assignment of qualifications and the award of the academic degree "Master of Technical Sciences".

The graduate is also given a diploma supplement, which includes final examination and testgrades in the disciplines studied, an assessment for the defense of the master's thesis, indicating the topic of the master's thesis.

#### 4. Passport of educational program

№	Field name	Comments
1	Code and classification of	7M07 Engineering, manufacturing and
	the field of education	construction industries
2	Code and classification	7M075 Standardization, certification and metrology
	of training directions	(by branches)
3	Educational program group	M130 Standardization, certification and
		metrology (by industry)
4	Educational program name	7M07502 - Metrology (by industry)
5	Short description of	Educational program 7M07502 – "Metrology (byindustry)"
	educationalprogram	includes fundamental, natural science, general engineering and
		professional training of undergraduates in the field of
		metrology, who have theoretical knowledge and practical skills
		in professional training in the field of industrial metrology,
		quality management systems,

#### 4.1. General information

		verification and calibration.
6	Purpose of EP	Training competitive personnel in the field of metrology,
		focused on ensuring the reliability of measurement results,
		quality and safety of products and services, with in-depth
		professional competencies in the development and
		implementation of regulatory and technical documentation,
		quality management systems, as well as in testing measuring
		instruments, contributes to the development of scientific and
		technical potential, increased confidence in measurement results,
		harmonization with international standards and the achievement
		of Sustainable Development Goals by increasing the efficiency
		and sustainability of production processes, as well as creating an
		inclusive environment that provides equal opportunities for
		professional growth and development for everyone, including
7		vulnerable groups.
/	Type of EP	New EP
8	The level based on NQF	7
9	The level based on IQF	
10	Distinctive features of EP	No
11	List of competencies of	General competencies:
	educationalprogram	• Proficiency in English for: searching for scientific and
		technical information; working with scientific and technical
		literature; oral and writtencommunication with a native speaker
		on professional topics and in real life situations.
		• Possession of critical systems thinking, transdisciplinarity
		and cross-functionality.
		• Possession of ICT competencies, ability to developsoftware
		using algorithmic languages.
		• Possession of skills: independent learning; deepening your
		knowledge; be open to new information; systems thinking and
		personal judgment.
		• The ability to be tolerant of another nationality, race, religion,
		culture; ability to conduct intercultural dialogue.
		• Possession of communication skills, ability to collaborate
		and work in a team.
		• Ability to work in conditions of high uncertainty and rapidly
		changing task conditions; work with consumer requests.
		• Possession of a broad social, political and professional
		outlook;
		• Ability to use data from various sources and specialized
		literature, analyze and critically evaluate historical facts and
		events.
		• Knowledge of the basics of entrepreneurship andbusiness
		economics, readiness for social mobility. Professional
		competencies:
		• Possession of skills in analyzing the causes of
		nonconformities;
		• Possesses the skills of generating management decisions in
1		the field of metrology in technical systems;

		• Has the skills to independently solve problems in the field of
		metrology based on the latest achievements of science and
		technology;
		• Has the skills to determine the forms and methods of legal
		protection and defense of rights to the results of intellectual
		activity;
		• Has the skills to develop and improve processes in relation to
		metrology problems;
		• Has the skills to reduce risks in quality assurance systems;
		• Has the skills to implement changes in quality assurance
		systems to maintain quality;
		• Possesses management skills in the creation of methodological
1.0		and regulatory documents in the field of metrology.
12	Education outcomes of	EO 1 – To use knowledge to apply methods of intellectual
	educationalprogram	property protection in the Republic of Kazakhstan
		EO 2 - To use the ability to carry out calculations to estimate
		errors, uncertainty of measurement results, to determine the
		requirements for factors affecting the measurement error
		(uncertainty).
		$EO_3 - 10$ use the acquired knowledge, skills and
		qualifications for carrying out work on metrological support
		of production, testing and operation of measuring instruments.
		EO 4 - 10 use the skills and abilities of developing
		verification methods, calibration methods, certification
		methods, measuring instruments test methods, measurement
		EQ5. To most on the basics of philosophical local and aritical
		thinking with application in life
		EQ 6 To use communication skills in professional and
		interpersonal relationships
		EO.7 - To use the acquired knowledge for the organization of
		work on preparation for laboratories accreditation
		EO 8 – To use the skills of an innovative approach to
		participate in the development of projects and planned tasks
		for the introduction of new measuring equipment.
		organizational and technical measures to improve production
		efficiency.
		EO 9 - To use the acquired knowledge to improve the legal
		framework of metrological activities, for further development
		of metrological services, for use and implementation of
		international experience.
		EO 10 – To use the acquired knowledge to monitor the
		condition and use of standards, measuring instruments, testing
		equipment and standard samples, ensuring the accuracy,
		reliability and reproducibility of measurements, compliance
		with regulatory requirements, improving product quality and
		achieving the Sustainable Development Goals (SDG 4)
		through the introduction of modern metrological support
		methods, as well as creating an inclusive environment that
		ensures equal access to technology and professional
		development for all, including vulnerable groups and people
		with disabilities.

13	Education form	Full-time
14	Period of training	2 years
15	Amount of credits	120
16	Languages of instruction	Kazakh, russian, english
17	Academic degree awarded	Master of technical sciences
18	Developer(s) and authors	Aymagambetova R. head of department, "Kazstandard";
		Tatybayev M., Deputy Director of the A. Burkitbaev Institute of
		Energy and Mechanical Engineering.
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		Moldabekova A., master's student, 1 year

# 4.2. Relationship between the achievability of the formed learning outcomes based on educational program and academic disciplines

N₂	Discipline	Short description of discipline	Numb	Generated education outcomes (codes)											
	name		er of	EO1	EO2	EO3	EO4	EO5	EO6	EO7	EO8	EO9	EO10		
			credit												
		Basic disciplines cycle	5												
	University component														
	Foreign	The course is aimed at studying the main problems of scientific knowledge in the context of													
	language	its historical development and philosophical understanding, the evolution of scientific													
1.	(professional)	theories, principles and methods of scientific research in the historical construction of scientific paintings of the world. The discipline will halp to master the skills of developing	3	V											
		critical and constructive scientific thinking based on research on the history and philosophy													
		of science. At the end of the course, undergraduates will learn to analyze the ideological and													
		methodological problems of science and engineering and technical activities in building													
		Kazakhstan's science and the prospects for its development.													
	History and	Purpose: to explore the history and philosophy of science as a system of concepts of global and Kazakh science. Content: the subject of philosophy of science, dynamics of science, the													
	philosophy of	main stages of the historical development of science, features of classical science, non-													
_	science	classical and post-non-classical science, philosophy of mathematics, physics, engineering and	_												
2.		technology, specifics of engineering sciences, ethics of science, social and moral	3		V										
		responsibility of a scientist and engineer.													
	Higher school	education nedagogy. The discipline will help to master the skills of modern nedagogical													
	pedagogy	technologies, technologies of pedagogical design, organization and control in higher													
2		education, skills of communicative competence. At the end of the course, undergraduates	2												
3.		learn how to organize and conduct various forms of organizing training, apply active teaching	3					V							
		methods, and select the content of training sessions. Organize the educational process on the basis of credit technology of education													
	Psychology of	The course is aimed at mastering the tools for effective employee management, based on													
	management	knowledge of the psychological mechanisms of the manager's activity. Discipline will help													
	C .	you master the skills of making decisions, creating a favorable psychological climate,													
4.		motivating employees, setting goals, building a team and communicating with employees. At	3		V										
		their own image analyze situations in the field of managerial activity as well as negotiate													
		be stress-resistant and effective leaders.													
	•	Cycle of basic disciplines													
		Component of choice													
	Copyright	Purpose: to investigate and employ strategies for safeguarding intellectual property within													
	protection in	the realm of metrology. It aims to analyze current challenges pertaining to metrological													
	the field of	protection of intellectual property in the Republic of Kazakhstan. Content: encompasses the													
5.	metrology	examination and application of methodologies for protecting intellectual property in	5				<b>.</b>								
		safeguarding of intellectual property within the specific context of the Depublic of					v				v				
		Kazakhstan													
		Kazakhstan.													

	Intellectual	The purpose of this course is to provide undergraduates with the knowledge and skills								
	property and	necessary to understand, protect and manage intellectual property (IP) in the context of								
C	research	scientific research and innovation. The course is aimed at training specialists who can	5							
0.		effectively work with IP, protect the results of scientific research and apply them in practice.	5			V				
	Commercializat	Purpose: to explore the commercialization system within the Republic of Kazakhstan, to								
	ion of new	analyze methods for developing and implementing new technologies in the enhancement and								
	technologies in	advancement of production technologies. Content: examination of the commercialization								
7.	metrology	framework in Kazakhstan, with particular emphasis on the operations of the National Agency	5							
-		for Technological Development. Involves studying strategies for the development and	_		V					
		integration of innovative technologies, as well as exploring contemporary directions for								
		enhancing and refining production technologies.								
	Metrological	Purpose: to delve into the principles of technical control, measurement instruments, and the								
	support of	process of control. It aims to enhance the mechanisms facilitating departmental collaboration								
	enterprises (by	to ensure measurement uniformity and metrological support across various sectors of the								
8.	industry)	economy. Content: entails the exploration of technical control principles, measurement	5							
		instrument functionalities, and control methodologies. It also focuses on refining		V				V		
		interdepartmental coordination to maintain measurement consistency and provide								
	D1 ' 1	metrological assistance across diverse economic sectors.								
	Planning and	Objective: To study methods for developing and structuring an action plan aimed at								
	implementation	implementing new methodologies to improve the efficiency of an organization (or								
9.	for sustainable	reductivity the implementation of innovative solutions improved resource management	5			V				V
	development of	and the achievement of the Sustainable Development Goals (SDG 4) through sustainable								
	the	development digital transformation and the creation of an inclusive environment that ensures								
	organization	equal opportunities for participation and professional growth of all employees including								
	orgunization	vulnerable groups. Content: delves into the study of methodologies for developing and								
		coordinating action programs aimed at the implementation of innovative approaches aimed								
		at optimizing organizational efficiency.								
	Modern trends	Purpose: To provide master's degree students with in-depth knowledge and practical skills to								
	in sustainable	develop, implement and manage strategies aimed at improving the quality of products and								
10.	development	services, optimizing production processes, ensuring compliance with international standards,								
	strategy	introducing innovative technologies and achieving the Sustainable Development Goals (SDG	5							
		4) through sustainable development, efficient resource management and creating an inclusive	2				v			
		environment that provides equal opportunities for professional growth and participation of								
		all, including vulnerable groups and people with disabilities. The course content covers the								
		following topics: principles and basic concepts of sustainable development, economic and								
		social aspects of sustainability, development and implementation of sustainable growth								
		strategies, innovative approaches and technological solutions for sustainable development,								
		ethical standards in the context of sustainable development, as well as the prospects and future								
		of sustainable practices in the context of global change.								
		Cycle of profile disciplines								
		University component								

11.	Accreditation of testing and calibration laboratories according to GOST ISO/IEC	Purpose: to establish the general prerequisites for the competency of testing and calibration laboratories. It further seeks to elucidate the accreditation process for such laboratories, including testing, verification, and calibration centers. Content: encompasses defining the essential criteria for ensuring the competence of testing and calibration laboratories. It delves into the accreditation procedures applicable to testing, verification, and calibration facilities. The course examines the hierarchical arrangement and functions of the accreditation body	5				v	v		
	Mathematical processing of	Purpose: to explore techniques for statistically processing measurement and test results. It is designed to provide students with an understanding of statistical methods for estimating								 
12.	verification and calibration results	distribution parameters and constructing multiple linear correlation models. Content: covers methods for estimating distribution parameters, such as mean and variance, and explores the construction of multiple linear correlation models to analyze relationships between variables. Through this course, students will gain proficiency in statistical analysis applicable to various fields of measurement and testing.	5			V				V
13.	Metrological examination and accreditation	Purpose: To impart knowledge and skills related to the assessment and certification of measurement processes, principles of metrology, calibration methods and compliance with standards necessary to ensure accurate and reliable measurements. Content: metrological principles, calibration techniques and examination and accreditation procedures. The importance of measurement accuracy, traceability and the role of regulators in ensuring compliance with international standards. Practical exercises and case studies are included to reinforce learning.	4				v			
14.	Quality assurance of measurements in laboratories	Purpose: to uphold the accuracy and impartiality of measurements by focusing on methods to ensure reliability and objectivity. It aims to equip learners with the skills to evaluate measurement results and ascertain their uncertainty. Content: covers strategies and techniques to maintain the reliability and objectivity of measurements. It delves into the evaluation of measurement outcomes and the assessment of their uncertainty. Furthermore, the course explores methods for estimating input values and determining their standard deviations.	5		V					
15.	Patent- licensing activity	Purpose: to enable students to identify and acquire patents for inventions, utility models, or industrial designs. It focuses on understanding the conditions necessary for the patentability of industrial property objects. Content: the conditions and criteria for determining the patentability of objects. Additionally, the course delves into the procedures and requirements involved in obtaining patents, providing students with practical knowledge and skills in navigating the patenting process.	5			v				
16.	Applied, regulatory and methodological aspects of verification and calibration	Purpose: to examine the system of verification and calibration for measuring instruments in Kazakhstan. It aims to familiarize students with the ILAC policy concerning the traceability of measurement results Content: encompasses a comprehensive study of the verification and calibration system for measuring instruments in Kazakhstan. It includes an overview of the ILAC policy focusing on traceability and the standards set forth by the BIPM for determining calibration frequencies.	5						V	
17.	Traceability of measurements	Purpose: To understand and determine the metrological traceability of measurement results, ensuring the accuracy and reliability of measurements in scientific and industrial applications. Content: studying the BIPM traceability chain, measurement uncertainty, and their roles in quality management. Explore standards, certification procedures, and data-driven decision-making, including modules on performance metrics, data analysis, and managing processes based on data insights.	5	v						

		Development of the reference	Purpose: to examine the reference base of the Republic of Kazakhstan and the state system established to ensure measurement uniformity, to explore methods for both quantitative and											
18.	8.	base	qualitative advancement and enhancement of the reference base within the republic. Content: encompasses an in-depth study of the reference base of Kazakhstan, including its establishment and maintenance. Additionally, the course covers strategies for both guantitative and qualitative development and improvement of the reference base	5				v	r					
19	9.	Development and certification of measurement techniques	Purpose: to delve into the methodologies for developing and certifying measurement techniques. It aims to elucidate the sequence for applying these techniques and the process of metrological control over measurement methods. Content: encompasses the study of techniques for developing and certifying measurement methods. It also includes the exploration of the order in which these techniques are applied and the procedures involved in metrological control to ensure the accuracy and reliability of measurement methods.	5				v	,		v	,		
	Cycle of profile disciplines													
2	20.	Conducting interlaboratory comparisons in accordance with GOST ISO/IEC 17043	Purpose: to investigate and assess the effectiveness and comparability of test or measurement methods. To equip students with the skills to evaluate method characteristics and identify differences between laboratories. Content: examination of various test or measurement methods, focusing on their effectiveness and comparability. Techniques for evaluating method characteristics and discerning disparities between different laboratory practices. Analyzing and comparing test or measurement methods, thereby enhancing students' ability to make informed decisions in laboratory settings.	5				V			v	,		
2	1.	Modern aspects of development of metrology	Purpose: to explore contemporary developments in metrology that address the material, social, and cultural needs of the present era. The evolution of methods for determining measurement accuracy, establishing unity, and creating standards and exemplary measuring instruments. Content: modern aspects of metrology, highlighting advancements that cater to current material, social, and cultural demands. Development of techniques for assessing measurement accuracy, fundamentals of ensuring unity in measurements, and the process of creating standards and exemplary measuring instruments.	5		V							v	