

**Ministry of Science and Higher Education of the Republic of Kazakhstan**

**NLC «Academician E. A. Buketov Karagandy University»**

«AGREED»

Director of the Zh. Abishev Chemical  
and Metallurgical Institute

S.O. Baysanov

«\_\_» \_\_\_\_\_ 2023 y.



«APPROVED»

Chairman of the Board-Rector  
academician E.A. Buketov  
Karaganda University

N.O. Dulatbekov

«\_\_» \_\_\_\_\_ 2023 y.



«AGREED»

Director of LLP «Energoservice-LTD»

Ye. Mugarazh

«\_\_» \_\_\_\_\_ 2023 y.



**EDUCATIONAL PROGRAM**

8D05303- Thermophysics and theoretical heat engineering

**Level: doctorate PhD**

Karaganda 2023 y.

**The educational program in the direction of preparation "8D05303-Thermophysics and theoretical heat engineering" is developed on the basis of:**

- Law of the Republic of Kazakhstan dated July 27, 2007 No. 319-III "On Education" (as amended and supplemented as of March 31, 2021),
- State Compulsory Standard of Higher Education dated August 31, 2018 No. 604 (as amended and supplemented as of May 5, 2020 No. 182).
- State obligatory standard of postgraduate education dated August 31, 2018 No. 604
- The National Qualifications Framework dated March 16, 2016 by the Republican Tripartite Commission on Social Partnership and Regulation of Social and Labor Relations.
- Order of the Ministry of Education and Science of the Republic of Kazakhstan "On approval of the Rules for organizing the educational process on credit technology" dated October 2, 2018 No. 152 (as amended and supplemented on October 12, 2018 No. 563)
- Classifier of areas for training personnel with higher and postgraduate education dated September 3, 2020 No. 1.

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### **Passport of the educational program**

- 1. Code and name of the educational program:** 8D05303-Thermophysics and theoretical heat engineering
- 2. Code and classification of the field of education, areas of training:** 8D05 Natural Sciences, Mathematics and Statistics, 8D053 Physical and chemical sciences
- 3. Group of educational programs:** D090 Physics
- 4. Volume of credits:** 180 academic credits.
- 5. Form of study:** full-time
- 6. Language of instruction:** Kazakh, Russian
- 7. Degree awarded:** Doctor of Philosophy PhD in the educational program "8D05303-Thermophysics and theoretical heat engineering".
- 8. Type of EP:** an innovative EP – educational program, which has no analogues in the Republic of Kazakhstan, is being put into effect for the first time.
- 9. Level according to the ISCE (International Standard Classification of Education) – level 8.**
- 10. Level according to the NQF (National Qualifications Framework) – level 8.**
- 11. Level according to the IQF (Industry Qualifications Framework) – level 8.**
- 12. Distinctive features of EP:** - no
- 13. Number of the appendix to the license for the direction of personnel training:** State license of the Ministry of Education and Science of the Republic of Kazakhstan KZ83LAA00018495, date of issue "July 28, 2020".
- 14. The name of the accreditation body and the validity period of the EP accreditation:** - there is no issue.
- 15. The purpose of the EP:** The purpose of education is to providing standard and legal bases of training of the competitive competent doctoral candidate according to the international requirements, capable is effective to carry out the professional activity of the teacher and research associate directed on: receiving fundamental, quality professional education, profound specialized knowledge in the chosen field of physics which will allow to develop science successfully; mastering all types and skills of theoretical and pilot studies in physics; mastering methods of creation of mathematical models and methods of computer modeling of physical processes; education of the highly qualified specialists capable to independently acquire new knowledge, to adapt to the changing social and economic conditions and to compete successfully in internal and external labor markets; mastering the high level of the professional culture promoting ability to formulate and solve modern scientific and practical physical problems, to train in physics in higher educational institutions to successfully carry out organizational and administrative activity; assimilation by doctoral candidates of fundamental knowledge on a joint of the sciences providing them professional mobility in labor market; preparation for scientific and creative work, critical judgment of results, formation of culture of professional communication.
  - a) Qualification characteristics of the graduate:** the graduate of the doctoral program is awarded the degree of Doctor of Philosophy (PhD) according to the educational program "8D05303-Thermophysics and theoretical heat engineering".
  - b) List of graduate positions:** a graduate can hold the following positions: lecturer, senior lecturer, associate professor, professor at universities, researcher, leading researcher, lecturer assistant, head of the organization, head of the structural unit, deputy head of the structural unit.
  - c) The scope and objects of professional activity of graduates** in this 8D05303-"Thermophysics and theoretical heat engineering" are educational institutions (physics lecturers in secondary vocational educational institutions and universities); translation of scientific and technical literature from a foreign language and into a foreign language; the field of science and technology, researchers in the scientific and technical research in-



stitutes; senior researcher, senior laboratory assistant, specialist of I, II and the highest category in research institutions, construction and design organizations.

The objects of professional activity of graduates who have mastered the educational program in the field of training "8D05303-Thermophysics and theoretical heat engineering" are:

- physical systems of various scales and levels of organization, the processes of their functioning;
- physical, engineering-physical, biophysical, physico-chemical, physico-medical and environmental technologies;
- objects of new or modernized production facilities for various purposes, technological processes and equipment, means of technological control and monitoring;
- methods and means of diagnostics and control of thermodynamic systems and processes.

**d) Types of professional activities** for which graduates who have mastered the educational program in the direction of training "8D05303-Thermophysics and theoretical heat engineering" are preparing:

- research work in the field of thermophysics, theoretical heat engineering, low-temperature plasma physics;
- design and development of technological and measuring equipment, automatic and automated control systems for production and technological processes;
- mathematical modeling of objects and processes;
- teaching activities in educational programs of higher education. The educational program of the doctoral program is aimed at mastering all types of professional activities for which the graduate is preparing.

#### **16. Functions of the graduate's professional activity**

Under the guidance of a leading (senior) engineer, a responsible executor or the head of the topic (task), the doctoral student carries out: participates in the learning activities:

- under the guidance of a mentor, determines the content and selects the forms, methods and means of training sessions (seminars, practical, laboratory) in accordance with the objectives of the course;
- plans and organizes independent work of students under the guidance of a mentor;
- under the guidance of a mentor, develops the TMC of the disciplines to be read;
- author's courses under the guidance of a mentor in accordance with the mission and goals of the organization of education.



## 17. Formulation of learning outcomes based on competencies

Type of competencies	Learning result code	Learning result (according to Bloom's taxonomy)
1. Behavioral skills and personal qualities: (Soft skills)	LO 1	To be able it is correct to correlate the maintenance of specific objectives to the general laws of physics and to effectively apply the general laws of physics to the solution of problem tasks; - to use the main physical devices, to solve the simplest experimental problems, to process, analyze and estimate the received results. Nobility: the physical principles of transformation of traditional, nonconventional and renewable energy in electric and thermal. To have skill possession of basic provisions of the Law of RK "About Energy Saving"; estimations the technical and economic potential of NVIE in relation to specific conditions. To be competent to analyze, make statistical processing of the massif of long-term observations and to predict data for calculation of potential of NVIE; to count arrival of solar energy to a concrete point on the Earth's surface in certain intervals of time.
	LO 2	As a result of the study of this discipline, the doctoral student should have an idea of the types and methods of measurement, the classification of measuring instruments and metrological characteristics of measuring instruments; the State system of ensuring the unity of measurements; know the methods of practical organization and work on technical regulation; classification of types and methods of measurement; basic metrological characteristics of measuring instruments; classification of measurement errors and measuring instruments; methods of processing measurement results; be able to correctly measure and calculate measurement errors; correctly process single and multiple measurements.
	LO 3	Be able to: apply the knowledge gained in the preparation and writing of research papers in written format; read the original literature of the relevant branch of knowledge in a foreign language; work with the bibliography; formalize information extracted from foreign sources in the form of translation, abstract, annotation; compare the content of different sources of information on the problem of scientific research, critically evaluate the opinion of the authors; correctly organize their own ideas, clearly and convincingly justify, and competently Express them in writing. Know: grammatical phenomena necessary for written presentation, translation and editing; complex syntactic structures of scientific and business speech; technology of structuring academic text; features of scientific style of written texts; principles of organization of scientific texts; vocabulary representing a neutral scientific style, structure of business writing; basic terms, concepts and categories of the specialty language; various methods of hypothesizing and building evidence. Possess: the language of the specialty (professional conceptual and terminological apparatus) in the volume of at least 4000-4500 units. Of these, 3000-3300 units are neutral and scientific vocabulary in a wide and narrow profile, 1200 units of vocabulary associated with the chosen specialty for the development of oral speech; the main methods of reading original literature on the specialty of various styles and genres; the style of written communication associated with the scientific work of a master's student; the culture of thinking, the ability to generalize and analyze information; the skills of analyzing scientific text.
2. Professional competencies: (Hardskills)	LO 4	Know: the purpose and content of research activities; methodological foundations of scientific research; methods of theoretical research and methods of empirical research; requirements for methods of thermal research; methods of organization and conduct of thermal experiments; be able to: use individual creative abilities to independently solve research problems aimed at designing content, technologies and teaching methods; plan, organize, conduct scientific observation, record results and summarize results; analyze the results of scientific research, apply them to solving specific problems in the field of Thermophysics; plan and organize an experiment; apply statistical methods in processing research results; analyze and process the results and formalize them in the form of a scientific report, report, article, term paper, etc. possess: the basics of methodology for conducting pedagogical research; a systematic approach to the study and analysis of thermophysical phenomena and processes.
	LO 5	Formation of doctoral knowledge and skills necessary for the qualified formulation and solution of technological problems with the help of electrohydraulic effect. Objectives of the discipline to master the skills of hydrodynamic regularities of vapor-liquid flows to measure electrical quantities in the liquid, the laws of destruction of wollastonite ore for the study of microstructure and grinding; learn how to conduct a computational experiment; learn how to use the features of phase separation in an organic medium to extract valuable components from bone.
	LO 6	To create a General theory of measurements; education of physical units and systems of units; development and standardization of methods and measuring methods for determining the accuracy of measurements, basics of ensuring the uniformity of measurements and uniformity of measuring instruments (so-called "legal Metrology"); development of standards and reference measuring instruments, verification of measures and measuring instruments. The priority task of this direct.
	LO 7	To study the basic laws of pulse technology and obtain structured materials with specified properties.



### 18. Determination of modules of disciplines in accordance with the learning results

Learning result code	Name of the module	Name of disciplines	Volume (ECTS)
LO 3	Methodological basics of research	Academic writing	5
LO 4		Methods of scientific research	5
LO 1	Unconventional energy sources and energy conservation	Physics and techniques of electric energy saving and renewable energy	5
		Teaching practice	10
		Research practice	10
LO 2	Method of research	Metrological support of physical research	5
LO 6		Bases of the theory of uncertainty of measurements	
LO 7		Destruction of materials underwater electric explosion	5
LO 5		Selected chapters of discharge pulse technologies	
	Research work by a doctoral candidate	Research work by a doctoral candidate, including internships and doctoral thesis	123
	Final assessment	Writing and defending doctoral thesis	12
	Total		180

### 19. Matrix of achievability of learning results

NN	Name of disciplines	Brief description of the discipline	Number of credits	Generated learning results (codes)						
				LO1	LO2	LO3	LO4	LO5	LO6	LO7
Cycle of basic disciplines University component										
D-1	Academic writing	The discipline is studied in order to form competencies related to analytical research and textual activities; skills of analytical-synthetic, critical and pragmatic thinking. In the process of studying the discipline, the types, methods and ethical principles of writing scientific texts, the principles of constructing a scientific text and preparing it for publication, the design of a bibliographic list, the basic rules for quoting scientific literature, the types of annotations and the features of their compilation, reviewing a scientific text are considered.	5			+				
D-2	Methods of scientific research	The discipline is studied in order to form the skills of doctoral students to carry out independent research activities; the use of scientific research methods to achieve the objectives set in the dissertation research; the use of methods of processing empirical data on the topic of their dissertation research.	5				+			
D-3	Teaching practice	The purpose of teaching practice is the formation of professional competencies among doctoral students that ensure readiness for pedagogical activity in universities, the design of the educational process in accordance with the profile of training and conducting certain types of training sessions using innovative educational technologies.	10	+						
Cycle of profile disciplines University component										
D-4	Physics and technology energy efficiency and renewable energy	The purpose of the course is to familiarize students with the current state of the problem of energy saving and renewable energy sources; legislative, economic and environmental aspects of the state energy-saving policy; scientific and technical bases for solving the problem of optimal energy consumption.	5	+						
D-5	Research practice	The purpose of the research practice is for doctoral students to study the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as to consolidate practical skills in applying modern methods of scientific research, processing and interpretation of experimental data in dissertation research	10	+						
Cycle of basic disciplines Component of choice										
D-6	Metrological support of physical research	The purpose of teaching of discipline - to create a General theory of measurements; education of physical units and systems of units; development and standardization of methods and measuring methods for determining the accuracy of measurements, basics of ensuring the uniformity of measurements and uniformity of measuring instruments; development of standards and	5		+					



		reference measuring instruments, verification of measures and measuring instruments.										
	Bases of the theory of uncertainty of measurements	The purpose of teaching the discipline is to study the basics of the theory of uncertainty in measurements. Formation of the knowledge, skills and abilities necessary for a qualified statement and to master the methods of processing measurement results. Tasks of studying the discipline - master methods of processing results of direct and indirect measurements, estimation of uncorrelated and correlated input values.									+	
Cycle of profile disciplines Component of choice												
D-7	Destruction of materials underwater electric explosion	The purpose of teaching the discipline is to study the basics of information systems. Formation of knowledge, skills and abilities necessary for qualified training and solution of technological problems using electrohydraulic effect.	5									+
	Selected chapters of discharge pulse technologies	The purpose of teaching the discipline is to study the basic laws of pulse technology and obtain structured materials with specified properties.									+	
Research work by a doctoral candidate												
D-8	Research work by a doctoral candidate, including internships and doctoral thesis	The purpose of the doctoral student's research work is to form the level of knowledge, skills and abilities necessary for the implementation of professional activity and to prepare for the defense of a doctoral dissertation. It includes conducting independent scientific research, foreign scientific internship, preparation of scientific publications, execution of a doctoral dissertation.	123								+	

## 20. Coordination of the planned learning results with the methods of teaching and evaluation within the module

Learning results	Planned learning results for the module	Learning methods	Assessment methods
LO 1	To be able it is correct to correlate the maintenance of specific objectives to the general laws of physics and to effectively apply the general laws of physics to the solution of problem tasks; - to use the main physical devices, to solve the simplest experimental problems, to process, analyze and estimate the received results. Nobility: the physical principles of transformation of traditional, nonconventional and renewable energy in electric and thermal. To have skill possession of basic provisions of the Law of RK "About Energy Saving"; estimations the technical and economic potential of NVIE in relation to specific conditions. To be competent to analyze, make statistical processing of the massif of long-term observations and to predict data for calculation of potential of NVIE; to count arrival of solar energy to a concrete point on the Earth's surface in certain intervals of time.	Interactive lecture, case-methods, round table, analysis of publications, demonstration of speech	Colloquium, test
LO 2	As a result of the study of this discipline, the doctoral student should have an idea of the types and methods of measurement, the classification of measuring instruments and metrological characteristics of measuring instruments; the State system of ensuring the unity of measurements; know the methods of practical organization and work on technical regulation; classification of types and methods of measurement; basic metrological characteristics of measuring instruments; classification of measurement errors and measuring instruments; methods of processing measurement results; be able to correctly measure and calculate measurement errors; correctly process single and multiple measurements.	Interactive lecture, experimental works intended for scientific research	Project preparation
LO 3	Be able to: apply the knowledge gained in the preparation and writing of research papers in written format; read the original literature of the relevant branch of knowledge in a foreign language; work with the bibliography; formalize information extracted from foreign sources in the form of translation, abstract, annotation; compare the content of different sources of information on the problem of scientific research, critically evaluate the opinion of the authors; correctly organize their own ideas, clearly and convincingly justify, and competently Express them in writing.	Interactive lecture, experimental works intended for scientific research	Written work
LO 4	Know the purpose and content of research activities; methodological foundations of scientific research; methods of theoretical research and methods of empirical research; requirements for methods of thermal research; methods of organization and conduct of thermal experiments; possess: the basics of methodology for conducting pedagogical research; a systematic approach to the study and analysis of thermophysical phenomena and processes.	Round table	Portfolio
LO 5	Formation of doctoral knowledge and skills necessary for the qualified formulation and solution of technological problems with the help of electrohydraulic effect. Objectives of the discipline to master the skills of hydrodynamic regularities of vapor-liquid flows to measure electrical quantities in the liquid, the laws of destruction of wollastonite ore for the study of microstructure and grinding; learn how to conduct a computational experiment; learn how to use the features of phase separation in an organic medium to extract valuable components from bone.	Interactive lecture, discussion, analysis of scientific literature, presentation of reports	Written work
LO 6	To create a General theory of measurements; education of physical units and systems of units; development and standardization of methods and measuring methods for determining the accuracy of measurements, basics of ensuring the uniformity of measurements and uniformity of measuring instruments (so-called "legal Metrology"); development of standards and reference measuring instruments, verification of measures and measuring instruments. The priority task of this direct	Interactive lecture, discussion, analysis of scientific literature, presentation of reports	Complex testing
LO 7	To study the basic laws of pulse technology and obtain structured materials with specified properties.	Analysis of conducted experiments, presentation of reports	Report, presentation



## 21. Criteria for assessing the achievability of learning outcomes

Codes of LO	Criteria
LO 1	<b>Knows:</b> physical principles on which the operation of installations for the production of unconventional types of energy is based
	<b>Can:</b> to introduce electrotechnological methods of conversion of non-traditional types of energy
	<b>Owns:</b> competently operate electrotechnological and power plants
LO 2	<b>Knows:</b> methods and means of control, technological measurements and automation system, general physics course, higher course mathematical analysis, differential equations
	<b>Can:</b> carry out calculations of industrial thermal power equipment, calculations of errors and processing of the results of joint and aggregate measurements
	<b>Owns:</b> apply processing of results of direct, indirect measurements, estimation of uncorrelated, correlated input quantities
LO 3	<b>Knows:</b> methods of compilation and registration of scientific documentation (scientific reports, articles in peer-reviewed journals, reports, reviews, abstracts, annotations), bibliography and references.
	<b>Can:</b> prepare and execute scientific and technical documentation, scientific reports, write articles, reviews, abstracts
	<b>Owns:</b> business communication skills, work with electronic databases in the field of professional and corporate ethics
LO 4	<b>Knows:</b> current methodologies of scientific and pedagogical research that contribute to the implementation of the main directions of educational policy.
	<b>Can:</b> analyze the problems that arise when solving research and practical tasks
	<b>Owns:</b> Has the skills to analyze methodological problems that arise when solving research and practical tasks
LO 5	<b>Knows:</b> study of electrical and energy characteristics of electrohydroimpulse method of processing multicomponent media
	<b>Can:</b> to conduct technological research and the results of destruction and crushing of ore of natural origin by an electric explosion
	<b>Owns:</b> to use the kinetics and energy characteristics of the disintegration of valuable components
LO 6	<b>Knows:</b> study of the basic properties of continuous media (gases and liquids), the laws of static dynamics of continuous media, the laws of thermodynamics
	<b>Can:</b> to carry out hydraulic and electrical calculations of industrial thermal power equipment
	<b>Owns:</b> creatively apply the laws of fluid motion to solve specific problems
LO 7	<b>Knows:</b> study of the problems of thermal and heat-mass transfer motion of a dispersed particle in the environment
	<b>Can:</b> the principle of operation of measuring instruments used in energy and transport
	<b>Owns:</b> mastering the rules of technology of experimental results



## 22. The graduate model of the educational program

Attributes:

- deep professional knowledge in their field of study;
- interest in mastering trends in education and science;
- ability to collaborate in the professional community;
- independence in the search for opportunities for professional and personal development;
- sociability;
- tolerance and good manners;
- academic integrity;
- willingness to participate in solving state tasks and strategies of Kazakhstan.

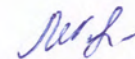
Types of competencies	Description of competencies
1. Behavioral skills and personal qualities (Soft skills)	<p>To be able it is correct to correlate the maintenance of specific objectives to the general laws of physics and to effectively apply the general laws of physics to the solution of problem tasks; - to use the main physical devices, to solve the simplest experimental problems, to process, analyze and estimate the received results. Nobility: the physical principles of transformation of traditional, nonconventional and renewable energy in electric and thermal. To have skill possession of basic provisions of the Law of RK "About Energy Saving"; estimations the technical and economic potential of NVIE in relation to specific conditions. To be competent to analyze, make statistical processing of the massif of long-term observations and to predict data for calculation of potential of NVIE; to count arrival of solar energy to a concrete point on the Earth's surface in certain intervals of time.</p> <p>As a result of the study of this discipline, the doctoral student should have an idea of the types and methods of measurement, the classification of measuring instruments and metrological characteristics of measuring instruments; the State system of ensuring the unity of measurements; know the methods of practical organization and work on technical regulation; classification of types and methods of measurement; basic metrological characteristics of measuring instruments; classification of measurement errors and measuring instruments; methods of processing measurement results; be able to correctly measure and calculate measurement errors; correctly process single and multiple measurements.</p> <p>Be able to: apply the knowledge gained in the preparation and writing of research papers in written format; read the original literature of the relevant branch of knowledge in a foreign language; work with the bibliography; formalize information extracted from foreign sources in the form of translation, abstract, annotation; compare the content of different sources of information on the problem of scientific research, critically evaluate the opinion of the authors; correctly organize their own ideas, clearly and convincingly justify, and competently Express them in writing.</p>
2. Professional competencies (Hard skills)	<p>Know the purpose and content of research activities; methodological foundations of scientific research; methods of theoretical research and methods of empirical research; requirements for methods of thermal research; methods of organization and conduct of thermal experiments; possess: the basics of methodology for conducting pedagogical research; a systematic approach to the study and analysis of thermophysical phenomena and processes.</p> <p>Formation of doctoral knowledge and skills necessary for the qualified formulation and solution of technological problems with the help of electrohydraulic effect. Objectives of the discipline to master the skills of hydrodynamic regularities of vapor-liquid flows to measure electrical quantities in the liquid, the laws of destruction of wollastonite ore for the study of microstructure and grinding; learn how to conduct a computational experiment; learn how to use the features of phase separation in an organic medium to extract valuable components from bone. To create a General theory of measurements; education of physical units and systems of units; development and standardization of methods and measuring methods for determining the accuracy of measurements, basics of ensuring the uniformity of measurements and uniformity of measuring instruments (so-called "legal Metrology"); development of standards and reference measuring instruments, verification of measures and measuring instruments. The priority task of this direct. To study the basic laws of pulse technology and obtain structured materials with specified properties.</p>



**Developers:**

**Members of the working group:**

Head of the professor Zh.S. Akylbaev Department of engineering Thermophysics



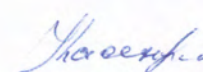
K.M. Shaimerdenova

Senior Lecturer professor Zh.S. Akylbaev Department of engineering Thermophysics



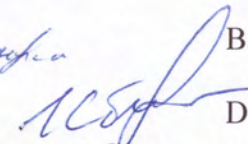
A.N. Dyusembaeva

Head of the Laboratory of Thermochemical Processes of the Zh.Abishev KHMI



B.K. Kasenov

Engineer of LLP «Energoservice-LTD»



D.A. Ibraev

Doctoral student 2 years of study



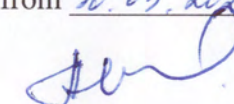
A.Zh. Tleubergenova

The educational program was reviewed by the Faculty Council from 16.03.2023 Protocol No. 1

The educational program was reviewed at the meeting of the Academic Council from 28.04.2023 Protocol No. 5

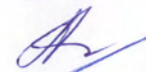
The educational program was reviewed and approved at the meeting of the University Board from 30.05.2023 Protocol No. 12

**Member of the Board-Vice-Rector for Academic Work**



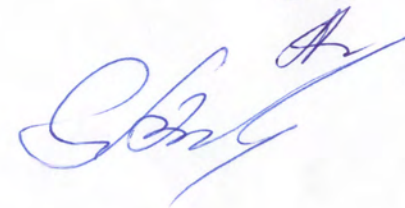
T.Z. Zhusipbek

**Acting Director of the Department for Academic Work**



S.A. Smailova

**Dean of the faculty of physics and technology**



A.K. Zeinidenov