НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ВОДНОГО ГОСПОДАРСТВА ТА ПРИРОДОКОРИСТУВАННЯ

Навчально-науковий інститут агроекології та землеустрою

Co-funded by the European Union

National University of Water and Environmental Engineering

05-03-61S (E)

СИЛАБУС **SYLLABUS**	**Рециркуляційна аквакультура** **Recirculating aquaculture**	
Шифр за ОП Code in Degree Programme	ВК.3	
Освітній рівень Level of Education	Магістерський (другий) Master's (second)	
Галузь знань Field of Knowledge	20	Аграрні науки та продовольство Agricultural Sciences and Food
Спеціальність Field of Study	207	Водні біоресурси та аквакультура Aquatic Bioresources and Aquaculture
Освітня програма Degree Programme	Охорона, відтворення та раціональне використання гідробіоресурсів Protection, reproduction and rational use of hydrobioresources	

RIVNE – 2024

The syllabus of the academic discipline "**Recirculating aquaculture**" for master's degree students of the educational program "Protection,

reproduction and rational use of hydrobioresources", specialty 207 Aquatic bioresources and aquaculture. Rivne. NUWEE. 2024. 16 p.

Educational Program (EP) on the university website: *https://ep3.nuwm.edu.ua/28749/*

Syllabus developer:*academic degree, academic title, and position* Konontsev Serhii Viktorovych, Doctor of Technical Sciences, Associate Professor, Professor of the Department of Aquatic Bioresources

Syllabus was approved at the meeting of the Department of Water Bioresources Protocol No. 23of August 27, 2024

Head of the department: *Tatyana Poltavchenko, Ph.D., Associate Professor, Head of the Department of Water Bioresources.*

The head (guarantor) of the EP:*Vasyl Sondak, Doctor of Biology Science, Professor of the Department of Water Bioresources*

Approved by the scientific and methodical quality council of NNIAZ Protocol No. 2 of 24 September 2024.

Head of the Scientific and Methodological Council for the Quality of the Institute of Agroecology and Land Management (NNIAZ):
Alla Pryshchepa, Doctor of Agricultural Sciences, Professor, Director the Institute of Agroecology and Land Management

The previous version of the syllabus (*specify code*) –

PROGRAM "Recirculating aquaculture"	
OVERVIEW	
Level of education	*Master's (second)*
Degree program	*Protection, reproduction and rational use of hydrobioresources*
Field of Study	*207 Aquatic Bioresources and Aquaculture*
Study year, semester	*1nd year 2st semester*

Number of credits	*4 ECTS credits*
Lectures:	20
Practicals /Laboratory classes:	20
Independent work:	80
Coursework:	-
Form of education	*full-time/part-time*
Type of Summative Assessment	*examination*
Language of instruction	*Ukrainian*

INFORMATION ABOUT THE DEVELOPER	
Lecturer 	*Konontsev Serhii, Doctor of Technical Sciences, Associate Professor, Professor of the Department of Water Bioresources*
Wikisitet	*specified URL:https://cutt.ly/9QrWuMI*
ORCID	*specified URL::https://cutt.ly/dQrQ7fQ*
How to communicate	*s.v.konontsev@nuwm.edu.ua* *https://exam.nuwm.edu.ua/my/*

INFORMATION ABOUT THE EDUCATIONAL COMPONENT
Purpose and tasks

The prospects for the development of recirculating aquaculture in Ukraine are related to its highest level of environmental safety and minimal impact on the environment compared to other areas of fish farming. Since recirculation aquaculture technologies are characterized by minimal specific water needs per unit of grown products, the dependence of production on water resources is significantly reduced, conditions for effective cultivation of valuable aquaculture objects appear.
The purpose of the course is for students to gain knowledge about modern technologies for growing aquaculture objects in circulating water supply systems.
Tasks:1) to expand knowledge about intensive technologies in aquaculture, 2) to develop skills in the design of aquaculture systems with a closed cycle of water supply, including the main technological tanks, nodes of automated feeding, water treatment, purification of polluted water and control of the main physico-chemical parameters, 3) to familiarize with promising aquaculture objects and technologies for their cultivation in recirculating aqua systems.

Link to the course on Moodle
https://exam.nuwm.edu.ua/course/view.php?id=6502
Course prerequisite and corequisite information (within the Degree Programme)
Prerequisites are provided by the module "Intensive Technologies in Aquaculture".
Competencies

The module "Recirculating aquaculture" develops the following general (GC), professional (PC), and subject-specific competencies:
GC1.*The ability to use information and communication technologies both to analyze the prospects of introducing innovations in production and to identify risks arising in the process of implementing an innovative project; justification of investment costs and the need for additional resources for the implementation of the innovation*

GC2.*The ability to search, process and analyze information from various sources, in particular when designing, implementing modern technologies and the latest techniques in the production of aquaculture products, forecasting the main economic and production indicators of innovation.*

GC3*. Ability to abstract thinking, analysis and synthesis, including search, development and implementation of innovations that increase the efficiency of production of fish farming products, create a new product on the aquaculture market and beyond, mastering the latest technologies in fish farming.*

PC10.*The ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments on the problems of aquatic biological resources and aquaculture to specialists and non-specialists, in particular to persons who are studying.*

PC11.*The ability to design technological maps and manage production processes that are complex and require new strategic approaches in the field of aquatic bioresources and aquaculture.*

Program learning outcomes (LO)*

LO 1. Have specialized conceptual knowledge that includes modern scientific achievements in the field of aquatic bioresources and aquaculture and is the basis for original thinking and conducting research.
LO 7. To develop, implement and apply effective technological processes of production of aquaculture products, to ensure its quality.
LO 13. The ability to design recirculation systems for industrial and decorative aquaculture, carry out calculations of modern technological equipment, justify the economic feasibility of the adopted technological decisions.
LO 15. To analyze the impact of parameters of the aquatic environment on the health of fish and to develop measures to preserve the quality of water in open reservoirs, to apply modern water purification and water treatment technologies in closed aquaculture systems, to reduce the negative impact of aquaculture on the environment.

The structure and content of the educational component	
Content module 1. Theoretical foundations of RAS functioning	
Topic 1. Architecture of modern fish farms operating as recirculation systems	
LO1; LO7 Number of hours: lectures - 2.0. Literature: 1-5	The educational component "Recirculating aquaculture" and its role in the preparation of masters in the specialty "Aquatic bioresources and aquaculture". World experience of recycling technologies. Peculiarities of growing aquaculture objects in recirculation systems.
Topic 2. Thermoregulation in RAS	
LO7; LO13; LO15 Number of hours: lectures - 2.0; practice – 2.0 hour Literature: 2-4, 7	Methods of thermoregulation in recirculation systems. The main sources of energy for heating water in RAS. Schemes of thermoregulation of pool complexes. Equipment for automation.
Topic 3. Water purification processes to meet the requirements of hydrobionts - RAS objects	
LO7; LO13; LO15 Number of hours: lectures - 2.0; practice – 2.0 hour Literature: 2-4, 7	The main indicators of pollution affecting the efficiency of growing aquaculture facilities in the RAS. Classification of methods of recovery of circulating water quality and their sequence in RAS.
Topic 4. Equipment for mechanical water purification of RAS	
LO7; LO13; LO15 Number of hours: lectures - 2.0; practice – 2.0 hour Literature: 2, 3, 5, 7	Purpose of facilities for mechanical purification of water from undissolved impurities. Methods of mechanical cleaning used in RAS. Structures of mechanical cleaning facilities.

Topic 5. Biological treatment of circulating water of RAS	
LO7; LO13; LO15 Number of hours: lectures - 2.0; practice – 4.0 hour Literature: 2, 3, 5, 7	Designation of facilities for biological treatment of circulating water of RAS. Biological treatment methods used in aquaculture. The principle of operation and design of biofilters, aeration tanks and combined bioreactors.

Topic 6. Disinfection of water in RAS	
LO7; LO13; LO15 Number of hours: lectures - 2.0; practice – 2.0 hour Literature: 2, 3, 5, 7	The importance of decontamination in the processes of growing aquaculture products. Methods of decontamination of RAS feed and circulating water. Designs of operation of ozonation units and ultraviolet sterilizers.
Content module 2. Technologies for growing aquaculture facilities in the RAS	
Topic 7. Cultivation of catfish in RAS	
LO1; LO7; LO13 *Number of hours:* *lectures - 2.0;* *practice – 2.0 hour* *Literature: 1, 2, 5, 7, 8*	*The world experience of breeding catfish in the RAS. Catfish requirements for water parameters and feed quality. Breeding and cultivation of catfish in RAS.*
Topic 8. Cultivation of tilapia in RAS	
LO1; LO7; LO13 Number of hours: lectures - 2.0; practice – 2.0 hour Literature: 1, 2, 5, 7, 8	*World experience of growing tilapia in the RAS. Tilapia requirements for water parameters and feed quality. Breeding and cultivation of tilapia in RAS. Directions of selection and hybridization for RAS.*
Topic 9. Cultivation of trout in RAS	
LO1; LO7; LO13 Number of hours: lectures - 2.0; practice – 2.0 hour Literature: 1, 2, 5, 7, 8	*World experience of salmon farming in the RAS. Trout requirements for water parameters and feed quality. The most promising forms for RAS. Combined technological schemes of trout cultivation.*

Topic 10. Cultivation of crustaceans in RAS	
LO1; LO7; LO13 Number of hours: lectures - 2.0; practice – 2.0 hour Literature: 1, 2, 5, 7, 8	*The world experience of growing higher crustaceans in RAS. The most promising types of crayfish for cultivation in RAS. Cultivation of freshwater shrimps in RAS. Peculiarities of breeding and feeding at different stages of development.*
Teaching methods	

Teaching is conducted through lectures (multimedia, interactive), seminars, practical work, and consultations with the instructor.

The forms of theoretical education include lectures and seminars. Lectures are delivered using explanatory and illustrative methods, multimedia presentations, handouts, and tables. Seminar sessions utilize methods such as oral questioning, discussions, debates, and presentations. The discussion of problematic issues is encouraged, for example, "How are the factors of fish stocking density and the frequency of water exchange in basins interconnected?", "Which of the RAS aquaculture facilities are the most promising for Ukraine?" etc. To earn additional points, students have the opportunity to give a public presentation on a chosen topic within the educational component.

The form of professional training is practical classes, which are held in a specialized laboratory of the Department of Water Bioresources, equipped with devices for electricity and water supply, containers for keeping hydrobionts (aquariums, plastic pools, bathtubs).

The research method is used when students perform individual tasks. Students use methodical material prepared by the teacher: presentations, lecture notes, methodical instructions for practical classes and independent work.

The research method is applied when students perform individual tasks. Students use methodological materials prepared by the instructor: presentations, lecture notes, and methodological guidelines for practical classes and independent work.

During the course, students are encouraged to participate in the department's scientific research work, prepare scientific articles, and present reports at scientific conferences and round tables.

Student-centered learning, problem-based learning, interactive self-learning, information technologies, the credit-transfer system of learning organization, e-learning in the Moodle system, and research and observation-based learning are all integrated into the teaching process.

Tools, equipment, software

Modern equipment of the integrated multitrophic aquaculture laboratory: pools and trays made of polypropylene, pumping and air-blowing equipment, automatic feeders, a line for the production of extruded compound feed for fish (including the newly established integrated multitrophic aquaculture laboratory created under the AFISHE project).

During lectures and practical classes, a multimedia projector, a laptop, library and internet resources, Google Sheets and Google Forms (corporate subscription), study guides, monographs, and scientific and popular articles are used.

The procedure for evaluating program learning outcomes/learning outcomes

Evaluation is carried out using two grading scales (excellent, good, satisfactory, unsatisfactory) and a 100-point scale.

Types of assessment:*current and final. Students take current (modular) and final assessments at the Educational and Scientific Center for Independent Assessment of NUWEE.*

The assessment of students' knowledge is conducted in accordance with the "System for Evaluating the Learning Outcomes of Higher Education Applicants (Semester Current and Final Control) with Amendments and Additions" (http://ep3.nuwm.edu.ua/21123).

Forms of assessment include: oral questioning, defense of practical work, verification of practical work reports, and computer-based testing.

The educational component concludes with an exam, where the points for practical and independent work (a total of 60 points) and the exam (40 points) are combined.

The results of the two module tests (20 + 20 = 40 points) during the semester may be counted as the exam result if they are completed on time and successfully.

To pass successfully, the combined score for current and modular assessments must exceed 60 points, with a maximum of 100 points.

The modular control and exam will be conducted in the form of testing on the university's educational platform MOODLE.

Intermediate (current) assessment is conducted on the NUWEE educational platform in the form of two modules.

The current module control No. 1*consists of 24 random test tasks of three levels of difficulty: Level 1 (choose one correct answer among the proposed options): 20 x 0.5 points = 10 points; Level 2 (choose one, two, or more correct answers among the proposed options, identify an incorrect statement among the proposed ones): 3 x 2.0 points = 6 points; Level 3 (identify the name and function of a compound based on an image, solve a problem to calculate the equilibrium concentration of dissolved oxygen; identify the incorrect statement among the proposed ones): 1 x 4.0 points = 4 points.*

The current module control No. 2*consists of 24 random test tasks of three levels of difficulty: Level 1 (choose one correct answer among the proposed options): 20 x 0.5 points = 10 points; Level 2 (choose one, two, or more correct answers among the proposed options, identify an incorrect statement among the proposed ones, match pairs): 3 x 2.0 points = 6 points; Level 3 (identify the incorrect statement among the proposed options): 1 x 4.0 points = 4 points.*

The final control (exam)*is conducted on the NUWEE educational platform. The exam consists of 40 random test tasks of three levels of difficulty: Level 1 (choose one correct answer among the proposed options): 30 x 0.9 points = 27 points; Level 2 (choose one, two, or more correct answers among the proposed options, identify an incorrect*

statement among the proposed ones, match pairs, solve a problem etc): 9 x 1.0 points = 9 points; Level 3 (identify the incorrect statement among the proposed options): 1 x 4.0 points = 4 points.
*Students can earn **additional points** for the following activities:*

- *Preparing a presentation or a short report on a course-related topic – 3 point;*
- *Presenting at a scientific conference on the subject of the course, publishing theses or a scientific article – 8 points;*
- *Participating in the All-Ukrainian Student Olympiad – 5 points;*

Participating in the All-Ukrainian Student Research Competition – 5 points.

Bibliography (primary, secondary)

Basic literature

1. Odd-Ivar Lekang. Aquaculture Engineering, Third Edition : Published by John Wiley & Sons Ltd., 2020. 525 p.
2. Bregnballe J. A. Guide to Recirculation Aquaculture. An introduction to the new environmentally friendly and highly productive closed fish farming systems: FAO and EUROFISH, 2015. 97 p.
3. Sherman I.M., Rylov V.G.. Production technology of fishery products: a textbook. Kyiv: "Higher Education", 2005. 351 p.
4. Modern aquaculture: from theory to practice: a practical guide / Sharylo Yu.E. etc. K.: "Prostobuk", 2016. 119 p.
5. Timmons M.B., Ebeling J.M., Wheaton F.W., Summerfelt S.T., Vinci B.J. Recirculating Aquaculture Systems. Ithaca, NY : Cayuga Aqua Ventures, 2001. 650 p.
6. Aquaculture: Farming Aquatic Animals and Plants. John S. Lucas, Paul C. Southgate, Craig S. Tucker (Editors). 2019. Wiley-Blackwell. ISBN 978-1119230861.

Additional literature

7. Konontsev S.V. Sabliy L.A., Grokhovska Yu.R. Ecological biotechnology of wastewater treatment and cultivation of feed organisms: monograph. Rivne: NUWEE, 2011. 151 p.
8. Andryushchenko A.I., Vovk N.I. Aquaculture of artificial ponds. Part II. Industrial aquaculture: a textbook. Kyiv, 2014. 586 p.
9. Sturgeon breeding. Textbook: recom. Ministry of Agrarian Policy of Ukraine: to the 50th anniversary of the establishment of the Department of Aquatic Bioresources and Aquaculture of the Ukrainian Academy of Sciences / I. M. Sherman. - Kherson: [Oldi-plus], 2018.
10. Mamenko O.M., Portyannyk S.V., Shcherbak O.V. Innovative technologies in fish farming. Kharkiv: RVV of the Kharkiv State Zooveterinary Academy, 2017. 320 p.
11. Intensive fish farming (Collection of instructional and technological documentation). - K.: Agrarian science, 1995. - 186 p.
12. Sabliy L., Konontsev S., Grokhovska J., Widomski M. and Lagod G. Nitrogen removal from fish farms water by Lemna minor and Wolffia arrhiza. *Proceedings Society of Ecological Chemistry and Engineering (SEChE), Proceeding of ECOpole.* Opole (Poland). 2016. Vol. 10. No. 2. R. 499-504.
13. Konontsev S.V., Sabliy L.A., Kozar M.Yu., Grokhovska Yu.R. Efficiency of removal of nitrogen compounds by plants in integrated multitrophic aquaculture. *SCIENTIFIC BULLETIN OF CONSTRUCTION*. T. 91. No. 1. 2018. p. 331-335.
14. Konontcev S., Sabliy L., Kozar M., Korenchuk N. Treatment of recirculating water of industrial fish farms in phytoreactor with Lemnoideae. *Eastern-European Journal of Enterprise Technologies*. 2017. No. 5/10 (89). P. 61-67.

Information resources on the Internet

15. Law of Ukraine on Aquaculture. Bulletin of the Verkhovna Rada (VVR), 2013, No. 43, Article 616. – Access mode: https://zakon.rada.gov.ua/laws/show/en/5293-17

16. Fish farming. Website of the Ministry of Agrarian Policy and Food of Ukraine. – Access mode: https://minagro.gov.ua/napryamki/rybne-hospodarstvo
17. Website of the Institute of Hydrobiology of the National Academy of Sciences - Access mode: https://hydrobio.kiev.ua/ua/
18. Website of the Institute of Fisheries of the National Academy of Sciences. – Access mode: http://if.org.ua/index.php/uk/.
19. Food and Agriculture Organization of the United Nations website. Food and Agriculture Organization (FAO). – Mode of access: https://www.fao.org/
20. Website of the journal "Fisheries of Ukraine". [Electronic resource]. – Access mode: http://fsu.ua/index.php/uk/arkhiv-zhurnalu.
21. World Organization for Animal Health website. World Organization for Animal Health (WOAH). – Access mode: https://www.woah.org/en/home/
21. Megalodon. Information and analytical platform for the development of fisheries: https://fishindustry.com.ua/

Methodical support

1. ***05-03-148M***Konontsev, S. V. (2024) Synopsis of lectures on the educational discipline "Recirculating aquaculture" for students of higher education of the second (master's) level under the educational and professional program "Protection, reproduction and rational use of hydrobioresources" specialty 207 "Water bioresources and aquaculture" full-time and part-time education*. – Access mode: https://ep3.nuwm.edu.ua/30730/*

2. ***05-03-149M***Konontsev, S. V. (2024) Methodological instructions for the implementation of practical work in the educational discipline "Recirculating aquaculture" for students of higher education of the second (master's) level under the educational and professional program "Protection, reproductionand rational use of hydrobioresources" specialty 207 "Aquatic bioresources and aquaculture" full-time and part-time study*. – Access mode: https://ep3.nuwm.edu.ua/30732/*

3. ***05-03-150M***Konontsev, S. V. (2024) Test tasks of the current control of knowledge from the educational discipline "Recirculating aquaculture" (content module 1) for students of higher education of the second (master's) level under the educational and professional program "Protection, reproduction and rational use of hydrobioresources" specialty 207 "Aquatic bioresources and aquaculture" full-time and part-time education*. – Access mode: https://ep3.nuwm.edu.ua/30734/*

4. ***05-03-151M***Konontsev, S. V. (2024) Test tasks of the current control of knowledge from the educational discipline "Recirculating aquaculture" (content module 2) for students of higher education of the second (master's) level under the educational and professional program "Protection, reproduction and rational use of

hydrobioresources" specialty 207 "Aquatic bioresources and aquaculture" full-time and part-time education. – *Access mode:* https://ep3.nuwm.edu.ua/30735/

Combination of learning and research* (if needed)

Graduates of higher education are involved in the implementation of scientific research topics, have the opportunity to research the technological parameters of modern equipment in laboratory conditions to support the main physico-chemical parameters of water, feed, etc. In the case of choosing the subject of the graduation qualification work, or including separate sections in its content, according to the subject of the course - innovative objects of aquaculture, the latest technology in RAS and the effectiveness of its application; during the practical work, applicants have the opportunity to obtain scientific research results for their inclusion in the qualification work.
In the educational process, the obtained individual and collective scientific achievements of the lecturer, which are related to the content of the educational component, are used:
- Innovative water purification technologies in recirculating aquaculture systems;
- Modern technical equipment for intensive aquaculture;
- Cultivation of feed organisms and cleaning agents within integrated multitrophic aquaculture;
Within the framework of individual studies, students have the opportunity to use the material base of the laboratory of integrated multitrophic aquaculture, namely at
– study of the cultivation of fodder organisms in a closed circle of RAS;
- determining the effectiveness of adding various ingredients to compound feed produced by the extrusion method;
- research on the effectiveness of innovative methods of water aeration in aquaculture conditions;
- economic justification of the introduction of automation schemes of the main production processes in aquaculture.
During training, students are shown the development of systems for biological treatment of circulating water of fish farms, implemented by S.Konontsev in production, as well as technologies of integrated multitrophic aquaculture in freshwater recirculation systems

TEACHING AND LEARNING POLICIES

List of social, "soft" skills (soft skills)

The components of the module contribute to the development of universal skills that enable quick adaptation to new conditions, changing fields of employment, and solving non-standard tasks in production and environmental protection: critical thinking, environmental literacy, curiosity, determination, perseverance, teamwork, responsibility, creativity, and self-directed learning for professional and personal growth.

Deadlines and rescheduling

Announcements regarding deadlines for submitting parts of the educational discipline are published on the course page on the MOODLE platform according to the calendar: https://exam.nuwm.edu.ua/calendar/view.php?view=month&course=6502
The deadlines for submitting intermediate control modules and the final control (exam) are established according to the Regulation on the semester's current and final control of educational achievements of higher education students. Link: http://ep3.nuwm.edu.ua/15311/.
Retaking of modules is carried out in accordance with the rules of the Center for Independent Assessment, announcement by the link: https://exam.nuwm.edu.ua/mod/forum/view.php?id=1.
Retaking of modules is allowed with the permission of the dean's office in the presence of valid reasons (e.g., medical leave).
Elimination of academic debt and re-study of the discipline are carried out in accordance with the "Procedure for the elimination of academic debts at NUWEE". Link: http://ep3.nuwm.edu.ua/4273/.
If a student disagrees with the assessment results, an appeal can be submitted to the NNIAZ dean's office on the day the test is taken, clearly stating the nature of the issue. A printed copy of all the student's answers during the attempt must be attached to the appeal. The director of the NNI convenes an appeal commission to consider the complaint, to which the student and a representative of the Center for Independent Assessment are invited, in accordance with the Procedure for appeals from students and other individuals studying at the National University of Water and Environmental Engineering http://ep3.nuwm.edu.ua/15467/.

Non-formal and informal education (if needed)

Students have the right to have their learning outcomes from non-formal and informal education credited according to the relevant regulations. http://ep3.nuwm.edu.ua/18660/. In particular, free courses on the Coursera platform. Link: https://www.coursera.org.

Rules of academic integrity

The principles of academic integrity are outlined on the NUWEE "Education Quality Department" website: https://nuwm.edu.ua/sp/akademichna-dobrochesnistj. *It is prohibited to cheat or discuss questions with fellow students during all control measures, including modular and final assessments. If such violations are detected, the student loses the right to continue performing tasks, which may result in a reduction of the overall grade or the failure to pass the entire course, necessitating the re-study of the educational component.* *Information on academic integrity, plagiarism, the student honor code, etc., is provided on the website of the National Agency for Quality Assurance of Higher Education https://naqa.gov.ua/; and on the NUWEE "Quality of Education" pagehttp://nuwm.edu.ua/sp/akademichnadobrochesnistj.*
Attendance requirements
It is mandatory to make up missed classes without valid reasons (e.g., medical leave, mobility, etc.). This can be done during consultations, the schedule of which is published on the Department of Water Bioresources page: https://nuwm.edu.ua/nni-az/kaf-vb/hrafik-konsultatsii. *With a medical certificate or a certificate of academic mobility, the student is exempted from making up missed practical classes. Missed lectures must be independently studied by students on the educational platform on the page of the relevant educational component https://exam.nuwm.edu.ua/course/view.php?id=839.* *During classes, students may use mobile devices only to search for information related to the module and calculators for solving tasks, except during control measures.*

Автор
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Затверджено

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