Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное образовательное учреждение высшего образования

«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»

Направление подготовки/профиль: 14.06.01 Ядерная, тепловая и возобновляемая энергия и связанные с ними технологии**,** 2.4.9. Ядерные энергетические установки, топливный цикл, радиационная безопасность (на английском языке)
Школа: Инженерная школа ядерных технологий
Отделение: Научно-образовательный центр международного ядерного образования и карьерного сопровождения иностранных студентов

Научный доклад об основных результатах подготовленной научно-квалификационной работы

Тема научного доклада
Исследование возможности реализации сверхдлинных кампаний ядерного топлива реакторов РИТМ-200

УДК 621.039.54

Аспирант

Группа	ФИО	Подпись	Дата
А9-43и	Алхассан Самиру		

Руководитель профиля подготовки

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Директор ИЯТШ	Долматов О.Ю.	к.т.н., доцент		

Руководитель отделения

Должность	ФИО	Ученая степень, звание	Подпись	Дата
И.о. зав. каф. – руководитель НОЦ ЦМЯО на правах кафедры	Верхотурова В.В.	к.ист.н.		

Научный руководитель

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Доцент	Нестеров В.Н.	к.т.н.		

Томск – 2023 г.

Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное образовательное учреждение высшего образования

«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»

Field of training (specialty): 14.06.01 Nuclear, Thermal and Renewable Energy and Related Technologies, 2.4.9. Nuclear Power Facilities, Nuclear Fuel Cycle, Radiation Safety (in English)
School: Nuclear Science & Engineering
Division: Research and Training Centre for International Nuclear Education and Career

Scientific qualification work

Title
Investigation of the possibility for achieving extra-long nuclear fuel campaigns in RITM-200 reactor

UDC 621.039.54

PhD student

Group	Full name	Signature	Date
А9-43И	Alhassan Samiru		

Programme Director

Job position	Full name	Academic degree, academic rank	Signature	Date
Director of Nuclear Science & Engineering School	Oleg Yu. Dolmatov	Candidate of Science, associate professor		

Research and Training Centre for International Nuclear Education and Career

Job position	Full name	Academic degree, academic rank	Signature	Date
Head of Research and Training Centre for International Nuclear Education and Career	Vera V. Verkhoturova	Candidate of Science, associate professor		

Scientific supervisor

Job position	Full name	Academic degree, academic rank	Signature	Date
Associate Professor, School of Nuclear Technology	Vladimir N. Nesterov	Candidate of Science, associate professor		

Tomsk – 2023

ANNOTATION

This scientific qualification work is devoted to the investigation of the possibility for achieving extra-long nuclear fuel campaigns in RITM-200 reactor comprising of an introduction, four chapters, a conclusion, list of reference and appendix. The material of the work is presented in 179 pages with 65 figures, 16 tables, 67 formulae and 160 references.

Keywords: Small modular reactor, RITM-200, pressurized water reactor, uranium-plutonium based fuel, thorium-uranium based fuel, multigroup calculations, neutron spectra, fuel burnup, fuel lifetime.

Relevance: Large territories are located outside the zone of centralized power supply. These remote, hard-to-reach areas depend largely on power plants run on fossil fuels which have high cost of operation. Also, these sources of power have serious environmental challenges involved with their operation.

The purpose of the work is the determination of the possibility of increasing the fuel lifetime of the RITM-200 reactor during the implementation of the thorium-uranium nuclear fuel cycle.

This goal is achieved through solving the following **tasks**:

– Determination of design and operational parameters of small modular reactors, in particular the floating nuclear power reactor RITM-200, taking into account the influence of the thorium fuel cycle on the service life of reactor fuel.

– Determination of the dependence of the reactivity margins, the mass of the nuclide and the effective neutron multiplication factor on the reactor operating time and the fuel burnup depth for fuel compositions ($^{238}U + ^{235}U)O_2$, ($^{232}Th + ^{235}U)O_2$ and ($^{232}Th + ^{233}U)O_2$ and subsequent calculation of the fuel campaign of each fuel composition for fuel rods of different diameters using a multigroup approach.

– Evaluation of the thermophysical properties of the RITM-200 reactor plant to determine the temperature distribution profile for different diameters of fuel rods. Calculate the critical heat flux for different fuel element diameters required to determine whether a boiling crisis will occur or not.

– Estimation of the dependence of the reactivity margin and the effective neutron multiplication factor on the reactor operation time and the fuel burnup depth for fuel compositions ($^{238}U + ^{235}U)O_2$, ($^{232}Th + ^{235}U)O_2$ and ($^{232}Th + ^{233}U)O_2$ and subsequent calculation of the fuel campaign of each fuel composition for fuel rods of different diameters using MCU-PTR.

Publications: The main content of this dissertation work has been published in 8 printed works, including 2 scientific articles in peer-reviewed scientific journal recommended by the Higher Attestation Commission of the Russian Federation, indexed by the database “Web of Science and Scopus”.

Introduction covers the relevance of the work, the formulated goals and objectives, the scientific novelty and practical significance achieved, the results and provisions submitted for protection, approbation, the scope of the research and personal contribution of the author.

The first chapter presents analysis of the small modular reactors and the potential of transitioning the fuel from uranium-plutonium based to thorium-uranium based fuel for fuel optimization.

The second chapter establishes the multigroup calculations involved in determining the dependency of neutronic parameters such as fuel burnup, reactivity margin and fuel lifetime on the outer fuel diameter of the different dispersed fuel compositions.

The third chapter analyzes the thermophysical properties of the RITM-200 reactor to determine if increasing the fuel element diameter to the optimal diameter will lead to boiling crisis or not.

In the fourth chapter, the Monte Carlo simulation tool MCU-PTR is used to determine the dependence of neutronic parameters such as fuel burnup, reactivity margin and fuel lifetime on the outer fuel element diameter.