بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

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تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

MONA MAGHRABY

Studies on the neutronics design of water-water energetic reactor

A thesis submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in the
Physics Department
Faculty of Science
Ain Shams University

By

Noura Hassan Hafez

Assistant Lecturer of Nuclear Physics
Egyptian Russian University

Supervisors

Prof. **Samir Yousha El-Khamisy**
Professor of Nuclear Physics, Physics Department, Faculty of Science, Ain Shams University

Prof. **Esmat Hanem Amin**
Professor of Reactor Safety Engineering, Nuclear Safety and Radiological Authority

Prof. **Soad Abd El-Monem Elfiki**
Professor of Radiation Physics, Physics Department, Faculty of Science, Ain Shams University

Dr. **Ahmed Abd-Elatef Mohamed**
Assistant professor, Physics Department, Faculty of Engineering, Fayoum University

2020 - 2021

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To my mother Shadya, the love and kind heart. To my father Hassan, the love and tender forever. To my sister Samah, Rose of my life. To my brother Ahmed, The encouragement, continuous Support and help.
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Abstract

The nuclear reactor core modeling is a challenging task, due to the many various interior and integrated physical phenomena included in the reactor core.

The basic characteristic and neutronic parameters including both criticality and safety parameters as the multiplication factor, temperature coefficient of reactivity, neutron spectrum, and others are considered as fundamental and substantial parameters for design, safety, and control of nuclear power reactors. Subsequently, the calculation of these safety parameters with wide types of codes and data libraries is necessary firstly for verification and secondly for validation purposes, in addition further development of reactor core designs.

As a result of the existence of only few analysis carried on the VVER-1200 reactor core, particularly using MCNP code, so the aim of this study is to make full analysis for the behavior of the nuclear criticality and safety parameters in different initial fuel loading prior startup of VVER-1200 core, in various conditions of operational modes, as cold, hot, and also normal states of reactor operation.

The investigated criticality and safety parameters involve the effective multiplication factor, reactivity temperature coefficient that contains the effect of system temperature that represents in both fuel and coolant, void coefficient and concentration coefficient, which are affected by the change in boric acid concentration, fuel temperature and coolant temperatures and densities. In

addition, the analysis of the neutron spectrum, neutron flux in both axial and radial directions with the analysis of influence of Gadolinium in the core, the power distribution and the evaluation of power peaking factor. Further, the present study is extended to analyze and investigate the behavior of neutron spectrum and neutron flux in the pressure vessel of reactor core to ensure the safety of reactor core from neutron radiation damage during its lifetime. Ultimately, the study is aimed to estimate the accumulated mass of actinides and non-actinides isotope after one fuel cycle burn-up, as well as the time variation of the mass of each isotope through the burn-up of one year.

The eigenvalue calculations including criticality of reactor were performed numerically using MCNP5 transport code and ENDF/BVII.0 nuclear data library. While the burn-up calculations were carried out by MCNPX code with the same nuclear data library.