Salwa Akl

# بسم اللّه الرحمن الرحيم

## مركز الشبكات وتكنولوجيا المعلومات

## قسم التوثيق الإلكتروني

Salwa Akl

# 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**

Salwa Akl

# بعض الوثائق الأصلية تالفة
# وبالرسالة صفحات لم ترد بالأصل

B18395

# *"Computer Modeling and Burnup Analysis in Light Water Nuclear Reactors"*

*Presented by*

**Basma Mahmoud Mohammed Fouad**

*A Thesis Submitted*
*to*
**Faculty of Science**

**In Partial Fulfillment of the Requirements for the Degree of Master of Science (Nuclear Physics)**

**Physics Department**
**Faculty of Science**
**Cairo University**

(2010)

# ABSTRACT

Student Name: **Basma Mahmoud Mohammed Fouad**

Title of the thesis: **Computer Modeling and Burnup Analysis in Light Water Nuclear Reactors**

Degree: **Master of Science**

*The purpose of this thesis is to study the feasibility of the Thorium/Uranium fuel cycle in heterogeneous Pressurized Water Reactors (PWR) core design. This thesis focuses on the neutronic and burnup analysis of the Thorium/Uranium fuel using the computer codes MCNPX and WIMS-D5. The design is based on the Whole Assembly Seed and Blanket (WASB) concept, in which the individual seed (Uranium) and blanket (Thorium-Uranium) units occupy one full-size PWR assembly in a checkerboard core configuration. The results of the present models are compared with the solution of the benchmark problems. Satisfactory agreement is obtained.*

Keywords: Thorium Fuel cycle, Whole Assembly Seed and Blanket, Neutronic calculations

Supervisors: Signature:

1- Prof. Dr. Hesham Mohammed Mansour H. Mansour

2- Prof. Dr. Moustafa Aziz Abd El Wahab Moustafa Aziz

**Prof. Dr. Gamal Abd El Naser**

G M-Naser

Chairman of Physics Department

Faculty of Science- Cairo University

## APROVAL SHEET FOR SUMISSION

Thesis Title: **Computer Modeling and Burnup Analysis in Light Water Nuclear Reactors**

Name of candidate: **Basma Mahmoud Mohammed Fouad**

**This thesis has been approved for submission by the supervisors:**

1- **Prof. Dr. Hesham Mohammed Mansour**

**Signature:** H. Mansour

2- **Prof. Dr. Moustafa Aziz Abd El Wahab**

**Signature:** Moustafa Aziz

**Prof. Dr. Gamal Abd El Naser**

Chairman of Physics Department
Faculty of Science- Cairo University

Cairo University
Faculty of Science

# To WHOM IT MAY CONCERN

This is to certify that: **Basma Mahmoud Mohamed Foad**

Has attended and passed successfully the following postgraduate Courses as a partial Fulfillment of the requirements of the degree of Master of Science:

1. Advanced Quantum mechanics,
2. Group Theory,
3. Quantum Field Theory,
4. Theories of Nuclear interactions,
5. Molecular Spectroscopy,
6. Statistical and electrodynamics

This certificate is issued at his own request.

Date of birth: 15/10/1981

Place of birth: El-Sharkya

Controller

9/6/2010 G.M. Na...

# ACKNOWLEDGMENT

I would like to give my appreciations to

- Prof. Dr **Hesham Mansour**, for his kind supervision and patience. He has been a great source of knowledge, encouragement and *guidance.*
- Prof. Dr **Moustafa Aziz**, for his supervision and continuous help, support and valuable guidance during this work.

I would like to express my deep appreciation to Prof. Dr **Esmat Amin** for her kind and enthusiastic help in both WIMS-input and computerization.

I would like also to thank all my friends in the National Center of Nuclear Safety and Radiation Control.

I am also grateful to my family, for their support and love.

# TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| AGR | Advanced Gas Cooled Reactor |
| ANL | Argonne National Laboratory |
| $B_d$ | Burnup duration |
| BNL | Brookhaven National Laboratory |
| BOL | Beginning Of Life |
| BWR | Boiling Water Reactor |
| CANDU | Canada Deuterium-Uranium Reactor |
| CASMO-4 | A multigroup transport code for burnup calculations |
| DOE | Department of Energy |
| FBR | Fast Breeding Reactor |
| HTGR | High Temperature Gas Cooled Reactor |
| IAEA | International Atomic Energy Agency |
| INEEL | Idaho National Engineering and Environmental Laboratory |
| $K_{eff}$ | Effective multiplication factor |
| KTF | Kyung-hee Thorium Fuel |
| LMFBR | Liquid Metal cooled Fast Breeding Reactor |
| LWR | Light Water Reactor |
| LWBR | Light Water Breeding Reactor |
| MA | Minor Actinides |
| MCNP | Monte Carlo N-Particle Transport Code System |
| MCODE | (MCNP + ORIGEN) |
| MOCUP | (MCNP4B + ORIGEN2) |
| MIT | Massachusetts Institute of Technology |
| MEU | Medium Enriched uranium |