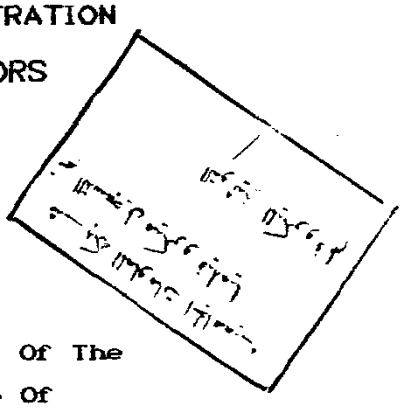
MEASUREMENT OF RADON CONCENTRATION USING SOLID STATE DETECTORS



A THESIS

Submitted In Partial Fulfillment Of The
Requirements For The Degree Of
Master Of Science

Presented by
MOUSTAFA AHMED LOTFY ABD-EL HADY
Rad. Dept. (NIS)

TO
The Physics Dept.,
University College For Women
Ain Shams University

1992

Thesis Advisors

Approved

Prof. Dr. Kenawy , M. A.

Physics Dept. Faculty of Girls

Ain Shams University.

Prof. Dr. EL-Fiki , M. A.

Head of Radiation Dept.

(NIS)

Prof. Dr. Gomaa , M. A.

Head of Radiation Prot. Dept.

(EAE)

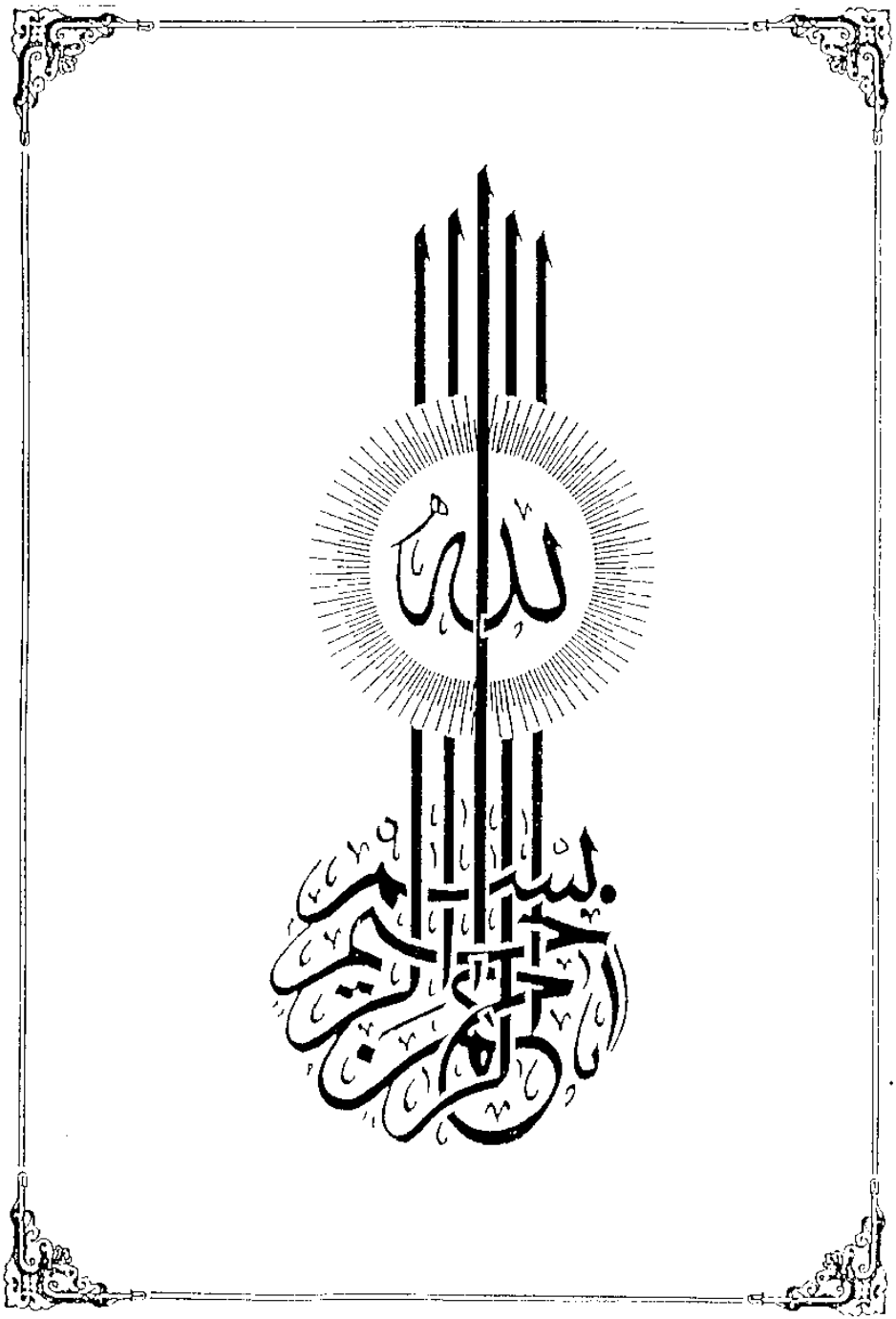
Dr. Sharaf , M. , A.

Radiation Dept.

(NIS)

Approved

Head of Physics Dept.



CONTENTS

CHAPTER IV

RESULTS AND DISCUSSIONS

SUMMARY

SUMMARY

It had been recognized that , radon and its progeny products can present a serious radiation hazards like lung cancer from the inhalation of this radioactive gases , particularly when concentrated in some enclosures such as tight houses , mines , caves , old Egyptian tombs and many other monumental places .

During the last few years extensive efforts have been devoted to the search for the development of test radon chambers through the world on national levels . In conclusion Radon and its daughter measurements is an important indicator for protecting the public .

From the foregoing it can be pointed out that , the need for a suitable design and testing of secondary standard radon chamber at the NIS of Egypt became evident , Which is the aim of this thesis . In this work , this problem has been studied experimentally to fulfill the following objectives :

1- To realize a good understanding of the alpha-particle registration using SSNTD's and TLD's techniques to be

familiar with the latest state of the art.

2- To gain more experiences in studying the various physical parameters of the used techniques which control its sensitivity and dosimetric characteristics .

3- To construct suitable and simple secondary standard radon chamber for the purpose of calibration the different integrating type detectors and testing of replicate devices as a part of national environmental radiation monitoring program .

In this thesis , theoretical and experimental materials are given in five chapters :

Chapter I presents a general review of ,

- The nature of radon gas and its decay by alpha-particle emission into series of short half life isotopes .
- The terminology and radiation units used and related to radon gas concentration measurements.
- The sources of radon in nature such as soil, rock , ground water and other sources of radon .

- The health hazards from radon daughters , and its direct relation with lung cancers .
- A brief account about the methods of radon detection , through the active methods and the integrating type techniques .
- A review about the calibration facilities of radon measurements throughout the world on national levels with the commonly used SSNTD's and TLD's in environmental measurements was also the objective of the present work .

In chapter II the theoretical aspects of the different integrating type techniques used in this work are reviewed . Physical considerations of the thermoluminescence , track detection , activated charcoal and the most important items related for each technique are discussed .

Chapter III presents a detailed description of the radiation measuring devices used in this study such as , the types of the used integrating type detectors with the read-out system for each technique and the irradiation facilities , the preliminary experiments with the measuring accuracy are also presented .

Chapter IV includes the experimental results and discussions of all measurements attained by the different devices . The results obtained can be summarized as :

* TLD's technique

- The TLD's have an excellent linearity response for γ and α doses in the studied range.
- $CaSo_4$:Dy possess the highest γ-ray sensitivity while LiF-100 has the highest response for α-particles.
- The relative sensitivity of $CaSo_4$:Dy was found to be more lower than that of LiF.
- liF-100 has a reasonable stability for dose conservation .

* Track etching technique

- Bulk etching rate V_B as a function of NaOH concentration (n) follows a power law $V_B = a\ n^b$, in which a = 0.24 and b = 1.17 .
- The determined values of V_B for CR-39 plastic detector were found to be in good agreement with the published date
- The response of CR-39 was found to be higher than that of LR-115 by three times where its values are 0.59 and 0.2 (track / α) respectively .

CHAPTER I

GENERAL REVIEW

CHAPTER I

GENERAL REVIEW

1.1 INTRODUCTION

Through history man has lived with ionizing radiation from natural sources and recently from man-mad sources. By time, the second part nas been integrated in the steady radiation environment. It is impossible for people to avoid exposures to radiation within their living environment .

It has long been recognized that the radioactive gas radon and its airborne daughter products can present a serious radiation hazard , particularly when concentrated in some enclosures such as homes , mines , caves ,etc. In addition to Uranium ore deposits, soil ,rocks and most of the common building materials contain trace amounts of the Uranium (natural Uranium is present in the earth crust with an average of 1.4 ppm [1]).

Radon has come to prominence since the first symposium on natural radiation environment about many years ago [2]. Because of the increasing social concern , a large number of groups throughout the world are engaged in the measurement

of radon and its daughters on national levels [3,4].

1.2 RADON FAMILY

Radon is a radioactive gas , first discovered in the early 1900 s . It is chemically a noble gas,it cannot be smelt by human beings and it is invisible. Radon being an inert gas , readily diffuses through solid mater and enters the atmosphere , it may then be inhaled and thus present a potential health hazard .

Radon (^{222}Rn) is a radioactive gas with a half life time 3.824 days [1,5]. It is the immediate daughter of ^{226}Ra produced in the decay series of ^{238}U , see Fig.(1-1).

The radon isotope ^{222}Rn decays by alpha particle emission into a series of short half life isotopes. This short half-life series includes two alpha particle emitters ^{218}Po and ^{214}Po , so effectively a ^{222}Rn decay includes three alpha particle emissions within a relatively short time .The other two daughters are ^{214}Pb and ^{214}Bi which emit energetic β and γ-rays . Table (1-1) [6-8] shows the decay products of radium and radon .