Measurements of Radon-222 and its Daughters Concentrations in Buildings of Department Physics in College of Sciences of Baghdad University

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Abstract:

The present work aims to investigate approaches, measures and detection of indoor radon level in buildings of the department of physics in college of science of Baghdad University.

CR-39 solid state nuclear track detectors were used to measure the radon concentrations inside the rooms, including five laboratories and five workplace rooms in ground and first storey of the department. The average radon concentration at first storey was found to be 43.1±13.2 Bq/m^3 and 40.1±13.4 Bq/m^3 at the ground storey. The highest level of radon concentration at the first storey in the radioactive sources store was 87.5±29 Bq/m^3 while at the ground storey in room(2) was 70.2±24 Bq/m^3 which is due to the existence radioactive sources in some selected places at the buildings.

Introduction:

Although there are several different isotope of radon, the one that is of greatest concern as a potential human health threat is Radon Rn-222. Rn-222 gas is formed naturally during a chain of radioactive disintegration reactions. The decay series begins when uranium-238 decays; uranium is widely distributed in rocks and soils throughout the earth's crust with half-life of 4.5 billion years, which means a very slow breakdown.

Because Rn-222 is a gas, it moves freely in the air spaces between rocks and in soils. It becomes a human health concern when it leaks from the underlying soil into homes and other buildings. If it builds up to high concentrations in indoor air, radon and its decay products can be inhaled and cause lung cancer.

Some amounts of radon can enter the buildings from the construction materials itself and some can also be carried in by the water supply. It does not find easy to escape back to the outside because of restricted ventilation. Restriction of ventilation is exacerbated in the modern homes and buildings. As far as human dwellings are concerned the possible enhanced risk could be expected only in a rather small faction of homes depending essentially on the building materials ventilation features and soil characteristics. These factors are directly responsible for enhanced input and subsequent stagnation of Rn-222 in indoor air.

Many studies of radon concentration have been performed [1-5]. The solid state nuclear track detectors (SSNTDs) have been widely used for the measurement of radon levels in dwellings under different conditions [6-13].

In offices and office-like rooms (indoor workplaces) there is no requirement for measuring and analyzing the concentration of radon. Generally speaking, only a minor level of radiation is to be expected, which should be in keeping with the average natural

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environmental radiation. There are some cases where the radon concentration in enclosed rooms is significantly higher than average. In these cases, the radon concentration needs to be determined, and it may be necessary to take some measures for the purpose of lowering the radon concentration, therefore in this work the indoor radon concentrations have measured using SSNTDs detectors, in the department of physics in College of Science of Baghdad University, at which radioactive sources are usually used.

Experimental Details:

Radon concentrations were measured using ten pieces of solid state track detectors CR-39. The pieces of 250µm thick and 1×1.5 cm^2 area were prepared and distributed inside the rooms and laboratories of the Department of Physics. Five detectors were placed at the ground storey and five at the first storey. The detectors were left in the rooms for a period of two months from July to September 2007. The exposed detectors were collected from different locations (as illustrated in Fig.1and 2) and etched chemically in 6M NaOH solution at 60c° for 5 hours. The counting of alpha damage tracks was done using an optical microscope with a magnification of 400X.

Calibration of the CR-39 plastic track detectors was done using standard source of Ra-226. The calibration curve of the CR-39 detector is shown in Fig.(3). It shows the variation of track density (ρ_s) in terms of number of tracks/mm^2 exposed to Ra-226 source.

The Rn-222 and its daughter's concentrations C_x in terms of Bq/m^3 were obtained by the following equation:

$$C_x(Bq/m^3) = \frac{C_s(Bq/m^3)}{\rho_s} \cdot \frac{\rho_x}{t} = \frac{\rho_x}{slope \cdot t}$$

where C_s: radon concentration of Ra-226 . ρ_s, ρ_x: track density number of the detectors exposed to Ra-226 and of distributed detectors respectively, and t: exposure time in days.

Results and Discussion:

The indoor radon concentrations at rooms and laboratories and the average concentration in the investigated sites were evaluated using the calibration curve Fig.(3) and Table 1.This table shows that the average radon concentration in the ground and first storey was 40.1±13.4 Bq/m^3 and 43.1±13.2 Bq/m^3 respectively. These radon concentrations are due to the contribution of radon emanations from soil located under the building, and the construction materials, and also due to the fact that the non-residential buildings remain closed after the hours working and have poor ventilation.

However, the average concentration at the first storey is higher than that at the ground storey, on the other hand there is a high value measured at room(2) (Fig.1), in the ground storey. It was 70.2±24 Bq/m^3 and at room in the first storey, was 87.53±29 Bq/m3,that is because room(2) in the ground storey is near the irradiation room, see Fig(2), in the department, and the room in the first storey is the nuclear radiation sources store, see Fig(2), that contains the radiation sources.

In general the results show that the radon concentration and its daughters in our department lies within the permissible range 200 Bq/m^3 stated by the International Commission of Radiological Protection[14]. However the exposure to radon must reduced to its possible minimum levels to avoid radiation hazards. Periodic radon testing should be employed to monitor any unexpected source of harmful dose.

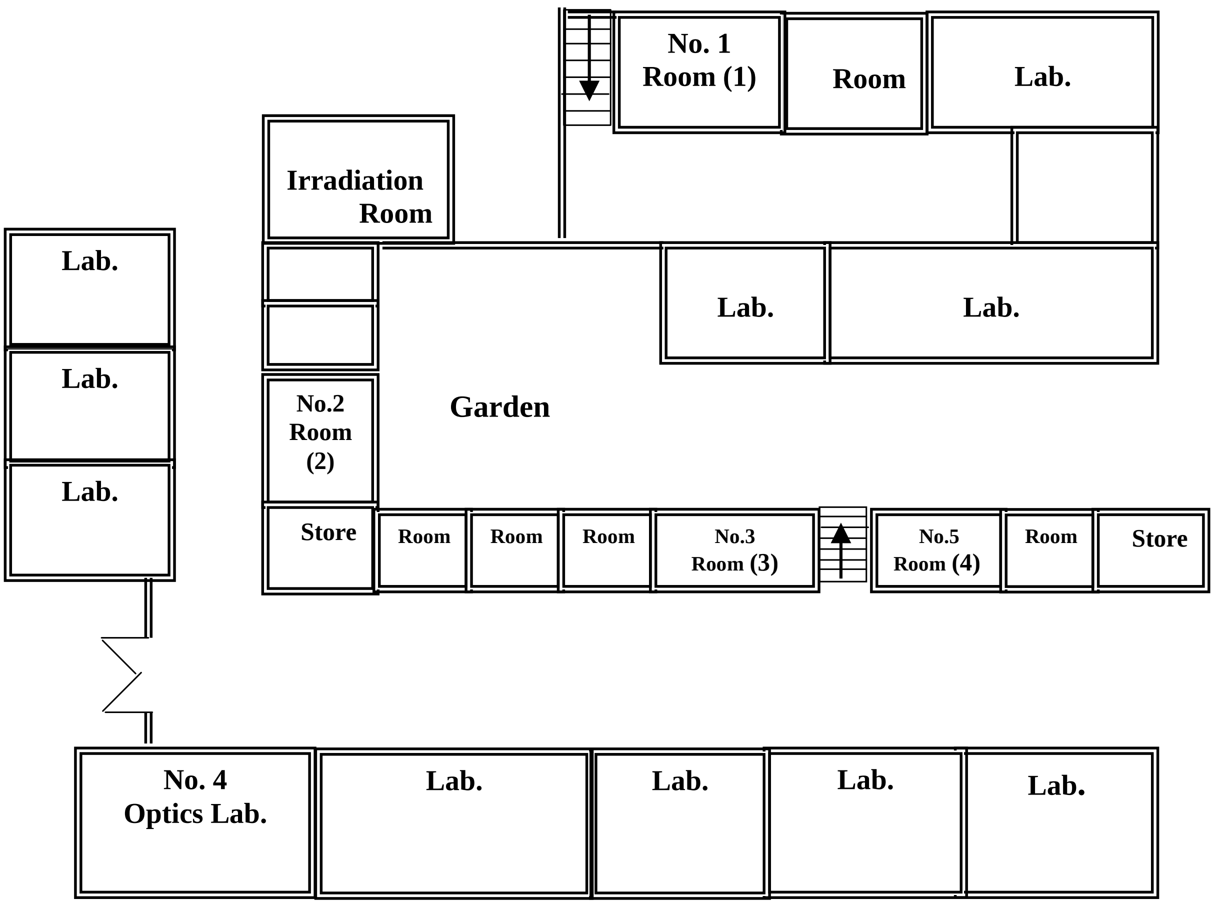
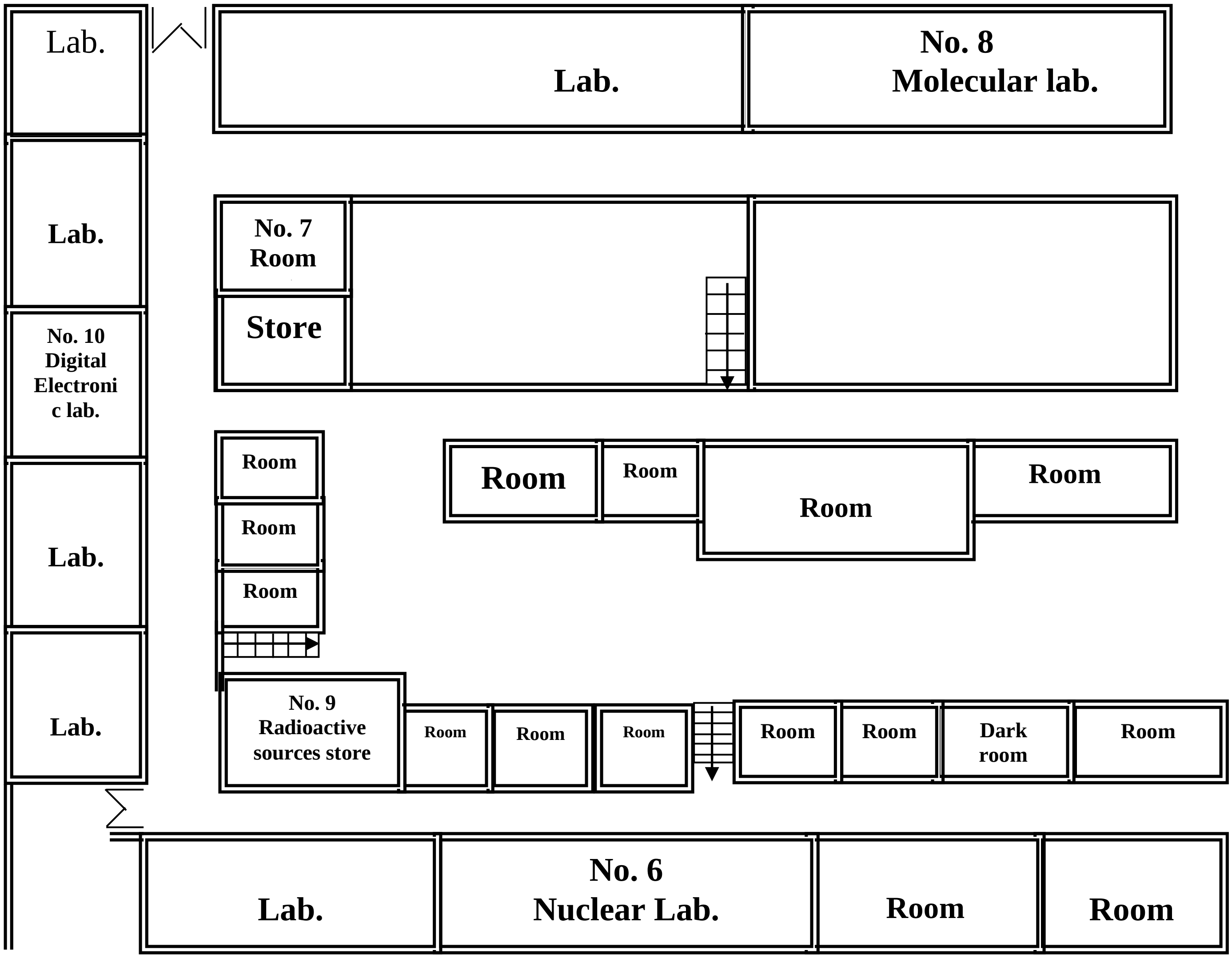
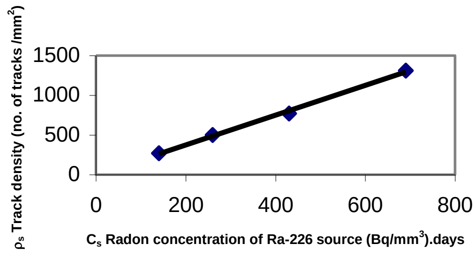


Fig (1) : Map of the ground story of department of physics in College Baghdad University.



Fig(2): Map of the first storey of department of physics in college of science of Baghdad university.



fig(3):Calibration curve of CR-39 detector

Table 1: Radon concentration in the ground and first storey of the buildings under study.

Sample no.	Place of mounting detector	Radon concentration in ground storey (Bq/m^3)	Average concentrations (Bq/m^3)
1	Room(1)	25.43 ± 13	40.1 ± 13.4
2	Room(2)	70.2 ± 24	
3	Room(3)	21.47 ± 10	
4	Optics lab.	46.25 ± 14	
5	Room(4)	37.16 ± 8	
Sample no.	**Place of mounting detector**	**Radon concentration in first storey(Bq/m^3)**	**Average concentrations (Bq/m^3)**
6	Nuclear lab.	21.47 ± 10	43.1 ± 13.2
7	Room(5)	46.25 ± 11	
8	Molecular lab.	23.94 ± 7	
9	Nuclear radiation sources store	87.53 ± 29	
10	Digital Electronic lab.	36.33 ± 9	

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قياس تراكيز الرادون ووليداته في بنايات من قسم الفيزياء في كلية العلوم في جامعة بغداد

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الملخص :

البحث الحالي يهدف إلى دراسة قياس وكشف مستوى الرادون داخل البنايات في قسم الفيزياء في كلية العلوم في جامعة بغداد.

أستخدمت كواشف الأثر النووي (CR-39) لقياس تركيز الرادون داخل الغرف ,وتضمنت خمسة مختبرات وخمس غرف مكاتب للاساتذة في الطابق الأرضي والطابق الأول في القسم .وجد إن معدل تركيز الرادون في الطابق الأول 13.2±43.1 بيكريل/ م^3 وفي الطابق الأرضي 40.1 ±13.4 بيكريل/ م^3 .إن أعلى مستوي لتركيز الرادون في الطابق الأول وجد في مخزن المصادر المشعة وكان 87.53±29 بيكريل/ م^3 بينما في الطابق الأرضي وجد في الغرفة(2) و كان70.2 ± 24 بيكريل/ م^3 ،وهذا يعود إلى وجود المصادر المشعة في بعض الأماكن المختارة في البنايات.