Measurement of Radiation Activity at Fallujah University in Anbar Governorate, Iraq

Ahmed H. Ali,1 Haitham T. Tafash,2 Ameel F. Al Shawi 2, Thaer M. Farhan2

1Department of Medical Physics, College of Applied Science, University of Fallujah, Iraq.
2College of Medicine, University of Fallujah, Iraq

1Corresponding author:  : dr.ahmedphysics@uofallujah.edu.iq

Abstract. In this work measured the exposure rates of background radiations in different locations of University of Fallujah, Iraq. Measurements the radiation exposure rate for the ionizing radiation (gamma rays, X-rays, Alpha and Beta particles) at the University of Fallujah and its colleges after the military operations in the period from 2013 to 2016. The scan was conducted by using the inspector XP for all colleges of the university. Our results were within the range allowed of the effective dose rate 1mSv/year and not any found the effect of radioactive sources.

1. Introduction

In radioactivity are atoms of the substance spontaneously emitting invisible light but energetic radiations and can penetrate materials that are opaque to visible light. The effects of these radiations can be risk to living cells but, when used in the right way, they have a wide range of advantageous applications, particularly in medicine [1].

Public health and radiation

In the air, water and soil can be found Natural radioactive sources and contribute to our exposure to ionizing radiation, also man-made sources output from mining and use of naturally radioactive materials in power generation, nuclear medicine, and consumer products, military and industrial applications. Children are in a dynamic state of growth and are more vulnerable to environmental risks than adults [2].

The cancer is the second major cause of death worldwide, and is responsible for an evaluated 9.6 million deaths in 2018. The cancer emerges from the conversion of normal cells into tumor cells in a multistage process that generally progresses from a pre-cancerous lesion to a malignant tumor. These changes are the result of the interaction between a person's genetic factors and 3 categories of external agents, including: physical carcinogens, such as ultraviolet rays and ionizing radiation. The total annual economic cost of cancer in 2010 was evaluated at approximately US$ 1.16 trillion [3]. A linear dose response relationship between tumor incidence like leukemia and radiation exposure [4].

Types of radiation

The radiation classify according to the effects it produces on matter, into non- ionizing and ionizing radiation. Non-ionizing radiation includes visible light, ultraviolet light, radiant heat, radio waves and microwaves. Ionizing radiation includes gamma rays, cosmic rays, X rays and the radiation from radioactive material [5]. Ionizing radiation causes neutral molecules or atoms to obtain either a negative or positive electrical charge. The types of ionizing radiation are alpha, beta, gamma, X, and neutron rays. Charged-particle radiation, such as alpha or beta rays, has a direct ionizing effect; whereas radiation without charge, such as gamma rays, X-rays and neutron rays have an indirect ionizing effect. These radiations first generate charged particles which then have the ionizing effect [6]. In figure 1 summarizes the types of radiation, each type from rays differs in its ability to penetrate various materials, such as paper, skin, and lead and water [7].

Radioactivity is a natural phenomenon and natural sources of radiation are features of the environment. Radiation [5] and radioactive material may also be of artificial origin and they have...
many beneficial applications, including uses in medicine, industry, agriculture and research as well as for nuclear power generation. The radiation risks to the environment and people that may arise from the use of radiation and radioactive material must be assessed and must be controlled by means of the application of standards of safety [8].

**Aim of the study**

Detection and Measurement the radiation exposure dose rate and research on the radioactive waste of the University of Fallujah due to a series of military operations on the city of Fallujah and the departure of its residents city for almost three years.

**Area of study**

Fallujah is a city in the Iraqi province of Al Anbar, located approximately 69 kilometers west of Baghdad on the Euphrates. Fallujah dates from Babylonian times. Within Iraq, it is known as the city of mosques for the more than two hundred mosques found in the city.

In 2014, Fallujah was appropriated by the Terrorist gangs of Iraq and suffered major population loss. In 23 May 2016, Iraqi forces announced the beginning of their try to retake Fallujah from Terrorist gangs. In 26 June 2016 the city was declared fully liberated by the Iraqi army. University of Fallujah is an Iraqi public educational institution. The University of Fallujah has already taken great strides towards academic accreditation and academic advancement. The radiation exposure was scanned for four different locations as shown Figure 2.

2. **Theory**

   **2.1. Radiation dose**

   Ionizing radiations pass through matter and transfer some or all of their energy to the material by exciting and ionizing direct the atoms of the material. The harm done by ionizing radiations depends both on the amount of material involved and the energy deposited. Ionizing radiation harm increases as the amount of energy deposited increases and decreases if it is spread throughout a greater amount of material. The effective dose can be thought of as the regular whole body dose which would have the same effect as the actual irregular dose. The effective dose is measured in units of sievert Sv or millisieverts mSv [1].

   Exposure radiation is defined for X rays and gamma in terms of the amount of charges particles they produce in air. The roentgen R is unit for exposure dose. It was originally defined as that amount of gamma or X radiation that produces in air 1 esu of charge of either sign per 0.001293 g of air. The charge particles concept in the definition of the roentgen includes both the ions produced directly by the incident photons as well as ions produced by all secondary electrons.

   The concept of exposure dose applies only to electromagnetic radiation; mass and the charge used in its definition, also in the definition of the roentgen, refer only to air [6].

   **2.2. Absorbed Dose**

   The definition of exposure and the roentgen provide a practical, measurable standard for electromagnetic radiation in air. Also additional concepts are needed to apply to other types of radiation and to other materials, particularly tissue live. The primary physical quantity used in dosimetry is the absorbed dose. It is defined as the energy absorbed per unit mass from any type of ionizing radiation in any material [6].

3. **Results and Discussion**

   The Inspector EXP is instrument used to detect low levels for exposure rate dose. It measures alpha rays, beta rays, gamma, rays and X rays. The Inspector EXP uses a Geiger-Mueller tube to detect exposure dose. It is generates a pulse of electrical current each time radiation passes through the tube and causes ionization. The Inspector EXP shows the counts in the mode you choose. The number of counts detected by the Inspector EXP varies from minute to minute due to the random nature of radioactivity [10]. Natural radiation that is called background radiation exists everywhere and varies from one site to another. The safety dose limit of 1 mSv per year (0.114 mR/hr) for a member of the public [11] as shown Table 1 [9, 12] where explain the effective dose for each organ in human according to the International Commission on Radiological Protection (ICRP) 1991.
The results were obtained using inspector EXP Digital Radiation Monitor (Cole-Parmer Scientific Experts, United States). In order to calibrate the survey meter, cesium-137 (\(^{137}\)Cs; 6.01 μCi) and cobalt-60 (\(^{60}\)Co, 0.23 μCi) sources were used in 2017. The total gamma radiation doses (mR h\(^{-1}\)) from soil and air were measured for 5 min with three readings per site 0.5 m above ground level. All measurement obtained using the inspector EXP for different locations and were compared with the safety dose. In Figure 3, radiation exposure rate in Presidency University of Fallujah and college of medicine was measured in air and the measurements in air were compared with the allowable exposure rate (AER), where the measurements rate showed approximate 0.007mR/hr (0.07mSv/hr) less than the allowable exposure rate 0.011mR/hr (1mSv/year) [11, 12] as shown in Figure 3 where denote P1 to University Presidency office, P2 University Presidency office, P3 offices the scientific assistant, P4 the administrative assistant offices and AER allowable exposure radiation.

The radiation exposure rate was measured in college of law and the measurements in air were less than the permissible limit for the allowable exposure rate 0.011mR/hr (1mSv/year) where denote L1 to administrative offices, L2 student club , L3 stores college, L4 gardens college and AER allowable exposure radiation as shown in Figure 4.

In Figure 5, radiation exposure rate in college of Veterinary Medicine was measured and the measurement in air were compared with the allowable exposure rate, where the measurements rate showed approximate 0.007mR/hr (0.07mSv/hr) less than the allowable exposure rate 0.011mR/hr (1mSv/year) except measurement laboratory was close allowable exposure rate except laboratory measurement was close to allowable exposure rate where denote V1 to administrative offices, V2 laboratories , V3 animal house, V4 gardens college and AER allowable exposure radiation as shown in Figure 5.

Finally, measured the radiation exposure rate at the college of Islamic Sciences and the measurement rate in air were 0.0075 mR/hr less than the permissible radiation exposure rate 0.011 mR/hr where denote S1 to administrative offices, S2 classrooms, S3 stores college, S4 gardens college and AER allowable exposure radiation as shown in Figure 6.

4. Conclusions
All colleges of the University of Fallujah have been scanned with Inspector EXP (USA-made) device to detect radioactive waste, as well as to measure radiation exposure. All the measurements we obtained were below the radiation safety exposure rate, according to the International Commission on Radiological Protection (ICRP) 1991/60.

References
[1] R.S.Lawson.1999. Introduction to Radioactivity.
[2] World health organization. 2018. (http://www.who.int/ceh/risks/cehradiation/en/) (accessed at Sept.
[3] World health organization. 2018. (http://www.who.int/news-room/fact-sheets/detail/cancer) (accessed at Sept.
[4] Gilbert ES. 2009. Ionizing Radiation and Cancer Risks: What Have We Learned From Epidemiology?. Int J Radiat Biol Jun; 85(6): 467–482.
[5] IAEA in Austria. 2004. Radition, Pepole and the enovermental IAEA/PI/A.75 / 04-00391.
[6] F. N. Flakus. 1981.Detecting and measuring ionizin g radiation - a short his- tory. IAEA Bulletin, vol. 23, no. 4,
[7] Introduction to Radiation. 2012. Canadian Nuclear Safety Commission (CNSC).
[8] Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, 2006. Vienna.
[9] H. Geiger & W. M‘uller, Das Elektronen-zahlrohr, Z. 1928. Technische Bemerkungen zum Elektronenz‘ahlrohr, Z. Physics 30 (1929).
[10] BasimAlmayahi, Hakeem J. I., Laith Sahe. 2018. The Impact of Low level Exposure to Radiation in Natural Ecosystems of Najaf and Dhi Qar Cities, Iraq. Iranian Journal of Medical Physics.
[11] U. Stahmer. 2015. Assessing Radiological Dose to Members of the Public and Workers During UFTP Transportation, Nuclear Waste Management Organization. 
[12] Winfried Koelzer. 2013. Glossary of Nuclear Terms.

Figure 1: Penetration abilities of different types of ionizing radiation [4].

Figure 2. The study area
Table 1. The effective rate doses of ionizing radiation [9]

| Tissue or Organ | rate doses (mSv per year) |
|-----------------|--------------------------|
| Whole Body      | 1                        |
| Lens of an eye  | 15                       |
| Skin            | 50                       |
| Hands & Feet    | 50                       |
| Gonads (testes and ovaries) | 0.3          |
| Red bone marrow, colon, lung, stomach | 0.3 |
| Effective dose for thymus, kidney, liver, adrenals, brain, spleen, breast, small intestine, thyroid, lung, muscle, oesophagus, pancreas, stomach, bladder, upper large intestine | 0.9 |
| Bone surface    | 1.8                      |
Figure 3. Radiation exposure rate of Presidency University of Fallujah

Figure 4. Radiation exposure rate in college of law
Figure 5. Radiation exposure rate of college of Veterinary Medicine

Figure 6: Radiation exposure rate of college of Islamic Sciences