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Assessment of Radiological Air Contamination for Selected Places at Al-Tuwaitha Nuclear Site during Winter and Spring

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Abstract:

This study presents the results of atmospheric particulates sampling using high volume air sampler for selected places at Al Tuwaitha nuclear site. The collected samples were analyzed for gross alpha /beta radioactivity using Ludlum model 3030 and measurement particles activity in Al Tuwaitha nuclear site and the surrounding areas for the period from 28/12/2016 to 13/4/2017.The measurement of activity concentrations ranged from (0.42±0.03 to 4.18±0.13) Bq/m^3 for alpha particles and from(0.93±0.06 to 9.21±0.26) Bq/m^{3}for beta particles. The activity concentration of nuclides inversely proportional with air temperature and wind speed while humidity is directly proportional with it. Highest value of activity concentration has been found at(Near nuclear and radiation safety directorate/ In the center of planning department/T9)while the lowest value has been found at (the right side of Nuclear application and researches directorate / building 61/T42). The results of this study show that the region has natural nuclides which are the daughters of the two decay series, namely the thorium and the uranium series. In both cases, it is a radioactive Radon isotope which can escape from the soil and ascend into the air.

Keywords: Air radioactivity concentration, Hi Vol3000, Ludlum model 3030, Tuwaitha Nuclear site.

Introduction:

Radiological contamination is the deposition of, or presence of radioactive substances on surfaces or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable. Such contamination presents a hazard because of the radioactive decay of the contaminants which emit harmful ionizing radiation (1).

Airborne radioactive particles may emit alpha, beta, gamma or neutron radiation, depending on the radioisotope present. The most dangerous of these is alpha particles, since they have high energy (>4 MeV for most alpha-emitting isotopes), leading to large localized radiation doses when inhaled or ingested, compared to betas, gammas and neutrons. For an airborne radioactivity detection system, it is the most important to be able to detect alpha particles and their energies, for radioisotope identification and risk evaluation (2). Atmospheric radioactivity is a matter of concern because the inhalation pathway is a major avenue for the entry of contaminants into the body.

We take in a larger mass of air than either food or water; the daily intakes by a reference person are only 1.9 kg of food and 2.2 kg of water, but 26 kg of air. Additionally, the area of interface in the lungs between the body's internal milieu and the outside atmosphere is 50–100 m^2. This large interface facilitates the transfer of noxious agents from the inhaled air into the body fluids. Therefore, if the quantity of radioactivity being handled is great enough to pose a significant inhalation hazard, in case of an accidental release of the radioactivity to the air (3).

In 2012, Clemenza *et al*. (4) studied the presence of air borne^{131}I, ^{134}Cs, and ^{137}Cs in air particulate due to accident of Fukushima reactors that have been detected and measured in the Low Radioactivity Laboratory operating in the Department of Environmental Sciences of the University of Milano-Bicocca. The sensitivity of the detecting apparatus is of 0.2 μBq/m^3 of air. Concentration and time distribution of these radionuclides were determined and some correlations with the original reactor releases were found. Radioactive contaminations ranging from a few to 400 μBq/m^3 for the ^{131}I and of a few tens of

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μBq/m^3 for the ^{137}Cs and ^{134}Cs have been detected(4).

In 2016, Mann *et al*.(5) showed that the radon and thoron at ground levels from Hisar district varied from 11 to 112 and 11 to 80 Bq m^{-3}, while for Fatehabad district from 5 to 24 and 59 to 105 Bq m^{-3}, respectively, in summer season. In winter season, indoor radon and thoron levels from Hisar district varied from 15 to 43 and 32 to 102 Bq m^{-3}, while for Fatehabad district from 18 to 31 and 11 to 80 Bq m^{-3}, respectively. The radon levels of 95 % locations lie well below the limit recommended by International Commission of Radiation Protection, 2011. The radon mass exhalation rate varied from 6 to 56 mBq kg^{-1} h^{-1}. The radon mass exhalation rates from the soil samples were lower than the worldwide average, i.e. 56 mBq kg^{-1} h^{-1} There exists a poor correlation between indoor radon and exhalation rates. More investigations of measurement of radionuclide contents from rock and stone of study area can improve the understanding (5).

In 2017, Hague and Ferdous (6) measured the radioactivity levels of naturally occurring radionuclides ^{226}Ra, ^{228}Ra and ^{40}K in eighteen water and eight air samples, collected from Savar Atomic Energy Center Bangladesh, were determined using gamma ray spectrometry system using a High Purity Germanium (HPGe) detector of 40% relative efficiency. The air samples had activity concentrations of ^{226}Ra, ^{228}Ra and ^{40}K varied from 1.49±0.00 to 613.56±0.01, 0.00±0.01 to 79.90±0.02 and from 19.70±0.05 to 206.82±0.00 mBq/m^3 respectively. They calculated average activity(6).

In 2017, Karkoush *et al*(7). measured the activity of airborne radon in the outdoor air environment near contaminated zones at two scrap yards at Al-Tuwaitha Nuclear Site and they recorded using RAD7 electronic radon detector. Outdoor air-borne radon activity ranged from 5.9 to 11.84 Bq/m^3 for the first zone and from below detection limit (<4 Bq/m^3) to 17.76 Bq/m^3 for second zone, which were less than the International Atomic Energy Agency (IAEA) prescribed action level (1000 Bq/m^3) for workplaces(7).

In 2016, Rejah determined the activity of natural radionuclides ^{226}Ra,^{232}Th and^{40}K by sodium iodide and assessed the annual effective dose in Dielac1,2 and Nactalia 1and 2for children. The activity was in the range of allowed levels globally(8).

In 2012, Al- Fifi *et al*.(9) measured the concentration of radon activities and exhalation rate from sand in collected sand samples from different locations in Jazan / Saudi Arabia. The mean exhalation rate was 18.72 mBq/m^2.d and radon concentration was 88.17 Bq/m^3(9).

Materials and Methods:

Areas of the Study

A number of sites in Iraq has some degree of radiological contamination and require decommissioning and remediation in order to ensure radiological safety. Many of these sites in Iraq are located at the nuclear research center at Al Tuwaitha. The International Atomic Energy Agency (IAEA) Board of Governors has approved a project to assist the Government of Iraq in the evaluation and decommissioning of former facilities that used radioactive materials (10). In this study, 50 locations were covered, many of them are inside Al Tuwaitha site and the other located outside are background areas as shown in Table (1) and Fig. 1.

Figure 1. Aerial photo for Al-Tuwaitha Nuclear Site shows locations of the measurement

Table 1. Sample Locations:

No.	sample Location	ID	GPS coordinates	
1	In the center of nuclear and radiation safety directorate	T1	N 33.20680	E 044.51370
2	Near library	T2	N33.20917	E044.51562
3	Near internal check point	T3	N33.20631	E044.51874
4	Near the center of nuclear application and researches directorate / building 61	T4	N33.20572	E044.50954
5	Outer check point/Dyala bridge	T5	N33.21860	E044.52541
6	In the right side of nuclear and radiation safety directorate	T6	N 33.20693	E044.51362
7	Al Rafidain bank -Dyala bridge	T7	N33.22712	E044.52054
8	Ishtar area near Al-Taachi primary school	T8	N33.19226	E044.53194
9	Near nuclear and radiation safety directorate/ In the center of planning department	T9	N33.20813	E044.51268
10	In the left side of nuclear and radiation safety directorate	T10	N33.20705	E044.51375
11	Near outer transport overland	T11	N33.20686	E044.51490
12	Behind nuclear and radiation safety directorate	T12	N 33.20699	E044.51308
13	Near agriculture & air condition storages	T13	N 33.20693	E044.51370
14	In the center of radiochemistry lab. building	T14	N 33.20589	E044.51554
15	In the right side of dispensary directorate	T15	N 33.20613	E044.51648
16	In front of Radioactive waste management directorate building	T16	N 33.20501	E044.51759
17	Near decommissioning building	T17	N 33.20693	E044.51370
18	In the center of nuclear application building	T18	N 33.20693	E044.51370
19	Near radioactive waste treatment system (RWTS)	T19	N 33.20144	E044.51816
20	In the right side of radiochemistry lab. building	T20	N 33.20142	E044.51584
21	Near radioactive waste silo	T21	N 33.20221	E044.51708
22	In the left side of radiochemistry lab. building	T22	N 33.20524	E044.51583
23	In the left side of nuclear application and researches directorate / building 61	T23	N33.20572	E044.50954
24	Near fuel fabrication facility	T24	N 33.20034	E044.51251
25	In front of restaurant	T25	N33.20509	E044.51770
26	Behind waste building RWTS &in front of radioactive waste storage	T26	N 33.20148	E044.51766
27	In front of Tammuz-2 reactor	T27	N 33.20341	E044.51746
28	In front of playground behind agricultural directorate	T28	N33.20760	E044.51640
29	Near Al Elwiat region	T29	N33.22059	E044.50797
30	Beside waste station /opposite side of old waste storage facility	T30	N 33.20196	E044.51830
31	Behind Central labs building	T31	N 33.20738	E044.51193
32	Near middle check point opposite refuge	T32	N 33.20808	E044.52279
33	Near park opposite Tammuz-2 reactor	T33	N33.20567	E044.51940
34	Near old production directorate	T34	N33.20575	E044.51516
35	Behind restaurant opposite Lama&Tammoz2reactor	T35	N33.20544	E044.51878
36	In the left side of dispensary directorate	T36	N33.20918	E044.51180
37	Near Monitory &internal audit directorate	T37	N 33.20733	E044.51752
38	Near 14 Tammuz reactor/IRT-5000	T38	N33.20467	E044.51547
39	Near extinguish center	T39	N33.20340	E044.52219
40	In front of second Decommissioning building	T40	N33.20674	E044.51859
41	In the left side of nuclear application building	T41	N33.20748	E044.51374
42	the right side of Nuclear application and researches directorate / building 61	T42	N 33.20576	E044.50926
43	Near transport building opposite production building	T43	N 33.20662	E044.51491
44	Near Salman Pack entrance check point opposite Al Salman bridge	T44	N 33.20746	E044.54850
45	Western Al-Tuwaitha – near Al Masudy school	T45	N 33.18438	E044.48763
46	On the top of earthen berms	T46	N 33.20883	E044.50990
47	Near nuclear application building/ in front of green houses	T47	N 33.20751	E044.51376
48	In front of nuclear and radiation safety directorate/ towards production building	T48	N 33.20672	E044.51367
49	Near nuclear and radiation safety directorate / In the left side of planning department	T49	N 33.20813	E044.51276
50	Near radioisotopes production facility	T50	N 33.20651	E044.51414

Collection of samples:

The method was based on the collection of aerosols, using high volume air sampling (High Volume 3000) sampler Particulate from Australia. This devise is used for outdoor sampling, with air flow rate (10-15) m^3/hr. The measurement was done by putting the devise 20 meter far from the building and within established periods of time, usually an hour. The total volume of air can be calculated from the flow –rate multiplied by the sampling time (11). The aspiration was done through an air filter, type No.37030, glass fiber with diameter 5.5 cm, with collection efficiency 99% (3).The samples was collected from many locations at Al-Tuwaitha Nuclear Site and the surrounding areas. The atmospheric parameters are: temperature range15 - 30 °C; pressure: 750.64-769.60mmHg; wind speed; wind direction and humidity are shown in Table (2).

Measurement of activity:

Almost all the air contaminants are alpha, beta, gamma emitters; in this study the measurements of air filters are performed by the measurement of alpha and beta particles using Ludlum 3030 alpha / beta sample counter from USA which have dual-channel counters designed for simultaneous alpha and beta sample measurement، and scintillation detector type ZnS(Ag) with a shielded chamber and chrome-plated brass sample tray that can accept a maximum sample size of 5.1 cm (2 inches) in diameter. The Ludlum 3030 is powered by main supply of 95-250 Vac. The instrument was calibrated daily (prior to use) using standard sources supplied by the manufacturer to be used that day، every Twenty-four hours QC must be done. This feature ensures that the instrument is tested daily and that measurements are valid (12).

Measurement of activity concentration in air:

The measurement of alpha and beta activity was made by the use of the Alpha-Beta counter Ludlum 3030, having the background counting rates 3cpm or less for alpha, and 50cpm or less for beta radiations. The method consists of the following: after the expiry of the aspiration time (1 hour), the filter is removed from the aspiration motor and put in Ludlum 3030 devise and counted for 1minute then repeat. The measurement was repeated 3 times. The average for the three values was estimated. The following equation was applied for estimating the alpha and beta activity concentration in air (13)؛

$$A = \frac{Activity\ net}{V \times E_f} \quad \dots (1)$$

where: A is radioactive concentrations (activity densities) expressed in units $Bq.m^{-3}$, V is the air total volume (m^3), E_f the filter efficiency=99% (4).The instrument subtracts the back ground automatically. One Becquerel (Bq) is equal to one disintegration per second.1 Becquerel (Bq) is equal to 60 DPM (14). $Activity_{net}$ $(Bq)=(DPM_{ins}-DPM_{B.G})/60$, where DPM is disintegration per minute, DPM_{ins} is instant disintegration per minute, $DPM_{B.G}$ is background disintegration per minute.

Results and Discussion:

In this study, the outdoor alpha and beta concentrations were measured in 50 locations at Al-Tuwaitha nuclear site and some surrounding locations in winter and spring. Table (2) shows the concentrations of alpha and beta in many locations at Al-Tuwaitha.

Table (3) shows the concentrations of alpha and beta in many locations out of Al-Tuwaitha and the effect of weather factors (which represents background levels) (15). The highest value of activity concentration is ($4.18\pm0.13 Bq/m^3$ for alpha and 9.21 ± 0.26 Bq/m^3 for beta) which has been found at (Near nuclear and radiation safety directorate/ In the center of planning department/T9) while the lowest value ($0.42\pm0.03 Bq/m^3$ for alpha and $0.93\pm0.06 Bq/m^3$ for beta) has been found at (the right side of Nuclear application and researches directorate / building 61/T42). The variation in the activity of alpha and beta particles are due to many reasons including: the air temperature, humidity, pressure, wind speed and rains.

To define the relation between different metrological parameters related to activity concentration, we evaluate the correlation factor (R). The value of (R) lay between (1,-1) , the maximum positive value (+1) refers to strong directly relation between any two parameters ,the minimum negative value (-1) refers to strong inversely relation , if the value of (R) approach to (0) from the left side, it means weak inversely relation, but if the value of (R) approach to (0) from the right side, it means weak directly relation, also if (R=0) that means no relation as shown in Table (4).

The alpha and beta concentration was lower in spring than in winter as shown in Table (2) because the temperature became higher and that caused atmospheric disturbance and then diluted and diffused the airborne radioactivity.

Alpha concentrations are always lower than beta concentrations as shown in Tables (2 and 3) because Alpha particle has small range and small penetration then investigating it became a very difficult in the laboratory.

Some sites out of Al-Tuwaitha were chosen as background (T5, T7, T8, T44 and T45) where the average alpha activity concentration was

(1.26±0.09) Bq/m^{3}for alpha and (2.79±0.20) Bq/m^3 for beta while the average measurement of alpha activity concentration was (1.84±0.11) Bq/m^3 for alpha and (4.07±0.24) Bq/m^{3}for beta at the studied areas which were considered within the background (less than twice the background level).

The alpha and beta radiations at Al-Tuwaitha site are from natural isotopes because of the fast disintegration for nuclides with time. This means that the nuclides have short half-life from natural decay series the thorium and the uranium series. As shown (In the left side of nuclear and radiation safety directorate T10) Fig. 2, (Near outer transport overland T11) Fig. 3, (Near agriculture and air condition storages T13) Fig. 4 and (In front of Radioactive waste management directorate building T16) Fig. 5 when the measurement is repeated after (30 minutes).Or (Near radioactive waste silo T21) Fig. 6, (In front of playground behind agricultural directorate T28) Fig. 7, (Beside waste station /opposite side of old waste storage facility T30) Fig. 8, (Near Al Elwiat region T29) Fig. 9, (In front of Tammuz-2 reactor T27) Fig. 10, (Behind waste building RWTS and in front of radioactive waste storage T26) Fig. 11, (Near radioactive waste treatment system(RWTS)T19) Fig. 12 and (In the right side of dispensary directorate T15) Fig. 13 when the measurement is repeated after (10minutes).

Table 2. Atmospheric parameters and the concentrations of alpha and beta in many locations at Al-Tuwaitha.

No.	ID	date	Starting Time	End time	Wind Speed (km/h)	Wind Direction	Temperature ^{0}C	Humidity %	Pressure mmHg	Alpha Activity concentration Bq/m^3	Beta Activity concentration Bq/m^3
1	T1	28/12/2016	09:40	10:40	10.8	NW	16.52	77	758.64	3.34±0.63	7.81±1.63
2	T2	2/1/2017	10:04	11:04	10.8	N	17.35	70	760.64	1.50±0.16	2.98±0.67
3	T3	5/1/2017	10:50	11:50	14.4	N	18.7	52	759.67	0.63±0.11	1.36±0.27
4	T4	8/1/2017	09:50	10:50	11	NW	18.5	73	765.5	2.84±0.18	6.30±0.29
5	T6	12/1/2017	09:50	10:50	14.4	NW	15.5	48	750.64	2.94±0.19	6.18±0.34
6	T9	19/1/2017	09:15	10:15	3.7	NW	15.5	79	763.93	4.18±0.13	9.21±0.26
7	T10	22/1/2017	9:30	10:30	14.4	NW	16.5	82	761.93	1.97±0.14	4.57±0.39
8	T11	24/1/2017	9:49	10:49	11	NW	16	83	765.15	2.63±0.31	5.76±0.30
9	T12	29/1/2017	09:10	10:10	14.4	W	16.4	82	763.15	1.97±0.08	4.68±0.07
10	T13	29/1/2017	10:35	11:35	18	NW	18.33	69	765.23	1.43±0.06	3.37±0.16
11	T14	31/1/2017	9:59	10:59	7.2	E	15 .00	43	758.64	3.05±0.08	6.69±0.10
12	T15	31/1/2017	11:25	12.25	14.4	calm	22.4	39	758.64	0.54±0.01	1.26±0.08
13	T16	1/2/2017	10.5	11.5	21.6	NW	18.57	56	761.43	1.52±0.10	3.39±0.19
14	T17	1/2/2017	11:20	12:20	25.2	NW	20.05	44	761.25	0.75±0.05	1.71±0.16
15	T18	5/2/2017	9:35	10:35	21.5	NW	29.4	53	765.23	3.00±0.08	6.02±0.13
16	T19	6/2/2017	9:55	10:55	10.8	N	15.4	38	765.23	2.54±0.04	5.61±0.15
17	T20	8/2/2017	9:12	10:12	10	NW	17.4	33	765.17	2.92±0.12	6.73±0.87
18	T21	13/2/2017	10:10	11:10	14.4	W	20	74	755.34	2.05±0.12	4.39±0.11
19	T22	13/2/2017	11:38	12:38	21.6	NW	22.37	67	755.34	1.37±0.10	3.04±0.06
20	T23	15/2/2017	10:10	11:10	21.6	SE	19.56	58	768.64	2.46±0.09	5.33±0.18
21	T24	16/2/2017	9:50	10:50	25	SW	26.35	63	765.27	2.31±0.20	4.65±0.26
22	T25	16/2/2017	11.10	12.10	11	SW	21.25	48	761.78	1.16±0.07	2.80±0.10
23	T26	19/2/2017	10:05	11:05	10.8	NW	17.25	37	769.6	1.84±0.11	4.21±0.12
24	T27	20/2/2017	10:20	11:20	14.4	NW	17.5	67	765.24	0.62±0.02	1.41±0.12
25	T28	21/2/2017	10:15	11:15	7.2	N	15.22	31	761.93	2.74±0.11	6.21±0.09
26	T29	26/2/2017	10:15	11:15	10.8	NW	22.25	41	764.24	2.65±0.02	5.71±0.08
27	T30	27/2/2017	10:15	11:15	10.8	W	23.13	36	761.93	2.40±0.18	5.49±0.16
28	T31	27/2/2017	11:35	12:35	7.2	W	23.5	31	761.93	1.04±0.07	2.58±0.14
29	T32	28/2/2017	9:45	10:45	3.7	W	19.4	27	763.87	2.58±0.20	5.36±0.26
30	T33	28/2/2017	11:2	12:2	7.2	S	19.5	21	762.92	1.74±0.04	3.98±0.22
31	T34	8/3/2017	10:03	11:03	10.8	NW	18	31	758.64	2.06±0.11	4.26±0.21
32	T35	7/3/2017	9:45	10:.45	22	NW	20	30	757.64	1.71±0.02	3.77±0.03
33	T36	7/3/2017	11:5	12:5	23	NW	22	62	757.64	1.54±0.04	3.47±0.12
34	T37	5/3/2017	10:55	11:55	23.5	N	24.45	72	760.45	0.66±0.05	1.69±0.09
35	T38	5/3/2017	9:40	10:40	18	N	24	41	759.61	1.44±0.02	3.23±0.18
36	T39	6/3/2017	9:40	10:40	18	NW	26	33	758.65	1.34±0.05	2.81±0.16
37	T40	6/3/2017	11:03	12:03	19	N	26.7	53	758.64	1.19±0.07	2.87±0.10
38	T41	12/3/2017	9:35	10:35	21	E	27	41	759.3	1.04±0.05	2.21±0.19
39	T42	12/3/2017	11:00	12:00	21.6	E	28	30	758.8	0.42±0.03	0.93±0.06
40	T43	13/3/2017	10:00	11:00	10.8	NW	25	52	754.34	1.55±0.05	3.41±0.18
41	T46	22/3/2017	09:45	10:45	7.2	E	25	65	758.64	1.66±0.12	3.54±0.18
42	T47	4/4/2017	09:42	10:42	21.6	N	26	49	763.8	1.14±0.15	2.48±0.46
43	T48	2/4/2017	09:37	10:37	7.2	N	25	65	758.64	1.43±0.18	3.44±0.17
44	T49	9/4/2017	10:18	11:18	10.8	NW	24	70	758.64	2.10±0.10	4.57±0.34
45	T50	13/4/2017	10:58	11:58	21.6	SE	30	23	755.34	0.63±0.09	1.47±0.17
									α AVR	1.84±0.11	
									βAVR	4.07±0.24	
									α MAX	4.18±0.13	
									β MAX	9.21±0.26	
									α MIN	0.42±0.03	
									β MIN	0.93±0.06	

Table 3. Atmospheric parameters and the concentrations of alpha and beta in many locations out of Al-Tuwaitha.

#	ID	date	Starting Time	End time	Wind Speed (km/h)	Wind Direction	Temperature	Humidity %	Pressure mmHg	Alpha Activity concentration Bq/m^3	Beta Activity concentration Bq/m^3
1	T5	8/1/2017	11:20	12:20	10.8	S	16.31	44	758.64	1.70±0.09	3.64±0.29
2	T7	16/1/2017	10:45	11:45	18	NW	17.50	67	765.23	1.38±0.08	3.35±0.32
3	T8	17/1/2017	9:47	10:47	14.4	NW	16.90	72	765.23	1.37±0.14	2.81±0.03
4	T44	14/3/2017	10:25	11:25	14.4	N	26.5	40	759.80	0.70±0.03	1.65±0.07
5	T45	15/3/2017	10:30	11:30	14.4	SW	26	53	758.64	1.15±0.09	2.51±0.27
	αAVR		1.26±0.09			αMAX		1.70±0.09		αMin	0.70±0.03
	βAVR		2.79±0.20			βMAX		3.64±0.29		βMin	1.65±0.07

Table 4. The behavior of different parameters.

Parameter 1	Parameter 2	proportional	R
Alpha Activity concentration	temperature	Weak inversely	-0.45
Alpha Activity concentration	Wind speed	Weak inversely	-0.45
Alpha Activity concentration	humidity	Weak directly	0.18
Beta Activity concentration	temperature	Weak inversely	-0.47
Beta Activity concentration	Wind speed	Weak inversely	-0.47
Beta Activity concentration	humidity	Weak directly	0.19

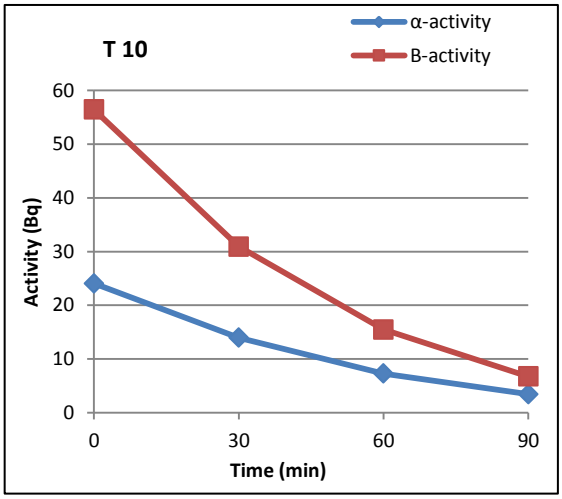

Figure 2.Fastdecay for nuclides with time after repeat the measurements each 30 minute

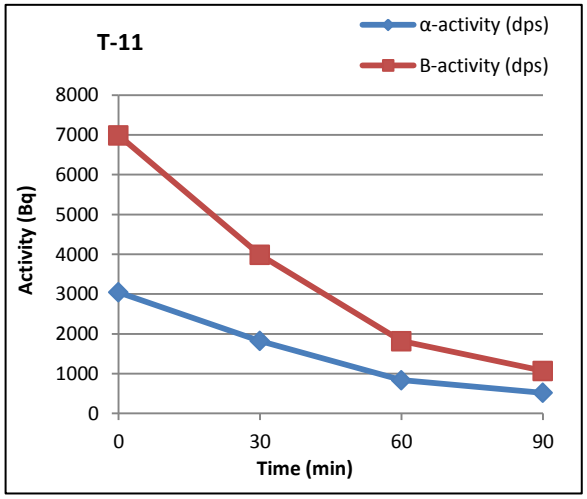

Figure 3.Fast decay for nuclides with time after repeat the measurements each 30 minute

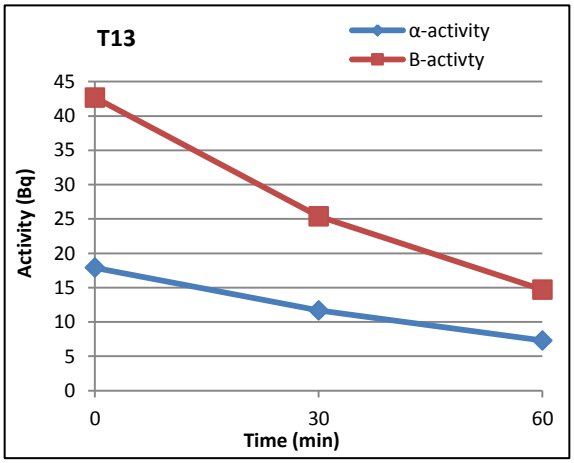

Figure 4. Fast decay for nuclides with time after repeat the measurements each 30

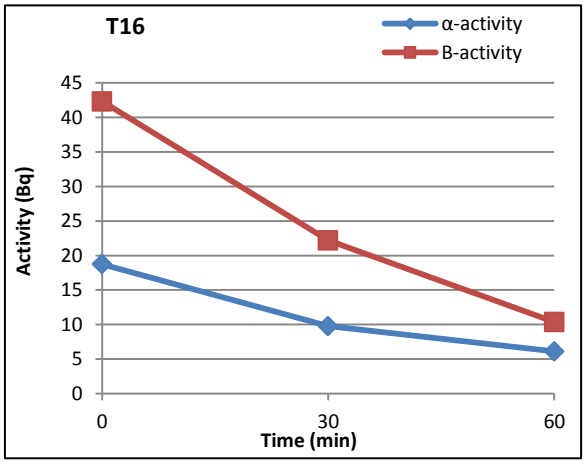

Figure 5. Fast decay for nuclides with time after repeat the measurement each 30 minute

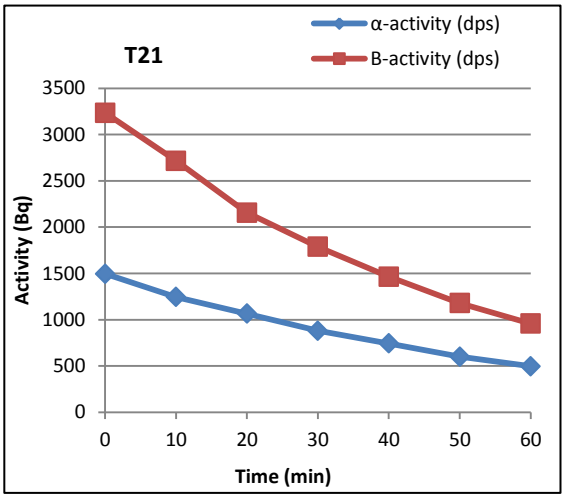

Figure 6.fast decay for nuclides with time after repeat the measurement each 10 minutes

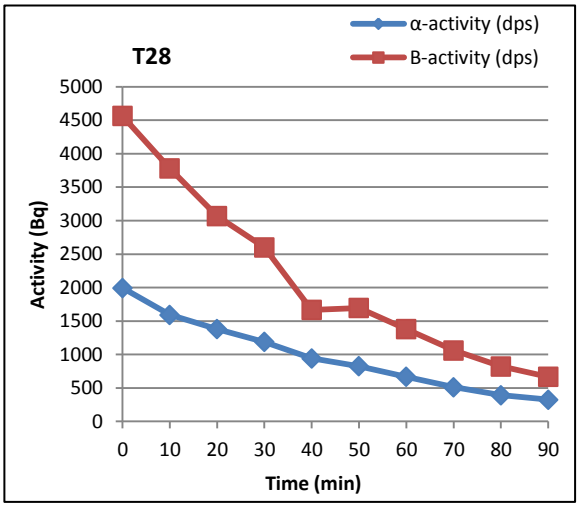

Figure 7.Fast decay for nuclides with time after repeat the measurement each 10 minutes.

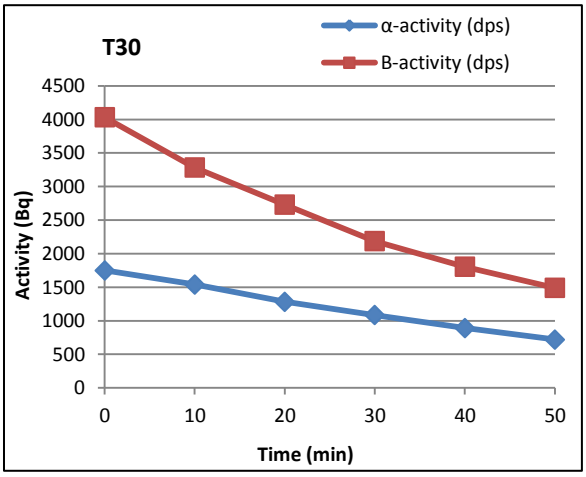

Figure 8.Fast decay for nuclides with time after repeat the measurement each 10 minutes.

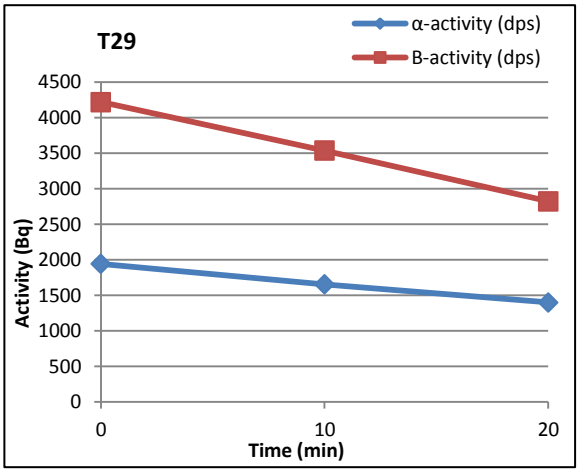

Figure 9.Fast decay for nuclides with time after repeat the measurement each 10 minutes.

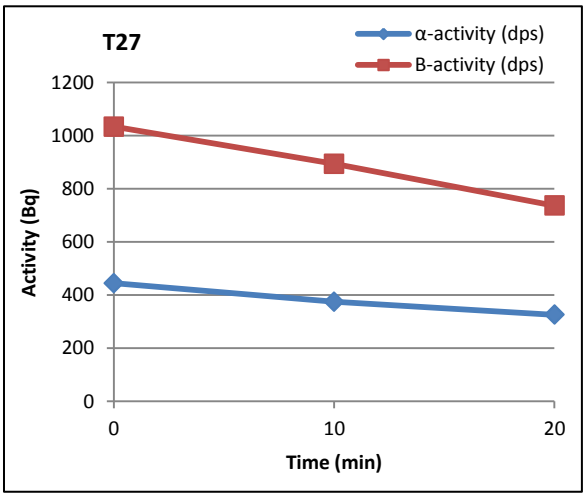

Figure 10.Fast decay for nuclides with time after repeat the measurement each 10 minutes

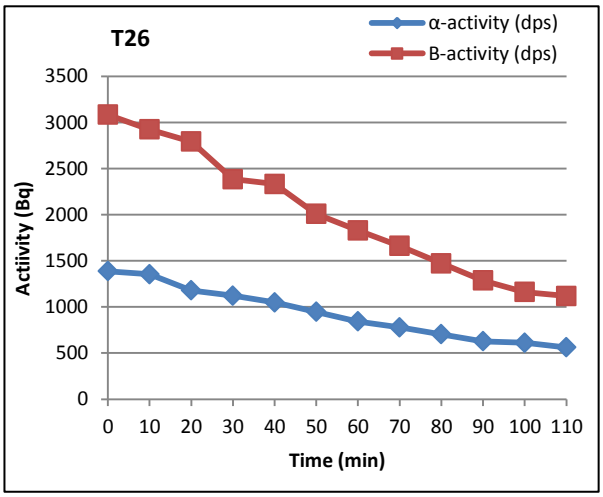

Figure 11.Fast decay for nuclides with time after repeat the measurement each 10 minutes.

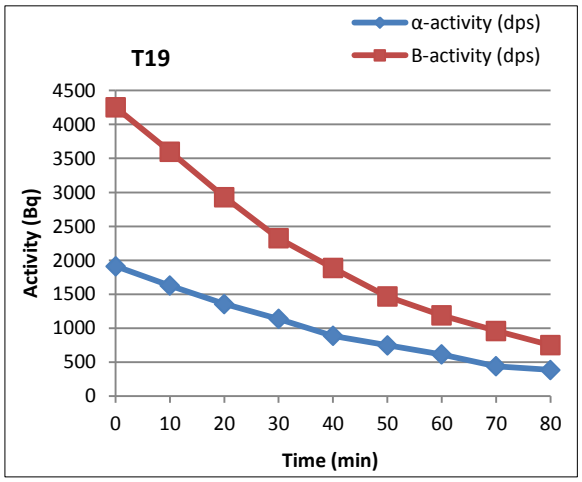

Figure 12.Fast decay for nuclides with time after repeat the measurement each 10 minutes

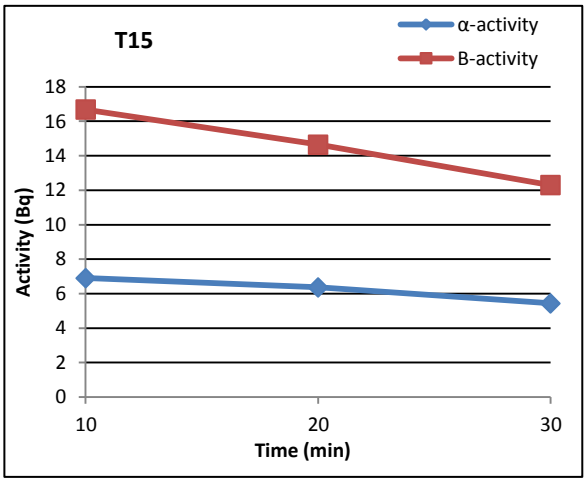

Figure 13.Fast decay for nuclides with time after repeat the measurement each 10 minutes

It was noticed that the activity concentration of nuclides decreased for same locations with existing of rain for sample T10. The activity concentration of T10 (1.97±0.14 Bq/m^3 for alpha and 4.57±0.39 $Bq/m^3$for beta) is less than the activity concentration of sample T1(3.34±0.63 Bq/m^3 for alpha and 7.81±1.63 $Bq/m^3$for beta) which is measured on a sunny day as shown in Table (2). This result can be found also for sample T9 where the activity concentration was (4.18±0.13$Bq/m^3$for alpha and 9.21±0.26 $Bq/m^3$for beta) for a sunny day and T49 where the activity concentration is (2.10±0.10$Bq/m^3$for alpha and 4.57±0.34 $Bq/m^3$for beta) for a rainy day. This behavior has revealed the effect of rain on airborne radionuclides. Since the Radon and the aerosols dissolve in the rain, the radioactivity will decrease on the rainy day.

Conflicts of Interest: None.

Conclusion:

This study involves evaluation of airborne radioactivity levels for selected places at Al-Tuwaitha Nuclear Site during winter and spring. In general, the estimated airborne activities in winter were slightly higher than in spring because of the effect of the meteorological parameters on the activity concentration of nuclides. The airborne activities were slightly higher than the mean background level, indicating that there is no abnormal airborne radiological contamination at the studied areas. Also, it is found that the weather conditions have a mean factor on the radioactivity concentration in air. It is inverse proportional with the rain, temperature and wind speed and direct proportional with the humidity.

References:

1. International Atomic Energy Agency. Terminology Used in Nuclear Safety and Radiation Protection. IAEA, 2007.
2. D H P. Human Protection and Performance Division Defense Science and Technology Organization: Defense Science and Technology Organization;2007.
3. Cember H, Jonsons D E. Human Protection and Performance Division Defense Science and Technology Organization: Defense Science and Technology Organization;2007.
4. Clemenza M O, Fiorini E, Previtali E, Sala E. Measurement of airborne 131I, 134Cs, and 137Cs nuclides dueto the Fukushima reactors accident in air particulate in Milan (Italy). J Environ Radioact. 2012;114:113-8.
5. Mann N, Kumar A, Kumar S, Chauhan R P. Measurement of indoor radon-thoron in air and exhalation from soil in the environment of Western Haryana India. Radiat Prot Dosim. 2016 April;171(2):248–53.
6. Haque M, Ferdous J, Natural Radionuclides Present in Air and Water near Nuclear Research Reactor Savar Bangladesh. Int J Sci Eng Res. 2017 may;8(5):978–83.
7. Karkoush H, Al-Tameemi N. Measurement of Outdoor RadonLevels and Assessment of Radiological Hazards for Radioactively Contaminate Scrap Yards at Al-Tuwaitha Nuclear Site. Thirteen. Arab Conf. Peac. Uses At. Energy.2016;7–8.
8. Rejah B. Specific activities of natural radionuclides and annual effective dose due to the intake of some types of children powdered milk available in Baghdad Markets. J Coll Sci women. 2017 sep;14(3):6219-24.
9. Alffi Z, El-Araby E, Elhaes H. Monitoring of Radon Concentrations in Jazan Beach Soil. J Appl Sci Res. 2012;8(2):823–27.
10. Al-Atia A, Helou A. Decommissioning of the Iraq Former Nuclear Complex. 11th International Conference on Environmental Remediation and Radioactive Waste Management: 2007:2–3.
11. Ferntree, G. HiVol-3000PUF/XAD Sampler manual: 2009.

12. Ludlum measurements Inc. measurements. LUDLUM MODEL 3030, 3030-2 &3030E Alpha-Beta Sample Counter manual:2012.
13. Al Banna, N. Fundamentals of protection from Ionizing radiation in Iraq:Iraqi Technical Institute authority;1990.
14. Reiman, R. Introduction to Radiation Physics, Quantities and Units:Duke University Medical Center Against Radiation; 2002.
15. Institute Iraqi Metrological. Metrological Records for Iraq: Iraqi Metrological Institute; 2017.

تقييم التلوث الاشعاعي للهواء لمناطق مختارة في موقع التويثة النووي خلال فصلي الشتاء والربيع

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الخلاصة:

تم في الدراسة الحالية تجميع الجسيمات العالقة في الهواء الجوي في موقع التويثة النووي والمناطق المحيطة بها على مرشحات هواء باستخدام جهاز سحب الهواء للفترة من 2016/12/28 لغاية 2017/4/13وتم قياس تركيز النشاط الاشعاعي للنويدات الباعثة لاشعة الفا وبيتا باستخدام جهاز لودلم 3030 وقد تراوحت قيمة النشاط الاشعاعي لأشعة الفا من (0.03±0.42الى0.13±4.18) بكريل لكل متر مكعب اما جسيمات بيتا فقد تراوح تركيز النشاط الاشعاعي لها من (0.06±0.93الى0.26±9.21) بكريل لكل متر مكعب .حيث ان هذه التراكيز تتناسب عكسياً مع درجة الحرارة وسرعة الريح وطردياً مع الرطوبة النسبية. وان اعلى تركيز وجد قرب (مديرية السلامة الاشعاعية والنووية – مركز قسم التخطيط النموذج T9) بينما اقل تركيز وجد قرب (دائرة البحوث والتطبيقات النووية- المبنى 61 النموذج T42) وقد تبين من خلال هذه الدراسة ان النويدات المشعة هي طبيعية ناتجة من سلاسل انحلال اليورانيوم والثوريوم والتي تنتج ضمن سلاسلها الرادون المشع الموجود في التربة والذي ينتشر الى الهواء الجوي.

الكلمات المفتاحية : تركيز النشاط الاشعاعي للهواء , جهاز سحب الهواءHi Vol3000 ،جهاز لودلم 3030،موقع التويثة النووي .