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ESTIMATION OF RADIATION DOSE IN SAKKARA AREA

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1. Introduction

One of the main tasks of the national radiation safety programme is the estimation of radiation source term wherever it is [2]. Potential radiation hazard may exist not only in nuclear power plants or uranium mining industry but also in unexpected areas that seems safe for the public. Sakkara area is a good example for that.

Our aim as radiation safety inspectors is to estimate the potential hazard and propose the suitable corrective actions taking into consideration the social, technical and economical factors.

Radon levels seemed relatively high in some deeply seated caves in various places in Egypt [3]. This has been attributed clearly to the U and Th content in the rocks lining the burial places that are situated deep in the ground. This showed clearly the importance of initiating a research plan to estimate the potential radiation hazards more systematically.

The engineering parameters as well as the working conditions for the workers and visiting conditions for the public are taken into consideration for the precise proposal of corrective actions.

2. Experimental

A systematic radioactivity measurement programme was conducted. This included the following :

A) Measurement of external β and γ exposure levels in mR/h is performed by using portable β and γ Eberline survey meter model L.B. 1200, which has calibrated using standard Cesium - 137 gamma source. Direct reading were obtained in mR/h.

B) To monitor the levels of radon and its daughters four tombs were selected. These measured tombs cover Sakkara area. An alpha scintillation cell (Lucas cell) of 160 ml volume coated with silver activated zinc sulphide phosphor was used. Air was passed through high efficiency filter paper (millipore) before reaching the cell to trap radon daughters.

Sampling continued for 5 min with a flow rate during sampling of 10 1/min . Scintillations from Lucas cell were counted using a photomultiplier tube in a light - tight enclosure and a counting system made by EDA of Canada. Filter papers were counted using the same counting system by placing the filter paper on a scintillation tray coated with the same material as the Lucas cell. The concentration of radon decay products in units of working level were evaluated by the Rolle method [1], [4]:

$$WL = \frac{R}{EVTF}$$

where : R = recorded count rate in count/min, E = counting efficiency (0.25), V = volumetric sampling rate in 1/m, T = sampling time in min, F = conversion factor, may be approximated by 212 for sampling periods from 1 to 20 min [4]. To estimate radon concentration all counts took place 3 h after the end of sampling for equilibrium to be reached between radon and its daughters. The concentration of radon gas is calculated by the following formula:

$$C_{Rn} = 1.612 \cdot R$$

where R is the recorded count / min, and 1.612 is the cell factor.

C) The effective dose equivalent is estimated using the relation 1 WL = 62.5 μSv/h. This dose is considered as a result of the exposure to β, γ and radon [5] .

D) Annual dose for the workers was evaluated considering the average time spent by the workers in certain location and the number of working days per year.

3. Results and discussion

The levels of β, γ radon decay product concentration, effective dose equivalent and annual dose for the workers for Sakkara area are shown in Table 1.

Table 1. A summary of exposure rates, effective dose, radon daughter concentrations and annual dose in Sakkara area

LOCATION	POINT OF STUDY	β AND γ LEVEL mR/h	RADON DAUGHTERS CONC.WL x 10^{-3}	EFFECTIVE DOSE EQUIVALENT μSv/h	ANNUAL DOSE FOR THE WORKERS mSv/y
MERIROKA TOMB	1	0.018	3.88	0.4225	0.440
	2	0.02	10.5	0.8563	0.893
	3	0.01	5.91	0.4694	0.489
	4	0.02	5.28	0.5300	0.553
	5	-	3.47	0.2169	0.226
TE TOMB	1	0.02	0.805	0.2503	0.2610
	2	0.01	1.045	0.1653	0.1724
	3	0.01	2.016	0.2256	0.2353
	4	0.02	1.045	0.2653	0.2767
	5	0.02	4.180	0.4613	0.4810
	6	0.02	4.180	0.4613	0.4810
ANKH MAHOR TOMB	1	0.02	6.918	0.6324	0.6595
	2	0.02	6.792	0.6245	0.6513
	3	0.02	4.940	0.5088	0.5305
	4	0.02	6.175	0.3859	0.4025
	5	0.02	5.887	0.5679	0.5923
SERAPUM TOMB	1	0.03	248.3	15.8187	16.497
	2	0.02	198.5	12.6062	13.146
	3	0.02	205.2	13.0250	13.583
	4	0.05	103.5	6.9687	7.267
	5	0.02	88.01	5.7056	5.950
	6	0.02	128.9	8.2563	8.610
	7	0.02	60.6	3.9875	4.158

It is clear from the reported values that there is no considerable radiation risk for the workers in the Sakkara area. The visitors as well are not liable to any radiation risk.

It is clear from Table 1 that the β and γ levels in Meriroka tomb, TE tomb, Ankh Mahor tomb and Serapium tomb are within the range 0.01 - 0.05 mR/h which is also within the natural background level and we notice that the Serapium tomb has the highest levels in investigated tombs.

With respect to radon daughters levels, we notice that only point of no.1 in Serapium tomb shows higher value (0.248 WL) than EPA recommended concentration for the public (0.02 WL). This point is very deep and it has bad ventilation. On the other hand the Meriroka, TE and Ankh Mahor tombs have very low radon daughters levels which ranged from 0.0007 to 0.01 WL. In fact there exists opening in the Meriroka, TE and Ankh Mahor tombs which provide continuous ventilation all the time. This shows that efficient natural ventilation is the most important factor to decrease the radon gas concentration.

Table 1 also contain the values for effective dose and annual dose for the workers, we notice that the Serapium tomb has maximum value of annual dose for the workers (16.49 mSv/Y) this value is lower than the ICRP recommended value for the workers (20 mSv/Y).

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