Calculation of Of Skin Absorbed Dose For The Staff And Students From External Gamma Ray Source In Nuclear Physics Lab

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Abstract

The aim of this project is to determine the amount of the dose absorbed by skin of the staff and students while they are working in nuclear physics lab. and to determine whether they are in safe side or not .

The parameters that which are studied in this project are the exposure time ,the distance from radioactive source and the activity of radioactive gamma ray source ,where two radioactive sources are involved in this study are CO^{60} (1.25 Mev) and Cs^{137} (0.266 Mev) .This project show that all of the studied parameters have significant effect on the skin absorbed dose whether it's in the positive or negative side.

Key words: Skin Absorbed Dose , External Gamma Ray , Nuclear Physics

حساب جرعة الجلد الممتصة للكادر التعليمي و الطلبة من مصدرخارجي باعث لاشعة كاما في مختبر الفيزياء النووية

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الخلاصة

الهدف من هذا البحث هو لتحديد كمية الجرعة الممتصة من قبل جلد الكادر التعليمي والطلبة إثناء فترة تواجدهم في مختبر الفيزياء النووية ولتحديد ما إذا كانوا (الكادر+ألطلبه) في الجانب الأمين أو لا (من ناحية خطر الإشعاع).

العوامل المدروسة في هذا البحث هي زمن التعرض ،المسافة عن المصدر المشع و النشاط الإشعاعي لمصدر باعث لأشعة كاما .في هذا البحث تم اخذ عنصرين مشعين هما (Co^{60} 1.25 Mev,) و(Cs^{137}, 0.266 Mev)).وضح البحث بان كل العوامل المدروسة لها تأثير واضح على جرعة الجلد سواء كانت في الجانب الايجابي أو السلبي.

كلمات مفتاحية: جرعة الجلد الممتصة ، أشعة كاما ، لاشعة كام

1.Introduction

Scientists have studied the effects of radiation for more than 100 years, and they know a great deal about how to detect, monitor and control even the smallest amounts. In fact, more is known about the health effects of radiation than about most other physical or chemical agents[1].

The goal of any radiation safety program is to reduce exposure, whether internal or external, to a minimum. The external exposure reduction and control measures available are of primary importance[2] .

In order to be able to protect people from ionizing radiation ,it is obviouslynecessary to measure the radiation to which they may be exposed , and so quantity Exposure.

Health effects of radiation exposure start with the deposition of radiation energy in cells, tissues and organs. When radiation passes through matter, it deposits energy in the material concerned.[3]

The energy present in ionizing radiation eventually appears as a heat if it is absorbed in tissues .

When an ionizing radiation is absorbed , may cause damage ,but the more likely method of damage is to sensitive target within biological structure of molecule .[4]

Quantities and units not restricted to the absorption of photons in air are obviously required. When substance other than air is put into photons beam it will be exposed to same energy fluence that passed through the air volume .Generally mass energy transfer coefficient of the new material will not be equal to that of air .Mass absorption coefficient are a function of atomic number and photon energy .The energy deposited in mass Δm of new material will be :

$$\Delta E = \psi\,(\mu en/\rho)m.\ \Delta m$$

Where ψ energy fluence , (μen/ρ)m is mass absorption coefficient .

A quantity known as absorbed dose , or more simply dose , can be defined in term of energy imparted by ionizing radiation to mass element (Δm)

$$D = \Delta E/\ \Delta M$$

The unit of dose is the rad where

1 rad = 0.01 J/kg (Gy) = 100 erg /g [3] .

Three main factors determine the radiation-induced damage that might be caused to living tissue, the number of radioactive nuclei that are present, the rate at which they give off energy, and the effectiveness of energy transfer to the host medium, i.e., how the radiation interacts with the tissue.[5]

Gamma radiation is extremely penetrating and can pass through most materials, being significantly attenuated only by thick slabs of dense materials, such as lead.[3].

2.Method of calculation:

Two radioactive sources were used in this study are (Cs^{137}) which emits gamma ray photons of(0.662 Mev)with the activity of(0.0112 μCi) and (Co^{60})which emits two photons (1.173 & 1.333 Mev) with activity of (0.2771 μCi) .The two sources that used in this study of disk shape of 2 cm diameter.

The radiation Exposure can be obtained using equation(1):

$$\text{where } \dot{X} = \Gamma \frac{A}{D^2} \quad \text{.................(1)}$$

$\dot{X}$: Exposure rate .

Γ : Specific gamma ray constant

A : Activity of the radioactive source.

D : The distance from the radioactive source..

The radiation dose in air can be obtained using the following conversion factor(2)[6]

1 Roentgen = 8.7 mGy……(2)

Absorbed dose can be calculated in different material by using the equation (3)

$$D_{Mediuem} = D_{Air} \frac{\mu_m(Medium)}{\mu_m(Air)} \quad \text{............(3)}$$

where : μ_m: the mass absorption coefficient which is equal:

$$\mu_m = \frac{\mu}{\rho} \quad \text{................(4)}$$

μ: the linear absorbed coefficient , ρ: density of material.[7]

3.Results:

1.The exposure rate values in unit of roentgen per hour relative to the distances from both radioactive source (Cs^{137}) andCo^{60}) are shown in tables (1).

2.The exposure values for three periods of time(1,2 and 3hours) relative to the distance from radioactive source (Cs^{137})in unit of roentgen are shown in table (2).

3. The exposure values for three periods of time (1,2 and 3hours) relative to the distance from radioactive source (Co^{60})in unit of roentgen are shown in table(3)

4.The air dose in (mGy) for three periods of time(1,2 and 3hours) relative to the distance from radioactive source(Cs^{137}) are shown in table (4)

5. The air dose in (mGy) for three periods of time(1,2 and 3hours) relative to the distance from radioactive source(Co^{60}) are shown in table(5)

6. The skin dose in (mGy) for three periods of time(1,2 and 3hours) relative to the distance from radioactive source(Cs^{137}) are shown in table(6)

7. The skin dose in (mGy) for three periods of time(1,2 and 3hours) relative to the distance from radioactive source(Co^{60}) are shown in table(7)

8.The relationship between the exposure rate and the distance from the radioactive source for both (Cs^{137}andCo^{60}) are shown in figure (1)(2), figure (3) and (4) show the exposure for(1,2and 3 hours)versus the distance from both radioactive source(Cs^{137}andCo^{60}).

9.Figures (5) and (6) show air dose in three periods of time (1,2 and 3 hours) versus the distance from radioactive sources (Cs^{137}andCo^{60}).

10.Skin dose for three periods of time versus the distance from radioactive Source are shown in figures (7) and (8).

Table1: Show the values of the exposure rate relative to the distance from radioactive sources ($Cs^{137}$and Co^{60}).

The Radioactive Source	Distance (cm)	Exposure Rate (Roentgen/h)
Cs-137	10	0.000000373
	20	0.000000093
	30	0.000000041
	40	0.000000023
	50	0.000000014
	60	0.00000001
	70	0.000000007
	80	0.000000005
	90	0.000000004
	100	0.00000000004
Co-60	10	0.0000357
	20	0.00000893
	30	0.00000397
	40	0.00000223
	50	0.00000142
	60	0.000000992
	70	0.000000729
	80	0.000000558
	90	0.000000441
	100	0.000000357

Table2: Showthe exposure values in (roentgen) for three periods of time relative to the distance from radioactive source(Cs^{137}).

	Distance/cm	Exposure In one hour	Exposure In 2 hours	Exposure In 3 hours
Cs-137	10	0.000000373	0.000000746	0.000001119
	20	0.000000093	0.000000186	0.000000279
	30	0.000000041	0.000000082	0.000000123
	40	0.000000023	0.000000046	0.000000069
	50	0.000000014	0.000000028	0.000000042
	60	0.00000001	0.00000002	0.00000003
	70	0.000000007	0.000000014	0.000000021
	80	0.000000005	0.00000001	0.000000015
	90	0.000000004	0.000000008	0.000000012
	100	0.00000000004	0.00000000008	0.000000000012

Table3: Show the exposure values in (roentgen) for three periods of time relative to the distance from radioactive source(Co^{60}).

	Distance/cm	Exposure In one hour	Exposure In 2 hours	Exposure In 3 hours
Co-60	10	0.0000357	0.0000714	0.0001071
	20	0.00000893	0.00001786	0.00002679
	30	0.00000397	0.00000794	0.00001191
	40	0.00000223	0.00000446	0.00000669
	50	0.00000142	0.00000284	0.00000426
	60	0.000000992	0.000001984	0.000002976
	70	0.000000729	0.000001458	0.000002187
	80	0.000000558	0.000001116	0.000001674
	90	0.000000441	0.000000882	0.000001323
	100	0.000000357	0.000000714	0.000002142

Table4: Show the values of dose in air(mGy) in three periods of time relative to the distance from radioactive source(Cs^{137}).

	Distance /cm	air Dose In one hour(m Gy)	air Dose In 2 hour(m Gy)	air Dose In 3 hour(m Gy)
Cs-137	10	0.0000032451	0.0000064902	0.0000097353
	20	0.0000008091	0.0000016182	0.0000024273
	30	0.0000003567	0.0000007134	0.0000010701
	40	0.0000002001	0.0000004002	0.0000006003
	50	0.0000001218	0.0000002436	0.0000003654
	60	0.000000087	0.000000174	0.000000261
	70	0.0000000609	0.0000001218	0.0000001827
	80	0.0000000435	0.000000087	0.0000001305
	90	0.0000000348	0.0000000696	0.0000001044
	100	0.00000000034	0.000000000696	0.0000000001044

Table5:Show the values of dose in air(mGy) in three periods of time relative to the distance from radioactive source(Co^{60}) .

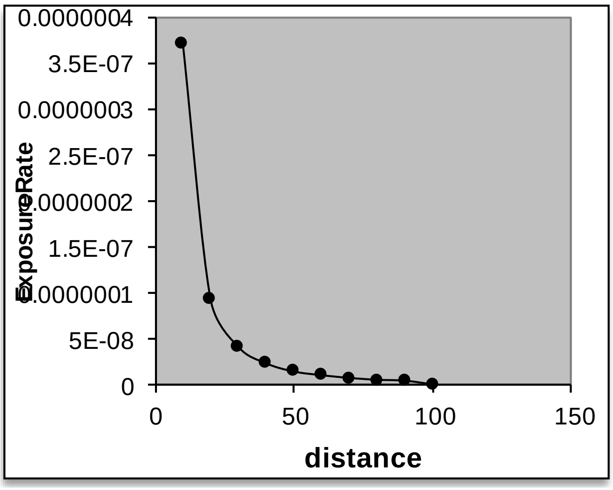
	Distance /cm	Skin Dose In one hour(m Gy)	Skin Dose In 2 hour(m Gy)	Skin Dose In 3 hour(m Gy)
Co-60	10	0.00034198	0.00068396	0.00102594
	20	0.000085544	0.000171088	0.000256632
	30	0.00003803	0.00007606	0.00011409
	40	0.000021362	0.000042724	0.000064086
	50	0.000013602	0.000027204	0.000040806
	60	0.0000095028	0.0000190056	0.0000285084
	70	0.0000069834	0.0000139668	0.0000209502
	80	0.0000053453	0.0000106906	0.0000160359
	90	0.0000042245	0.000008449	0.0000126735
	100	0.0000034198	0.0000068396	0.0000102594

Table6: Show the values of skin absorbed(mGy) in three periods of time relative to the distance from radioactive source(Cs^{137}).

	Distance /cm	Skin Dose In one hour(m Gy)	Skin Dose In 2 hour(m Gy)	Skin Dose In 3 hour(m Gy)
Cs-137	10	0.00000357	0.00000714	0.00001071
	20	0.00000089	0.00000178	0.00000267
	30	0.000000392	0.000000784	0.000001176
	40	0.00000022	0.00000044	0.00000066
	50	0.000000134	0.000000268	0.000000402
	60	0.0000000957	0.0000001914	0.0000002871
	70	0.000000067	0.000000134	0.000000201
	80	0.000000047	0.000000094	0.000000141
	90	0.000000038	0.000000076	0.000000114
	100	0.0000000000383	0.0000000000766	0.0000000001149

Table7: Show the values of skin absorbed(mGy) in three periods of time relative to the distance from radioactive source(Co^{60})

	Distance /cm	Air Dose In one hour(m Gy)	Air Dose In 2 hours(m Gy)	Air Dose In 3 hours(m Gy)
Co-60	10	0.00031059	0.00062118	0.00093177
	20	0.000077691	0.000155382	0.000233073
	30	0.000034539	0.000069078	0.000103617
	40	0.000019401	0.000038802	0.000058203
	50	0.000012354	0.000024708	0.000037062
	60	0.0000086304	0.0000172608	0.0000258912
	70	0.0000063423	0.0000126846	0.0000190269
	80	0.0000048546	0.0000097092	0.0000145638
	90	0.0000038367	0.0000076734	0.0000115101
	100	0.0000031059	0.0000062118	0.0000093177



.Fig.1: Show the exposure rate in unit of (R/hr) versus the distance (cm) from the radioactive source (Cs^{137}).

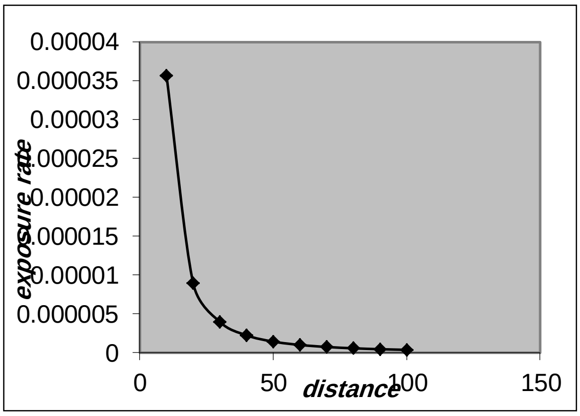


Fig.2: Show the exposure rate in unit of (R/hr) versus the distance (cm) from the radioactive source (Co^{60}).

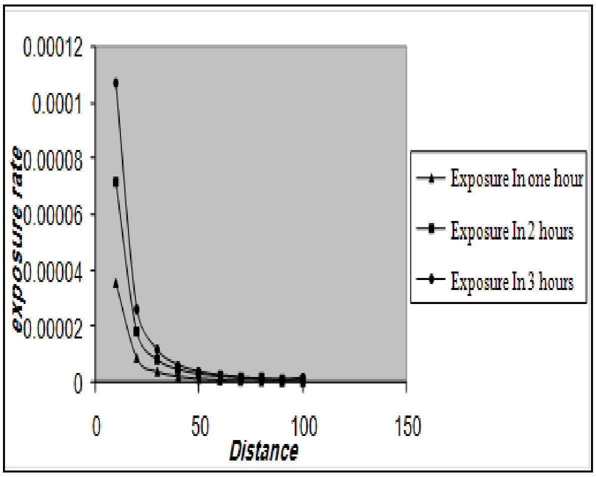


Fig3: Show the exposure(R) for three periods of time relative to the distance from radioactive source(Cs^{137}).

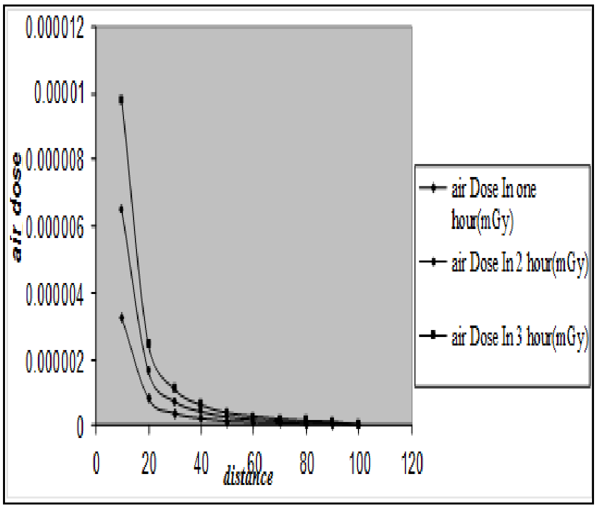


Fig.4: Show the exposure(R) for three periods of time relative to the distance from radioactive source (Co^{60}).

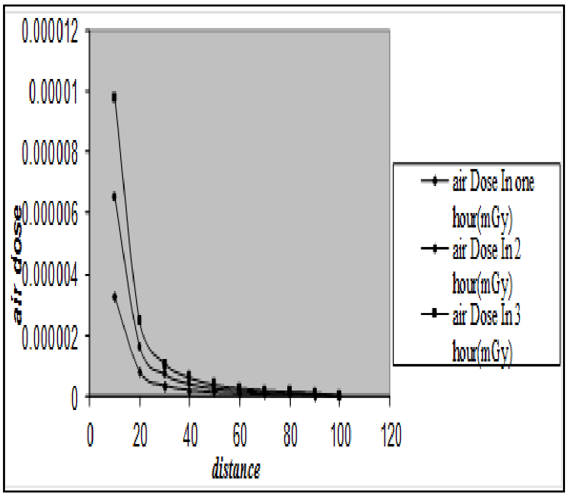


Fig.5: Show the air dose in (mGy) for three periods of time relative to the distance from the radioactive source(Cs^{137}).

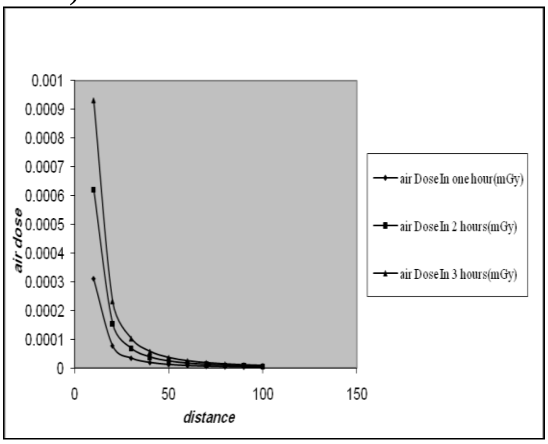


Fig.6: Show the air dose in (mGy) for three periods of time relative to the distance from the radioactive source(Co^{60}).

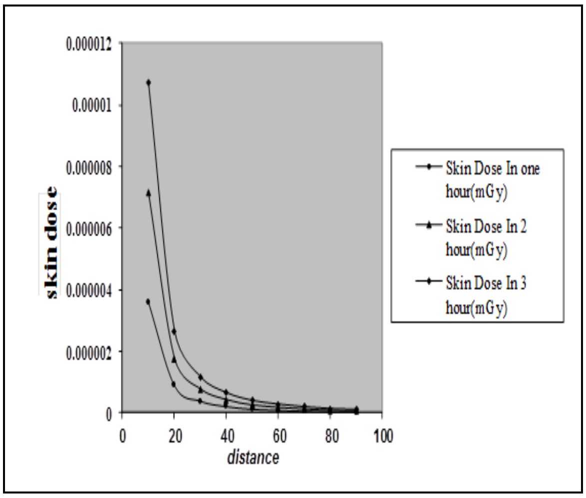


Fig.7: Show the skin dose in (mGy) for three periods of time relative to the distance from the radioactive source (Cs^{137}).

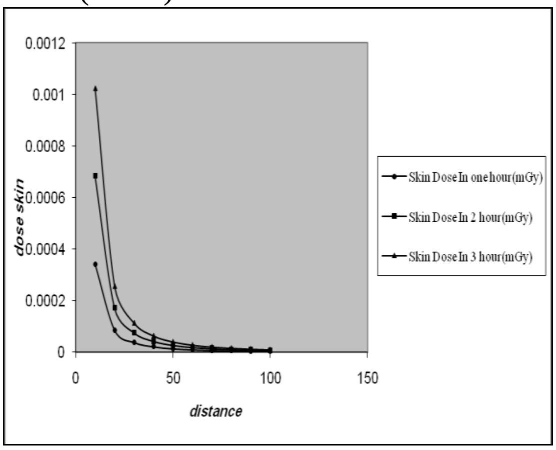


Fig.8: Show the skin dose in (mGy) for three periods of time relative to the distance from the radioactive source(Co^{60}).

3.Discussion:

The External Radiation Dose Calculationdetermines the radiation dose from a shielded gamma source. The source can be a point source, or a cylindrical volume source with an evenly distributed concentration of radionuclides[8]

The results of this project show significantly the effect of the inverse square law on the both the exposure and the absorbed dose , so as the distance between the source and the persons increase the exposure and the dose increase proportionally and vice versa ,this parameter was studied by [9] as he was interested in the distance between the patient who are up taking radiopharmaceutical drug and considering the patient as portable radiation source .

Other parameters was time of the exposure that which clarify that as the time of exposure increase the radiation dose increase significantly and this come in agreement

With [10].

Regarding the activity of the radiation source we found that the activity has significant effect on the radiation absorbed dose , so as the activity increase the exposure and dose increase so , where in this project despite of the high energy of Co-60 (average 1.25 Mev ,1.09μci) ,but the absorbed dose from Cs-137 was higher than Co-6 we think that the reason belong to the higher activity of Cs^{137}(123.29, 0.333Mev).

Many of the projects were dealing with the calculation and measurement of skin absorbed for the persons [11] and for patient [12] ,but by the x-ray .

Finally the highest absorbed dose that calculated by this project was in the safe side for the staff and students as the dose threshold of 2 Gy for deterministic effects was not approached, [13].

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