

Evaluation of the Levels of Radiation Emission from Elecrtic Light Sources

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Abstract
In this paper, the evaluation of the levels of radiation emission from electric light bulbs were carried out, using a Gamma Scout portable (GS_{20} model). At varied distances from 2 to 10cm with 7 energy saver bulbs and 4 incandescent bulbs were used. The readings for window 1, window 2 and windows 3 were obtained in µSv/h and pulse counts. The results of the measurement and analysis carried out revealed that, there are possible x-ray and UV radiation emission from the electric light bulbs and at a distance of 2cm. The emission was highest for the Compact fluorescent lamps which ranged from 0.71 µSv/h to 3.22 µSv/h for window 1, 0.67µSv/h to 2.83µSv/h for window 2 and 0.64 µSv/h to 2.61 µSv/h for window 3. But at farthest distance of 10cm, the emission decreased from 0.43 µSv/h to 0.30 µSv/h for window 1, 0.78 µSv/h to 0.26 µSv/h for window 2 and 0.40 µSv/h to 0.25 µSv/h for window 3. The radiation emission varied with the wattage of the bulbs for different manufacturers. However, the emission values from incandescent bulb with values 0.25 µSv/h to 0.36 µSv/h for window 1, 0.25 µSv/h to 0.40 µSv/h for window 2 and 0.25 µSv/h to 0.38 µSv/h for window 3 at 2cm distance from the light source were not as high as those of the energy saver bulbs. The values are still within the safety limit in accordance with Radiation Sources and Effects of Ionizing Radiation.
Keywords: Emission, energy saver bulb, gamma Scout, ionizing radiation and window.

1. Introduction

The lighting sources differ from each other in so many ways; for instance, the incandescent light bulbs have been known to produce light by heating a metal filament wire to a high temperature until it glows. The heat generated by the filament are used for purposes such as incubators, brooding boxes for poultry etc. (Bellis 2007).The incandescent bulbs are been in existence for many years. Approximately 90% of the power consumed by an incandescent light bulb is emitted as heat, rather than as visible light. They also work well on either alternating current or direct current; as a result they are widely used in household. However, they are being replaced in applications by other types of electric lights such as Fluorescent lamp, high-intensity discharge lamps, ultraviolet fluorescent lamps, compact fluorescent lamps(CFL),light-emitting diodes(LED), electrodeless lamp also known as magnetic induction lamps, cold cathode fluorescent lamps (CCFL) and black light. These newer technologies improve the ratio of visible light to heat generation. They also produce light by luminescence and these mechanisms produce discrete spectral lines. (Dahl, 2008). The fluorescent light is most often a long straight glass tube that produces white light. Inside the glass tube there is a low-pressure mercury vapour, when ionized, mercury vapour emits ultraviolet light. (Kanellos, 2007).The inside of a fluorescent light is coated with phosphor. Phosphor is a substance that can accept energy in one form and emit the energy in the form of visible light. For example, energy from a high-speed electron in a TV tube is absorbed by the phosphors that make up the pixels. The light we see from a fluorescent tube is the light given off by the phosphor coating the inside of the tube. However, all fluorescent tubes used for domestic and commercial lighting as well as TV screens are mercury UV emission bulbs.

The effectiveness of an electric lighting source is determined by two factors: the relative visibility of electromagnetic radiation and the rate at which the source converts electric power into electromagnetic radiation.(Labrie, et al , 2011).

Radiation is all around us. It is naturally present in our environment and has been since the birth of this planet. Consequently, life has evolved in an environment which has significant levels of ionizing radiation. (Ike, 2010). It comes from outer space (cosmic), the ground (terrestrial), and even from within our own bodies. It is present in the air we breathe, the food we eat, the water we drink, and in the construction materials used to build our homes. (Arogunjo, et al, 2005). High radiation doses tend to kill cells, while low doses tend to damage or alter the genetic code (DNA) of irradiated cells. High doses can kill so many cells and tissues and organs are damaged immediately. This in turn may cause a rapid body response often called Acute Radiation Syndrome. The higher the radiation dose, the sooner the effects of radiation will appear, and the higher the probability of death. Because radiation affects different people in different ways, it is not possible to indicate what does is needed to be fatal. Conversely, low doses – less than 10,000 mrem (100 mSv) spread out over long periods of time (years) don't cause an immediate problem to any body organ. The effects of low doses of radiation, if any, would occur at the cell level, and thus changes may not be observed for many years (usually 5-20 years) after exposure.(USEPA , 2000).

2. Materials and method

2.1 Materials

The light bulbs were produced to serve for 220 – 240 V and at a frequency of 50 – 60 Hz. The energy efficiency of each light bulb was indicated by the manufacturer. The light bulbs were mostly those used in house, offices, workshops, hotels; restaurants .The bulbs are designed and built to work in fixtures. The bulb must be connected to a power source with an input voltage of 220 – 240 V to enable then work effectively.

2.2 The Radiation Detector

The gamma-scout (GS_{20} model) was to measure the radiation from each of these bulbs.

2.3 Operation

When one window is faced in the direction of the radiation to be measured the detection beings immediately as the GM counter is always open, once set on the right model, the radiation button having the symbol of radiation is press and the reading is instantly given for each window that is required.

2.4 Method

Ten samples of electric light bulbs were connected one after the other on a lamp holder; measurement was then taken for window 1, window 2 and window 3 using the gamma scout. The measurement of window 1, window 2 and window 3 was done in µSv/h according to the calibration of the detector.

At a varied distance of 2cm to 10cm each light bulb was placed and at 60seconds the radiation reading was taken for window 1, window 2 and window 3 in µSv/h. While for the pulse count at the same distances of 2cm to 10cm and at 30 seconds the radiation reading was taken. The background count for each window was measured and recorded before taking readings.

3. Results

The results obtained from this work were based on the operation of the detector at the time of the work. They are shown in Tables 1-13.The analysis of the results are also shown in the histograms.

Figures 1 - 6 showed the histogram for window 1, window 2 and window 3 at a distance of 2cm and 10cm with the incandescent bulbs and energy saver lamps (CFLs). Also figure 7 - 10 shows the graph of possible x-ray and UV radiation emission in µSv/h against the varied distances.

Background counts:
Window 1: 0.23 - 0.25µSv/h
Window 2: 0.19 - 0.21µSv/h
Window 3: 0.20 - 0.23µSv/h
Average background count for all the windows is 0.21 – 0.23 µSv/h

4. Discussion

4.1 Discussion of Results

Table 1 shows radiation levels for the window 2 radiation emission (possibly x-rays and UV) readings obtained for energy saver lamps. This shows that 23W bulb had the highest reading (2.83 µSv/h) at the distance of 2cm and next to this bulb is the 85W with 2.53 µSv/h at the same distance. Also at 4cm away from the light source, 23W has a value1.59 µSv/h which is the highest for that distance and next to it is 85W with a radiation value of 1.27 µSv/h. As the detector is placed at distances of 6, 8 and 10cm, the measured values obtained reduced with the least value as 0.30 µSv/h obtained at 2cm from15W bulb. Table 2 shows the readings obtained for window 1 for each energy saver lamps with the highest value of radiation emission obtained for 23W which is 3.22 µSv/h and next to it is for 85W with a value of 1.46 µSv/h. At 10cm, 0.43 µSv/h was also obtained as the highest value which is for 23W bulb and next to it is the value 0.39 µSv/h for 85W bulb. From Table 3, 2.61 µSv/h (85W) is the highest radiation emission value obtained at 2cm and 2.10 µSv/h for 23W bulb at the same distance. For 9W, 11W and 15W bulbs, the values are 1.17 µSv/h 0.67µSv/h and 0.64 µSv/h respectively were obtained at 2cm. As the distance from the source is increased to 6cm, the radiation values reduce. 23W has a value of 1.36µSv/h, 85W 0.65µSv/h and 11W is 0.37µSv/h. Also the pulse counter readings collected for all the energy saver lamps are shown in Tables 4, 5, 6. Window 2 , window 1 and window 3 showed higher values of pulse counter at a distance of 2cm.Tables 7, 8 and 9 show the radiation measurements for the Incandescent bulbs of 40W,60W,100W and 200W respectively and each Table of radiation emission showed no outstanding difference for all the distances from the light sources. For instance in Table 7, 100W the value is 0.35 µSv/h while for 200W it is 0.30 µSv/h and for 60W it is 0.29 µSv/h at 2cm.In Table 8 at distance of 2cm, the 100W bulb has a value of 0.30 µSv/h, while 200W has 0.27 µSv/h and 60W has 0.29 µSv/h. Also for Table 9 at the same 2cm distance the emission of 0.38 µSv/h was obtained for 100W, 0.31 µSv/h for 200W and 0.30 µSv/h for 60W. At a distance of 10cm, the readings for each of the Tables have almost the same values as 2cm. In Table 7, 8 and 9, the readings at 10cm distance are 0.30, 0.35 and0.29 µSv/h for 100W, 0.33, 0.29, 0.27 µSv/h for 200W and for 60W 0.25, 0.27, 0.36 µSv/h respectively. In Table 10, 11 and 12 where the values for pulse counter are recorded, it also showed similar findings to that of pervious readings obtained for Tables 7 – 9. For example in Table 11 at 2cm 60W has a pulse count of 22, while 100W has 18 and 200W also has 22.At 10cm 60W bulb has pulse count of 22,100W has 15 and 200W has18. Table 13 showed the readings obtained using a generator set for the incandescent bulbs to find out if there is any variation in values with that from electricity. The result obtained showed that there is a negligible difference.

Figures 2 and 3 are histograms showing measured radiation values for energy saver lamps at a distance 2cm for radiation in µSv/h and pulse count with highest value of 3.22µSv/h on the which is for 23W bulb for window 1 radiation emission levels and with the least values of 0.63 µSv/h for 11W bulb. Fig. 1 and 4 are also histograms for values of radiation measured from incandescent bulbs at 2cm.The highest value of 0.35µSv/h and 29 pulse count is for the 100W bulb. Fig.5 and 6 show histograms of measured radiation values from energy saver bulbs at 10cm in µSv/h and pulse count with the least value of 0.25 µSv/h and 14 for 9W bulb and highest value of 0.78 µSv/h for 23W bulb. The results obtained established:

4.2 Presence of Radiation Emission: The presence of ionizing radiation were detected for all the energy saver lamps. This is because all the values obtained are above the average background count range of 0.21 - 0.23µSv/h. A closer look at the results show that at a distance of 2cm the possible x-ray and UV radiation emission are more, as indicated on Tables 1 to 10. In accordance to an earlier work done by Environmental and Radiation Health Sciences Directorate Canada, 2008 (Ultraviolet radiation and Electric and Magnetic Fields from Compact Fluorescent Lamps) showed that for UV radiation ,unintentional long-term skin exposure is foreseeable at close distance to CFLs(i.e. hands under a desk or short term activity near the source).However, the measurements obtained in this study with the incandescent bulbs show that there is really no outstanding radiation emission from the bulbs, as their values almost correspond to the background count.

4.3 Safety limits: Despite the presence of radiation in the CFLs, in the study carried out by the HPA (Health Protection Agency) it was found that up to one in five energy –saver bulbs emit UV radiation which at the closest range of about 2cm away could be equivalent to sun exposure on a hot summer's day (David, 2008).Hence, people are advised not to use an exposed CfLs at close proximity to the body for more than one hour a day, (Canada Health Agency, 2009).Even though, it is still within the health acceptable limit. According to General Electric (GE), their typical electronically-ballasted CFL operate in the 24-100 kHz frequency range. This range is within the radio frequency band of the electromagnetic spectrum and is classified as Intermediate Frequency by the World Health Organization. The study done by Canada Health Agency, 2008 and Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), 2008 show that compact fluorescent lamp bulbs generate "dirty" electricity, emit radio frequency radiation, contain mercury and emit UV radiation. Alternative light bulbs are available that are much more energy efficient than CFL and do not contain mercury, do not produce radio frequencies or UV radiation, and do not cause sickness. Unfortunately, these bulbs (CLED lights) are still too expensive for residential use. Tube fluorescent bulbs have advantage of having diffusers that filter the UV radiation, while the new compact fluorescent light bulbs do not have these diffusers.

However Individuals, Scientists, Organization and health agencies around the world had done some research on these light sources are calling on the government to impose stricter guidelines for electromagnetic exposure. These guidelines are for both extremely low frequency (ELF) electromagnetic fields and for radio frequency radiation.

5. Conclusion

In this study, the presence of ionizing radiation has been established from the 10 light bulbs studied. It has been observed that the compact fluorescent light lamps (CFLs) emitted higher radiation values as the wattages increases at close proximity to the bulb. The possible x-ray and UV radiation emissions measured in this work were found to be within the acceptable radiation limit and may not pose a health hazard. However, it is recommended that CFLs should not be used at a very close distance, for example at bed side lamp or reading lamp etc to avoid any long-term health effects. The information obtained from this research work will provide a guide for further research work regarding the light sources used in our homes, offices, workshops, hotels, restaurants etc.

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Table: Names of energy savers lamps (compact florescent bulbs) and incandescent bulbs used.

Names	Manufacturer	Wattage(W)
Incandescent bulb	Thungsram	40
Incandescent bulb	Thungsram	60
Incandescent bulb	Philips	100
Incandescent bulb	Pila	200
Compact fluorescent lamp	Philips Tornado	11
Compact fluorescent lamp	Zhongshan AKT lighting	9
Compact fluorescent lamp	Zhongshan AKT lighting	26
Compact fluorescent lamp	Zhongshan AKT lighting	85

Table 1: Window 2 radiation (possibly x-ray and UV) reading for energy saver lamps

Dista-nce (cm)	9W μSv/h	11W μSv/h	15W μSv/h	23W μSv/h	26W μSv/h	85W μSv/h
2	0.99	1.30	0.67	2.83	1.43	2.53
4	0.52	0.68	0.48	1.59	0.53	1.27
6	0.29	0.42	0.35	1.25	0.44	0.67
8	0.37	0.35	0.30	0.67	0.36	0.56
10	0.30	0.31	0.38	0.78	0.26	0.30

Table 2: Window 1 radiation (possibly x-ray and UV) reading for energy saver lamps

Distance (cm)	9W μSv/h	11W μSv/h	15W μSv/h	23W μSv/h	26W μSv/h	85W μSv/h
2	1.05	0.63	0.71	3.22	1.11	1.46
4	0.54	0.54	0.56	2.03	0.61	1.43
6	0.31	0.38	0.30	1.03	0.48	0.62
8	0.32	0.31	0.35	0.54	0.34	0.59
10	0.36	0.32	0.30	0.43	0.32	0.39

Table 3: Window 3 radiation (possibly x-ray and UV) reading for energy saver lamps

Dist-ance (cm)	9W µSv/h	11W µSv/h	15W µSv/h	23W µSv/h	26W µSv/h	85W µSv/h
2	1.17	0.67	0.64	2.10	0.73	2.61
4	0.47	0.52	0.40	1.66	0.53	1.17
6	0.32	0.37	0.31	1.36	0.46	0.65
8	0.42	0.36	0.37	0.56	0.35	0.46
10	0.31	0.36	0.33	0.40	0.25	0.35

Table 4: Window 2 radiation (possibly x-ray and UV) reading for energy saver lamps in pulse count.

Distance (cm)	9W µSv/h	11W µSv/h	15W µSv/h	23W µSv/h	26W µSv/h	85W µSv/h
2	30	36	30	96	52	60
4	16	22	28	52	49	59
6	16	18	23	30	24	51
8	14	15	25	38	33	35
10	19	15	15	21	25	30

Table 5: Window1 radiation (possibly x-ray and UV) reading for energy saver lamps in pulse count

Distance (cm)	9W µSv/h	11W µSv/h	15W µSv/h	23W µSv/h	26W µSv/h	85W µSv/h
2	23	43	37	67	68	62
4	16	19	23	70	47	49
6	15	18	22	35	31	36
8	16	15	19	33	25	46
10	19	16	22	29	19	18

Table 6: Window 3 radiation (possibly x-ray and UV) reading for energy saver lamps in pulse count

Distance (cm)	9W µSv/h	11W µSv/h	15W µSv/h	23W µSv/h	26W µSv/h	85W µSv/h
2	36	42	36	77	42	53
4	27	24	20	46	48	45
6	16	21	23	37	24	41
8	15	17	14	29	21	22
10	17	19	11	19	20	22

Table 7: Window 1 radiation (possibly x-ray and UV) reading for incandescent bulbs in µSv/h

Distance(cm)	40W	60W	100W	200W
2	0.31	0.29	0.35	0.30
4	0.27	0.26	0.30	0.27
6	0.26	0.36	0.32	0.33
8	0.30	0.28	0.28	0.27
10	0.28	0.25	0.30	0.33

Table 8: Window 2 radiation (possibly x-ray and UV) reading for energy incandescent bulbs in µSv/h

Distance(cm)	40W	60W	100W	200W
2	0.30	0.29	0.30	0.27
4	0.28	0.33	0.28	0.29
6	0.25	0.25	0.31	0.27
8	0.26	0.40	0.37	0.27
10	0.25	0.27	0.35	0.29

Table 9: Window 3 radiation (possibly x-ray and UV) reading for incandescent bulbs in µSv/h

Distance(cm)	(40W)	(60W)	(100W)	(200W)
2	0.32	0.30	0.38	0.31
4	0.26	0.28	0.33	0.30
6	0.25	0.35	0.35	0.31
8	0.27	0.33	0.27	0.36
10	0.30	0.36	0.29	0.27

Table 10: Window 1 radiation (possibly x-ray and UV) reading for incandescent bulbs in pulse count

Distance(cm)	40W	60W	100W	200W
2	15	22	18	15
4	19	20	21	12
6	18	23	20	17
8	24	21	17	17
10	21	18	20	17

Table 11: Window 2 radiation (possibly x-ray and UV) reading for energy incandescent bulbs in pulse count

Distance(cm)	40W	60W	100W	200W
2	19	22	18	22
4	20	16	13	18
6	14	22	14	21
8	20	20	18	19
10	23	22	15	18

Table 12: window 3 radiation (possibly x-ray and UV) reading for incandescent bulbs in pulse count

Distance(cm)	40W	60W	100W	200W
2	13	17	29	15
4	16	16	17	12
6	19	17	21	18
8	16	20	24	20
10	20	20	22	12

Table 13: Window 3 radiation (possibly x-ray and UV) reading for incandescent bulbs in µSv/h using a generator

Distance(cm)	40W	60W	100W	200W
2	0.31	0.22	0.38	0.33
4	0.25	0.25	0.33	0.27
6	0.25	0.29	0.35	0.28
8	0.27	0.29	0.27	0.36
10	0.30	0.21	0.29	0.27

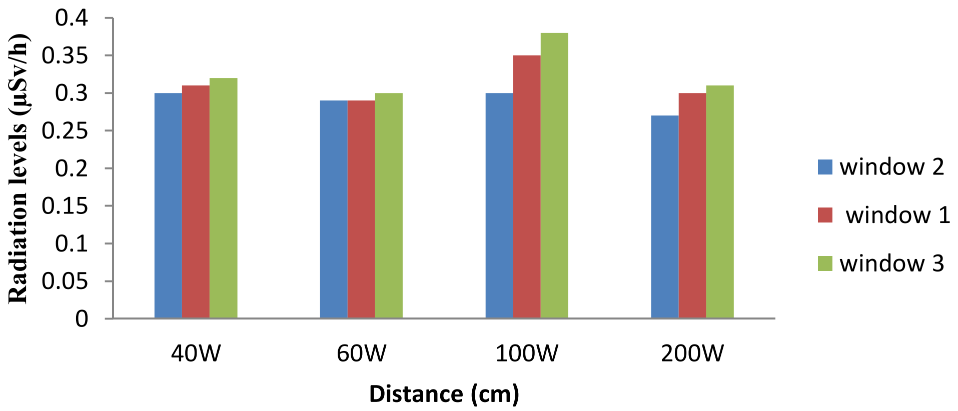

Figure 1: Histogram of measured radiation from incandescent bulbs at a distance of 2cm

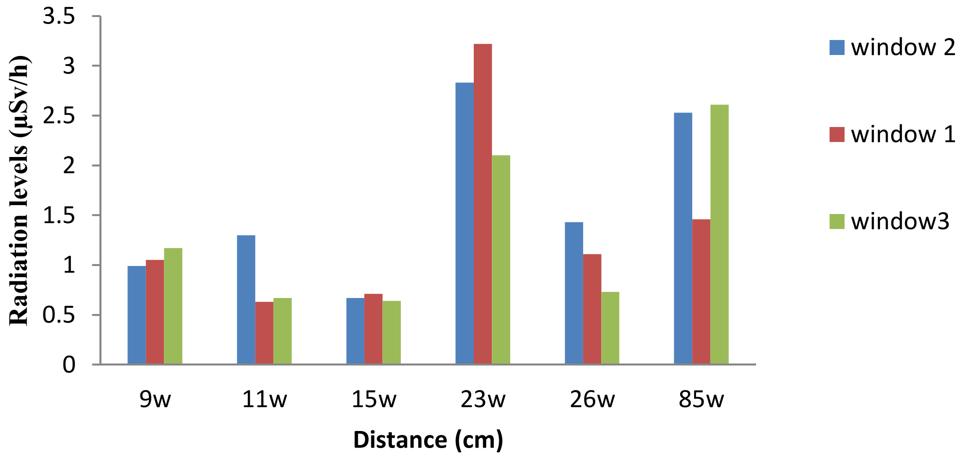

Figure 2: Histogram of measured radiation from energy saver bulbs at a distance of 2cm

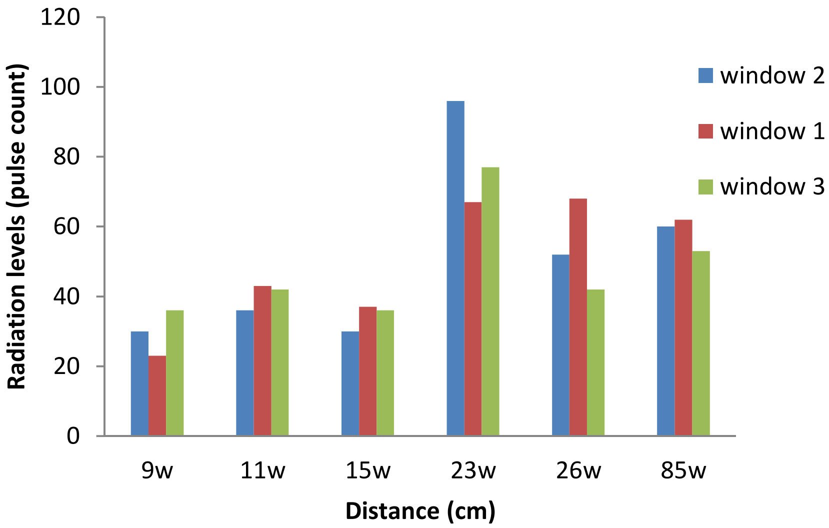

Figure 3: Histogram of measured radiation from energy saver bulbs at a distance of 2cm

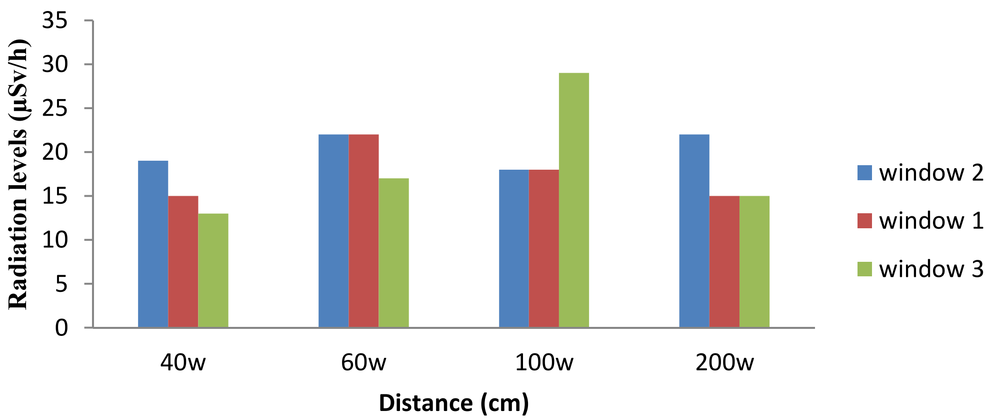

Figure 4: Histogram of measured radiation from incandescent bulbs at a distance of 2cm

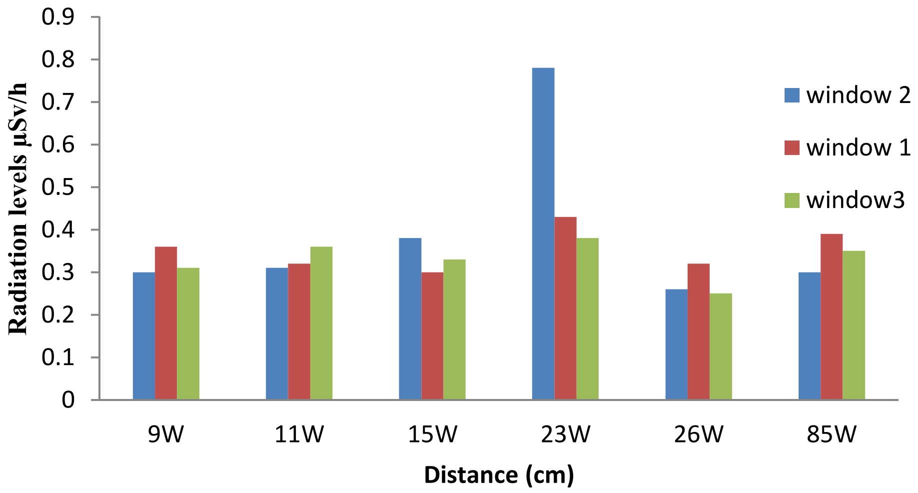

Figure 5: Histogram of measured radiation from energy saver bulbs at a distance of 10cm

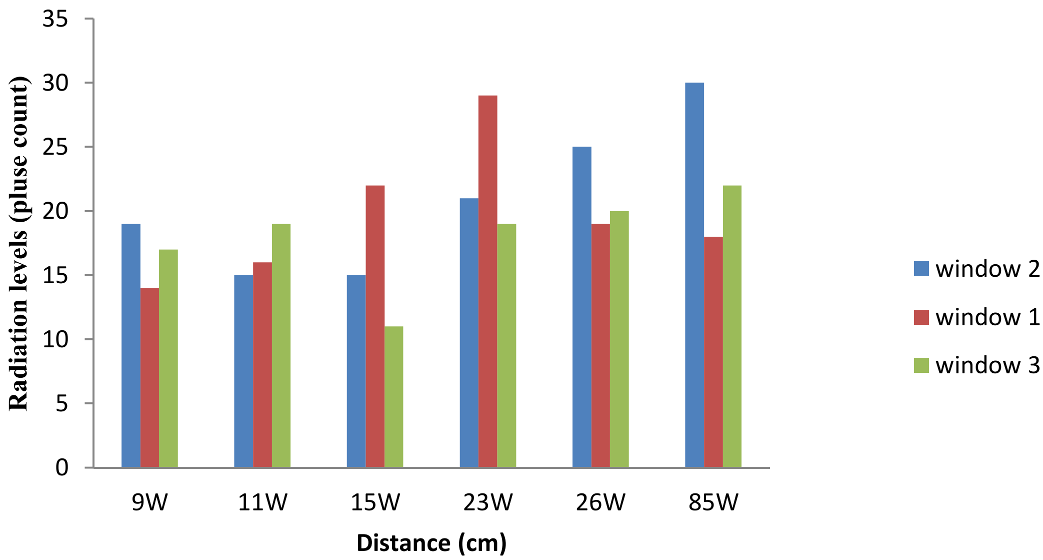

Figure 6: Histogram of measured radiation from energy saver bulbs at a distance of 10cm