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Measurement and Evaluation of Extremely Low Frequency (Radiation) from Computer Monitors and Laptops

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Abstract:

In This Modern Age Of High Computer Literacy And Computer Usage, An Average Knowledge On The Radiation Emitted By Computer Monitors, Laptops, And Other Computer Components Are Important For All Computer Users. It Has Been Reported That Many Computer Users Spend Hours In Front Of Computer Monitors, Surrounded By Its Related Electronic Appliances, Each Of Them Emit Radiation. Because Of The Duration Of This Exposure Say, Many Hours A Day, Computer Radiation Is A Real Hazard. Thus, The Electromagnetic Radiation Emitted From Various Laptops And Monitors Model Was Measured Using An All-Sun Digital Emf Meter (Em-556) That Was Optimized To Measure Radiofrequency And Extremely Low Frequency Radiation. The Elfradiation Measured Vary Between 0.03 And 2.53 Mg For All The Laptops And Monitors Studied. Compaq Evo N400c Laptop Emitted Highest Radiation As It Has 2.53 Mg And 1.51 Mg At 10 Cm And 30cm From The Front Of The Screen Respectively. This Reported Values Are Higher Than The Specified Exposure Limit Of 1 Mg At 30 Cm. This Work Reveals That Those Using Laptops And Monitors Are Exposed To Elf Radiation But The Amount Now Depends On The Model Of Laptops And/ Or Monitors Used. The Results Showed That Radiation From Laptops And Monitors May Likely Produce Health Effects On The Users Therefore There Is Need For Regulations On The Type Of Laptops And Monitors Imported Into Nigeria To Avoid Health Challenges That May Results From Exposure To Radiation From Laptops And Monitors.

Keywords: Extremely low frequency (Elf), radiation, laptops, monitors, measurements

1. Introduction

Electromagnetic radiation is emitted by many natural and man-made sources and play an important part in our lives. Electromagnetic (EM) radiation is a self-propagating wave in space or through transparent matter. EM radiation has an electric and magnetic field component which oscillate in phase perpendicular to each other and to the direction of energy propagation, these includes radio waves, microwaves, terahertz radiation, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays. The electromagnetic spectrum extends from below the frequencies of radio waves at the long-wavelength end through gamma radiation at the short wavelength end. Human body is exposed to different kinds of radiation that includes the natural radioactivity in the earth, cosmic rays from outer space and also manmade radiations coming from electric and electronic instruments. Diagnostic machines, television sets, computers, microwave oven, radar devices, laser devices, mobile phones etc., generates radiations of different frequencies which also exists in our environment as electronic smog. An effect of heart rate variability seen in laboratory studies was the basis for a hypothesis that electromagnetic radiation exposure might affect the risk of cardiovascular disease and some initial epidemiologic results[2]. An increasing number of people report subjective symptoms and hypersensitivity to a wide variety of electromagnetic sources including power lines and TV broadcasting stations, cellular phones and computer monitors [6]. Electromagnetic radiations are known to affect nerve and muscle cells although little evidence was found for effects on the nervous system or behavior at environmental exposure levels. Variety of symptoms, like dermatological symptoms such as redness, tingling and burning sensations, fatigue, headache, concentration difficulties, nausea, heart palpitation have been suggested to be caused by electromagnetic radiation exposure. Following the initial epidemiological study on childhood, cancer is a great number of other diseases that have been studied in relation to electromagnetic radiations. In this modern age of high computer literacy, average knowledge on the radiation emitted by computer monitors, laptops, and other computer components are important for all computer users. This type of radiation is known as extremely low frequency (ELF) electromagnetic radiation. It is essentially the same kind of radiation emitted from electric power lines, television sets and other electrical and electronic appliances. Electric and magnetic fields are produced by any wiring or equipment carrying electric current. This includes overhead and underground power lines carrying electricity, wiring in buildings, and electrical appliances. Computer radiation

may be the largest single source of electromagnetic radiation exposed to every computer user. Although the intensity of radiation from computers may be far less than from a high voltage power line, but it produces health problems due to the fact that users get much closer to the monitors and laptops. A computer user is exposed to an electromagnetic field, visible and ultraviolet light, radio range waves and extremely low frequency [1]. Computers emit both ionizing and non-ionizing radiation like most electrical appliances. These include visible light, ultraviolet, infrared, x-ray and radio frequency emissions. However, computer emissions are often so low as to be immeasurable or are found to be significantly below recommended safety levels. Numerous studies have been conducted to determine what effect, if any, radiation levels emitted from computers may have on workers' health. Repeated studies to date have failed to find any direct link between computer use and radiation related general or eye health problems [9]. Although there is no conclusive evidence, it has been suggested that these charges may be related to the development of skin rash or eye irritation in some very sensitive people [4].

Many computer users spend hours in front of computer monitors, surrounded by its related electronic appliances, each of them emit radiation. Because of the duration of this exposure say, many hours a day, computer radiation is a real hazard. Computers' central processing system (CPU) contain power supplies, fans, drives and other units which generate radiation strong enough to cause concern at distances up to about 50 cm. Visual discomfort and related symptoms occurring in computer workers is a growing health problem [7]. Often the letters on a computer screen are not as precise or sharply defined, the level of contrast of the letters to the background is reduced and the presence of glare and reflections on the screen may make viewing more difficult [8]. The magnetic portion of this electromagnetic radiation (which is probably more dangerous than the electric portion) can penetrate just about anything, so it does not help to place a shield or screen between you and the CPU. Another item most likely to cause a health hazard in many offices is the computer monitor, or screen. The box-shaped cathode ray tube (CRT) computer monitors generally have quite high levels of radiation even at 30 cm compared to the modern low-radiation flat screens [5]. Thus, the aim of this study were to access electromagnetic radiation from various computer monitors and laptops at three computer business centers in Ondo South Senatorial District (Ore, Okitipupa and Igbokoda) for the purpose of establishing the presence of electromagnetic radiation and evaluate the risk of the measured EM radiation as well as suggesting ways of limiting the radiation in order to limit the health hazard associated with such radiations and to evaluate the health hazard associated with the EM radiation measured.

2. Materials and Methods

2.1. Geographical Description of the Study Area

Igbokoda is the head quarter of Ilaje Local Government Area of Ondo State, Southwestern Nigeria. It has geographical coordinates of $6^{\circ}21'0''$ North and $4^{\circ}48'0''$ East, it has an area of 1,318km² and a population of 290, 615 [3]. There is presence of various computer centers that serves many communities from the riverine areas in Igbokoda. Okitipupa is a Local Government Area in Ondo State, Nigeria. It has always been the central town for inhabitants of the Ondo South senatorial district of Ondo state, with the presence of a University. It has an area of 803 km², coordinates $6^{\circ}30'0''$ North, $4^{\circ}48'0''$ East and a population of 233,565⁶. Ore is located in Odigbo Local Government Area of Ondo State, Nigeria. It has latitude 6.74569 and longitude 4.87748. Its geographical coordinates are $6^{\circ}45'0''$ North, $4^{\circ}52'0''$ East. It has an area of 1,818 km² and a population of 230,351 [3]. There are many amenities in the town due to its strategic location.

2.2. Measuring Extremely Low Frequency Radiation

Extremely Low Frequency (ELF) radiation is a byproduct of electronic devices that use electricity to operate. When microprocessors, hard drives and other electronic device components operate, they emit radiating fields, just like those generated by overhead power lines or for that matter, identical to fields emitted from our TVs. At a distance these fields tend to be potentially less harmful. However, when these fields are at a zero distance from our bodies, they tend to be more dangerous to our health. The way to determine the strength of the field is by measuring the gauss. The gauss (G) is the unit of measurement of a magnetic field also known as the magnetic flux density" or the "magnetic induction.

The continuous increase of modern day electromagnetic pollution makes radiation measurements more relevant and necessary than ever, especially for the most vulnerable population groups (pregnant women, children, elderly and ill people). Measurements of the invisible electromagnetic fields is the only way to determine if the areas like computer business centers exceed the proposed limits exposure to artificial radiation due to the presence of visible and invisible radiation sources. Measuring electromagnetic fields can significantly reduce the daily electromagnetic burden, by identifying and avoiding electromagnetic hotspots.

2.3. Samples Collection and Measurement Procedures

Measurements were carried out at three different computer business centers in Ondo South Senatorial District of Ondo State, Southwestern, Nigeria. Different brand of laptops and desktop computers were used for business purposes at the various sampling sites. All computer measured were in use and running for at least 90-120 minutes before taking measurements. The computer monitors measured were IBM 6307-47N, Sampo PD-70FA, HP 2011x LCD, Hanns.G HSG 1027 LCD and IBM 9417-AB6 Monitors while the laptops measured were HP 500, Dell-Presario F700, Dell 1706-FPvt, HP - S84048-001, Compaq C501NR, Compaq evo n400c, HP Pavilion dv6 and Toshiba M700. All-sun digital EMF meter (EM-556) was used

to measure the ELF radiation from the laptops and monitors. The measuring instrument is a radiation detector dosimeter. The measurements were in milliGauss (mG) and measurements were carried out at distance 10cm, 20cm, 30cm, 50cm and 100cm respectively from the front and back of the laptops and monitors.



Figure 1: Em-556 Radiation Detector Dosimeter

The measurements from the right and left side of the computers and monitors were taken but were found to be very low at distance 35-40cm and so were assumed insignificant. The measurements from the front and the back were taken for both the laptops and the monitors.

3. Results and discussions

3.1. ELF Radiation Measurements from Front of Screens

The result obtained for this present study confirmed the presence of ELF radiation above background level to a minimum of distance of 50cm from all the laptops and monitors studied at different locations of computer business centres in Ondo state (Igbokoda, Okitipupa and Ore). The measurements were shown in Table 1 – 3 for all centres at different distances from various laptops and monitors (front screen and back screen). Comparison study were reported in Figure 2-7 for ELF radiated from front and back of screen. The ELF obtained from the front of the screen ranged between 1.65 – 2.53, 1.35 – 2.08 and 1.60 – 1.90 mG with mean values of 2.03, 1.70 and 1.75 mG at distance 10cm; from 1.10 – 2.05, 0.90 – 1.65 and 1.25 – 1.35 mG with mean values of 1.50, 1.31 and 1.37 mG at distance 20cm; from 0.80 – 1.62, 0.87 – 1.16 and 0.67 – 0.98 mG with mean values of 1.14, 0.97 and 0.85 mG at distance 30cm; from 0.10 – 0.25, 0.27 – 0.51 and 0.06 – 0.35 mG with mean values of 0.38, 0.35 and 0.23 mG at distance 50cm and from 0.03 – 0.06, 0.03 – 0.20 and 0.03 – 0.04 with mean values of 0.05, 0.04 and 0.56 mG at distance 100cm for different laptops and monitors at Igbokoda, Okitipupa and Ore respectively. Compaq evo n400c has the highest radiation level of 2.53 mG followed by HP Pavilion dv6 with radiation level of 2.45 mG. At distance 100cm, Compaq evo n400c has radiation level of 0.06 mG above background. The radiation measured from the right and left sides of the laptops and monitors and almost same and seems insignificant due to the low values recorded and therefore not used in this present study.

3.2. ELF Radiation Measurements from Back of Screens

The ELF obtained from the back of the screen ranged between 0.45 – 0.85, 0.45 – 0.85 and 0.45 – 0.80 mG with mean values of 0.62, 0.64 and 0.56 mG at distance 10cm; from 0.30 – 0.55, 0.30 – 0.55 and 0.30 – 0.50 mG with mean values of 0.42, 0.42 and 0.39 mG at distance 20cm; from 0.04 – 0.06, 0.09 – 0.30 and 0.18 – 0.30 mG with mean values of 0.05, 0.19 and 0.25 mG at distance 30cm; from 0.03 – 0.05, 0.02 – 0.06 and 0.05 – 0.08 mG with mean values of 0.04, 0.04 and 0.06 mG at distance 50cm and from 0.01 – 0.03 with mean value of 0.02 mG at distance 100cm for different laptops and monitors at Igbokoda, Okitipupa and Ore respectively. The radiation measured from the back side of the laptops and monitors was the lowest. However, users of the systems do not stay at the back operating the systems. It was observed that some laptops have radiation level above the recommended 1.0 mG at 30cm and these includes Compaq evo n400c and HP Pavilion dv6 having 1.51 and 1.62 mG respectively at 30cm and are both located at the computer centre in Igbokoda. This effect can be linked to the thermal effects as a result of heat generated from various laptop parts that are compressed under the keyboard because at times the users feel the heat when laptop is ON especially for a long period of time. IBM 6307-47N box-shaped monitor also has radiation level of 1.16 mG at 30cm at the business centre in Okitipupa, other monitors used were the recent LCD type and therefore emits low radiation. All other laptops and monitors studied meet the guideline regulation of 1.0mG at 30cm. The mean radiation level at 30cm of the computer centre at Igbokoda is above the recommended level while that of Okitipupa and Ore are within limits.

GPS Location	Type of Systems	Front Screen (Mg)					Back Screen (Mg)				
		10cm	20cm	30cm	50cm	100cm	10cm	20cm	30cm	50cm	100cm
N06°21'13.2" E004°48'08.8"	HP Pavilion dv6	2.45	2.05	1.62	0.40	0.03	0.60	0.40	0.06	0.03	0.01
	Toshiba M700	1.80	1.27	0.87	0.30	0.05	0.85	0.55	0.05	0.05	0.03
	HP-550	1.70	1.30	0.80	0.25	0.04	0.50	0.40	0.06	0.03	0.02
	HP-550	1.65	1.10	0.90	0.10	0.05	0.45	0.30	0.05	0.04	0.03
	Compaq evo n400c	2.53	1.80	1.51	0.85	0.06	0.70	0.45	0.04	0.04	0.01
	Total	10.13	7.52	5.70	1.90	0.23	3.10	2.10	0.26	0.19	0.10
	Range	1.65-2.53	1.10-2.05	0.80-1.62	0.10-0.25	0.03-0.06	0.45-0.85	0.30-0.55	0.04-0.05	0.03-0.05	0.01-0.03
	Mean	2.03	1.50	1.14	0.38	0.05	0.62	0.42	0.05	0.04	0.02

Table 1: ELF Radiation Measured from Front and Back of Computer Screens at IGBOKODA

GPS Location	Types of Systems	Front Screen (Mg)					Back Screen (Mg)				
		10cm	20cm	30cm	50cm	100cm	10cm	20cm	30cm	50cm	100cm
N06°30'08.2" E004°46'42.1"	IBM 6307-47N Box-shaped Monitor	2.08	1.65	1.16	0.35	0.04	0.60	0.40	0.25	0.04	0.01
	Sampo PD-70FA Monitor	1.35	1.13	0.87	0.27	0.03	0.85	0.55	0.20	0.05	0.01
	Compaq C501NR	1.54	0.90	0.87	0.33	0.04	0.50	0.40	0.12	0.04	0.02
	Dell-Presario F700	1.80	1.54	0.94	0.51	0.04	0.45	0.30	0.09	0.06	0.03
	Dell-Presario F700	1.72	1.34	1.00	0.30	0.05	0.80	0.45	0.30	0.02	0.01
	Total	8.49	6.56	4.84	1.76	0.20	3.20	2.10	0.96	0.21	0.08
	Range	1.35-2.08	0.90-1.65	0.87-1.16	0.27-0.51	0.03-0.04	0.45-0.85	0.30-0.55	0.09-0.30	0.02-0.06	0.01-0.03
	Mean	1.70	1.31	0.97	0.35	0.04	0.64	0.42	0.19	0.04	0.02

Table 2: ELF Radiation Measured from Front and Back of Computer Screens at OKITIPUPA

GPS	Type/Model of System	Front Screen (Mg)					Back Screen (Mg)				
		10cm	20cm	30cm	50cm	100cm	10cm	20cm	30cm	50cm	100cm
N06°44'49.78" E004°52'3.96"	HP 2011x LCD Monitor	1.70	1.45	0.80	0.35	0.04	0.45	0.33	0.20	0.06	0.03
	Hanns.G HSG 1027 LCD Monitor	1.89	1.50	0.98	0.06	0.03	0.57	0.45	0.30	0.05	0.03
	IBM 9417-AB6 Monitor	1.65	1.35	0.67	0.09	0.03	0.50	0.35	0.18	0.07	0.02
	Dell 1706-FPVt	1.90	1.25	0.80	0.34	0.04	0.50	0.30	0.25	0.06	0.02
	HP - S84048-001	1.60	1.32	0.98	0.30	0.04	0.80	0.50	0.30	0.08	0.02
	Total	8.74	6.87	4.23	1.14	0.18	2.82	1.93	1.23	0.32	0.12
	Range	1.60-1.90	1.25-1.35	0.67-0.98	0.06-0.35	0.03-0.04	0.45-0.80	0.30-0.50	0.18-0.30	0.05-0.08	0.02-0.3
	Mean	1.75	1.37	0.85	0.23	0.04	0.56	0.39	0.25	0.06	0.02

Table 3: ELF Radiation Measured from Front and Back of Computer Screens at ORE

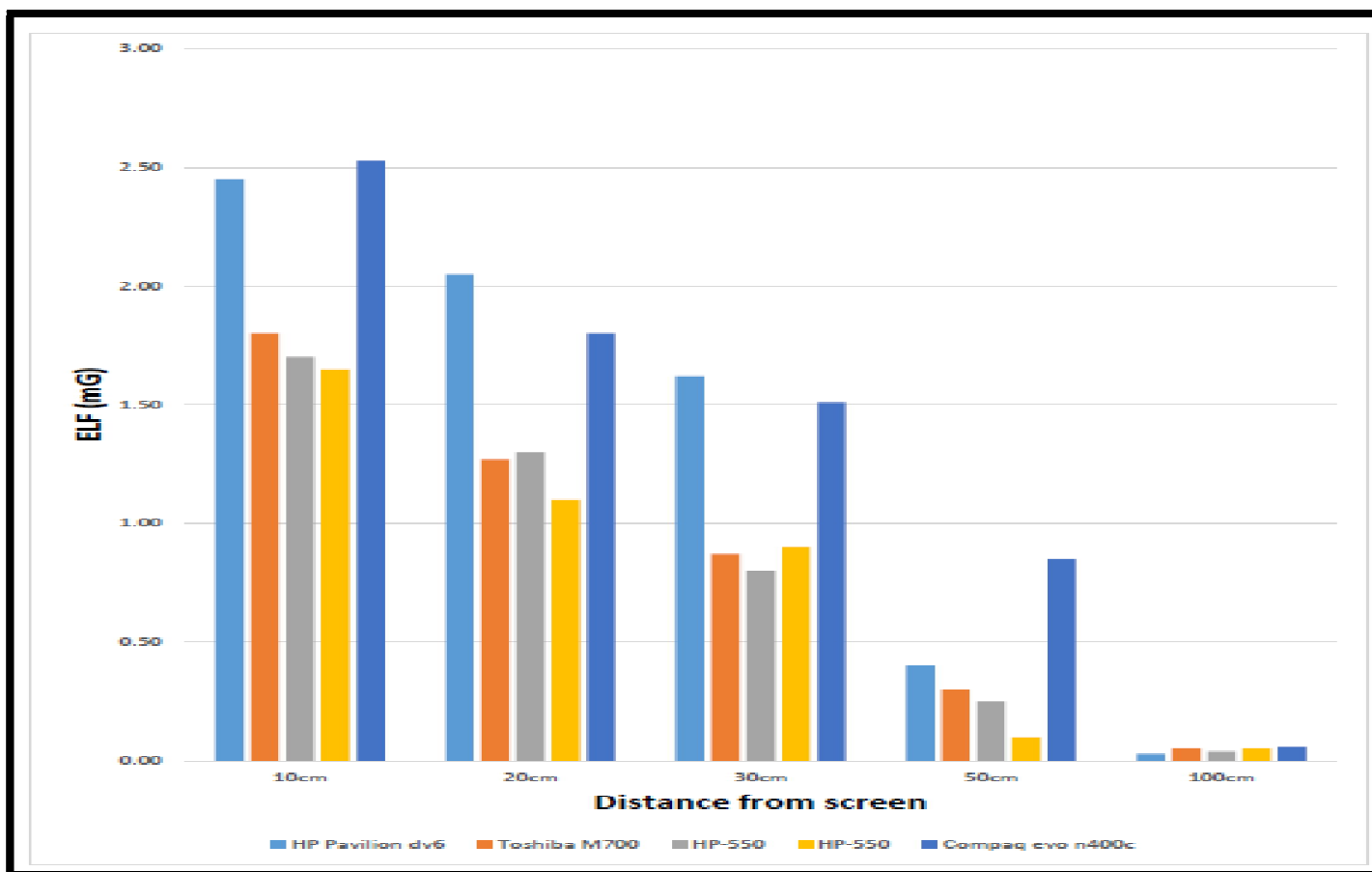


Figure 2: ELF Measurements from Front of Screen at IGBOKODA

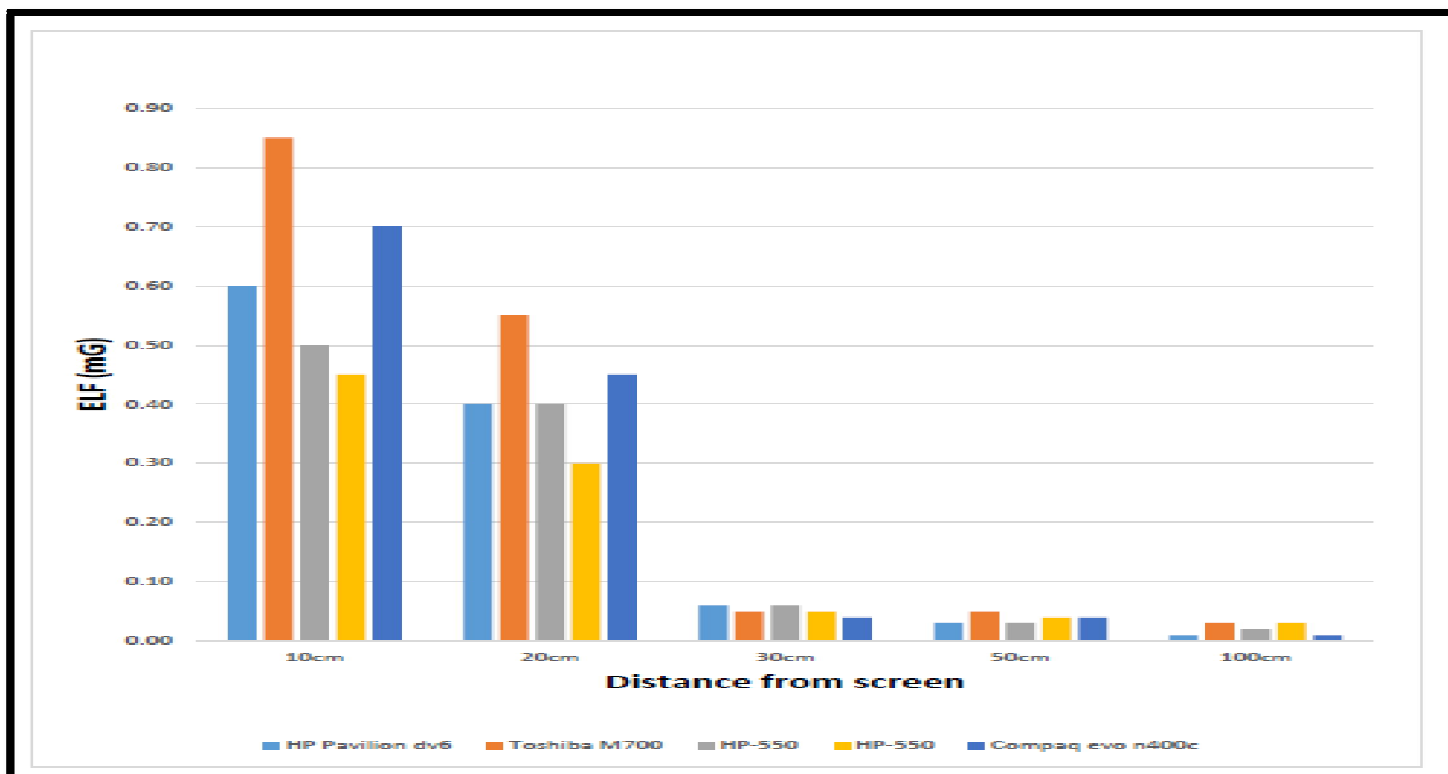


Figure 3: ELF Measurements from Back of Screen at IGBOKODA

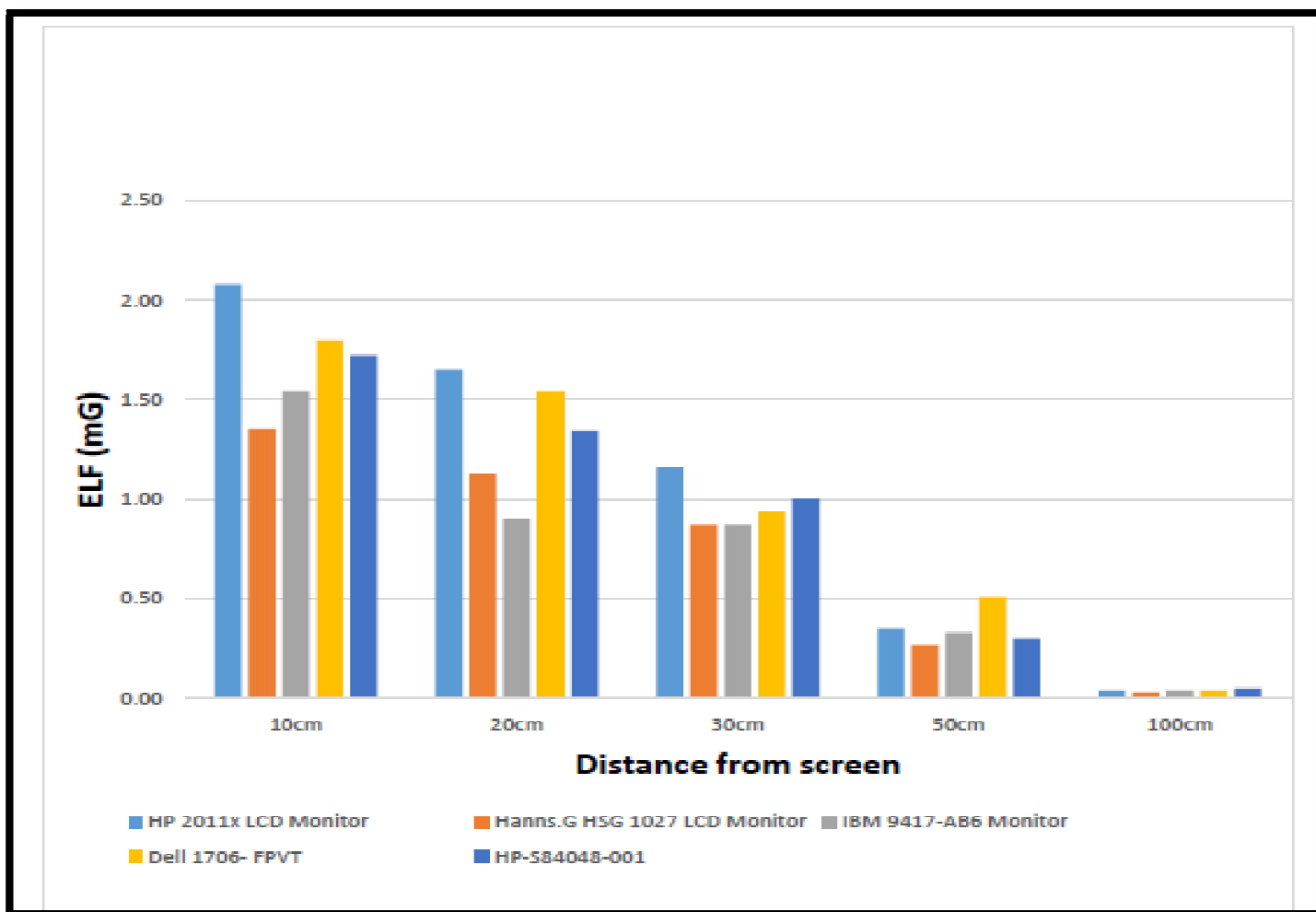


Figure 4: ELF Measurements from Front of Screen at OKITIPUPA

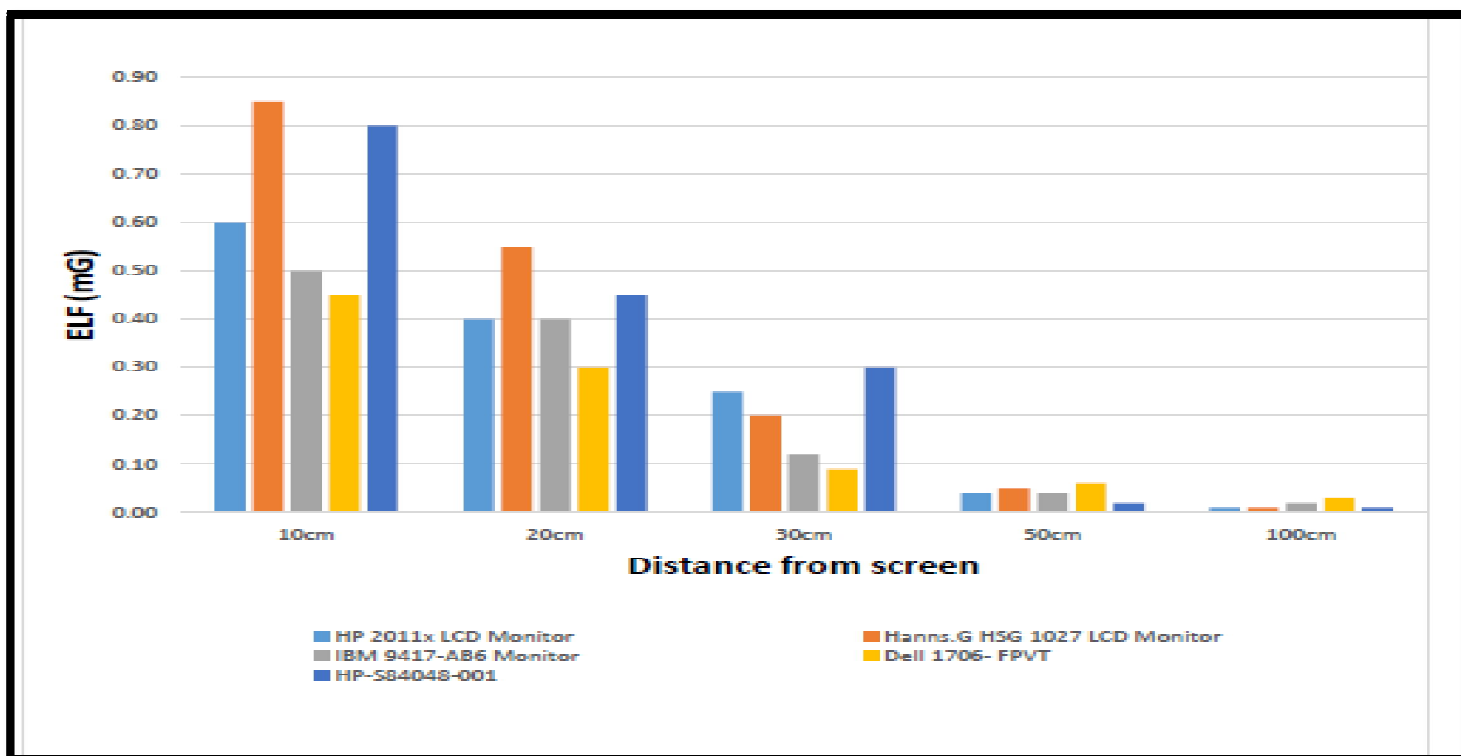


Figure 5: Elf Measurements from Back of Screen at Okitipupa

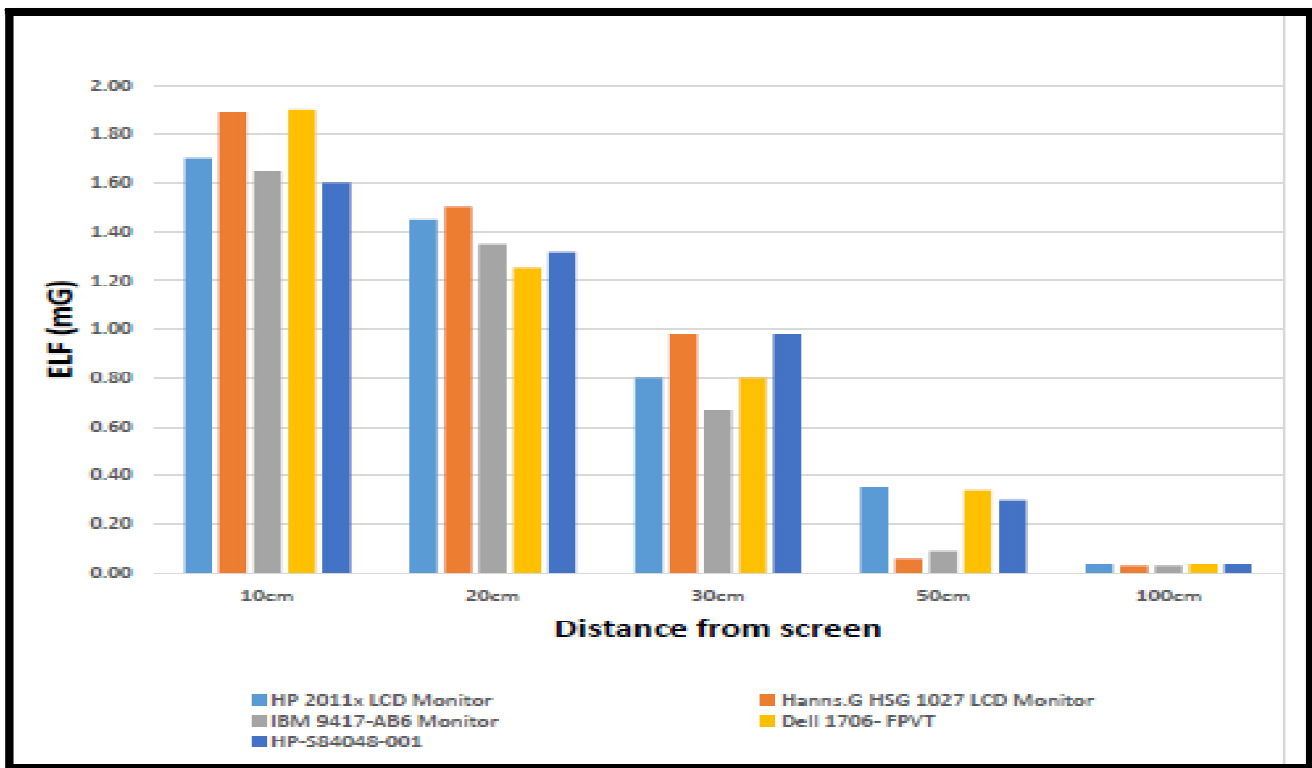


Figure 6: ELF Measurements from Front of Screen at ORE

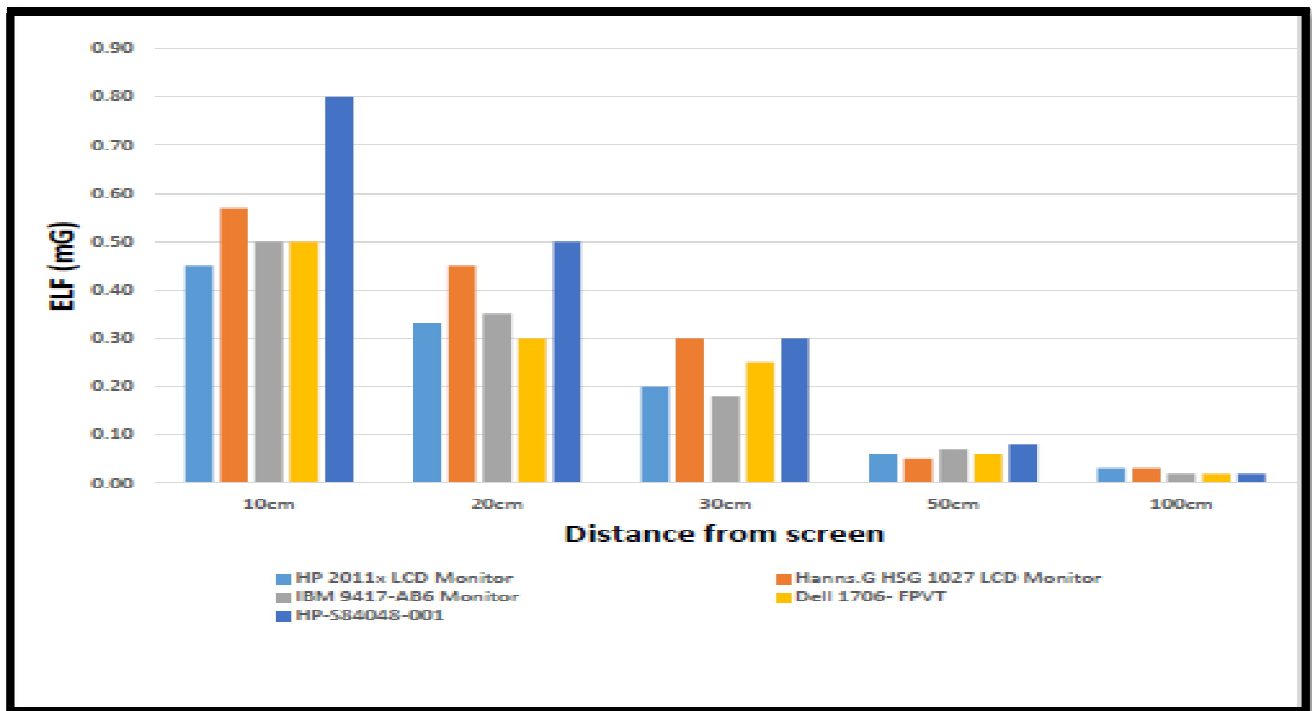


Figure 7: ELF Measurements from Back of Screen at ORE

4. Conclusion

The measurements of extremely low frequency radiation were carried out with the aid of EM-556 radiation detector dosimeter. The study confirmed the presence of radiation from laptops and monitors above background level. It also confirmed the hypothesis that radiation reduces with distance. Compaq evo n400c has the highest radiation level of 2.53 mG followed by HP Pavilion dv6 with radiation level of 2.45 mG. At distance 100cm, Compaq evo n400c has radiation level of 0.06 mG above background. The radiation measured from the right and left sides of the laptops and monitors and almost same and seems insignificant due to the low values recorded and therefore not used in this present study. The result also shows that

radiation from laptops and monitors may likely produce health effects on the users as some systems emits radiations far above the recommended limits of 1.0 mG at 30cm with the fact that many users may spend considerable hours a day using the systems.

5. Recommendation

It was observed that the radiation from right and left side of the systems are same and the values are low, therefore it is recommended that systems should be placed between 30-40cm apart from either side in a computer laboratory setting as radiation level is highest between 5 – 30cm. Zero radiation emission cannot be achieved in the technological world. But by following safety measures protection from harmful radiation is possible. The following guidelines may be followed to reduces the level of radiation exposure due to systems usage: occasional rest or alternate task breaks, users should sit at least 30 – 40cm from the screen of the laptops and monitors, basic guidelines on system maintenance should be followed, there should also be regulations on the type of laptops and monitors imported into the country and probably guidelines on the type of system computer business owners can use in the practices.

6. References

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