



An Empirical Study on Electromagnetic Radiation in a Residential Complex in Ajmer City with Special Reference to the Household Electrical and Electronics Appliances

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Abstract— Radiation, radiation everywhere but just a few radiations is of expend. Journey of our life from nativity to our mortality, each and every second of our life we are exaggerated by radiations whether we are in our residence or outside. Radiation is energy that is travelling through space in the form of waves or particles. The radiation energy is spreading into atmosphere and getting wasted and it is increasing atmospheric temperature too. Though there are radiations which are useful for an individual like radiations used for cancer treatment; but enhanced amount of anything is always destructive. Nowadays every people have all the necessary electrical and electronics widgets like TV, fridge, washing machine, micro-wave oven, computer, mobile, Wi-Fi modem, power strip etc. in normal house. In this paper we studied about how much radiation is produced by the appliances those are used in house and how these radiations are harmful for human beings. In this paper with the help of spectrum analyzer, AT3000 triaxial antenna, EMF meter, we will calculate the radiations emitted from different mobiles and various house hold appliances that are used in residential complex in Ajmer and a survey is done to calculate the total amount of radiations being emitted from this small area. We also discussed that how much radiation a human body can accept and how to lower down these radiations.

Keywords— radiation energy, spectrum analyzer, mobile phones, home appliances, safety measures, emf meter.

I. INTRODUCTION

The word radiation expresses the emanation of energy which is present in the form of waves or particles through space or through a material medium. Depending upon the radiated particles radiations are further sub-divided into many categories. Present youth is very much anxious about their skin since problem of skin burn is increasing day by day, which is a very good example to demonstrate how harmful is the radiations that are present all around us.

Since these radiations are emitted continuously and trapped in the air, proves to be very harmful for human being.

Nowadays every people having all the necessary electrical and electronics appliances like TV, fridge, washing machine,

micro-wave oven ,computer, mobile, wi-fi modem, power strip etc in normal house. In this paper we studied about how much radiation is produced by the appliances those are used in house and how these radiations are harmful for human beings. In this paper we also discussed that how much radiation a human body can accept and how to lower down these radiations.

1.1 WHAT IS RADIATION ENERGY

Radiation energy is the energy of electromagnetic waves that can travel through space. Harnessing freely available radiant energy from the atmosphere to produce usable power was the discovery of Nikola Tesla [1].

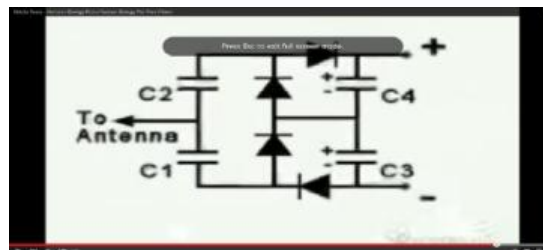


Figure 1 harnessing available radiant energy from atmosphere small circuit diagram

Source: <https://www.youtube.com/watch?v=uZSvbPjb518>



II. TYPES OF RADIATIONS

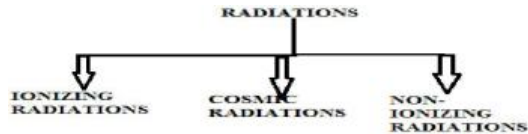


Figure 2: Types Of Radiations

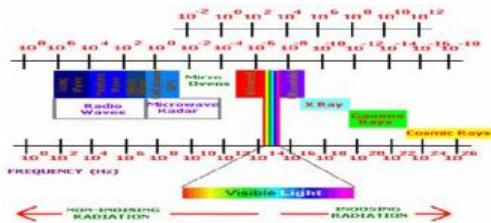


Figure 3: different radiations with their wavelengths

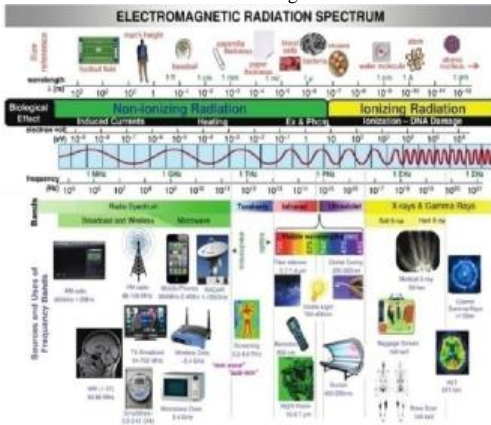


Figure 4: electromagnetic spectrum

II.1 IONIZING RADIATIONS

Those type of radiations that carry enough of energy to ionize atoms. If living tissues are exposed to this radiation then all the cells that are responsible for making up of DNA in cells become ionized and thus causes DNA to malfunction and could lead to cancer. Though these radiations works for good as well like to sterilize medical equipment, medical imaging and most important breath-taking astronomical images

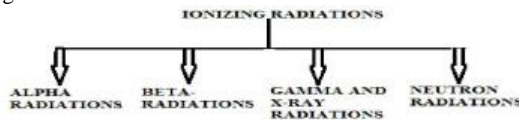


Figure 5: Types Of Ionizing-Radiations

II.2 COSMIC RAYS

All the living things on earth are constantly affected by the radiations coming from the space due to the interaction of sun and stars with earth's atmosphere thus producing magnetic field. Cosmic rays are originated in outer space and travel towards the earth from all the directions at the speed of light. Cosmic rays include high energy electrons, positrons and other sub-atomic particles.

Cosmic rays include 89% of nuclei as hydrogen (proton), 10% helium and about 1% heavier elements. Since cosmic rays are electrically charged so they are easily deflected by magnetic fields making its direction randomized. However they can be traced by electro-magnetic radiations that they produce.

II.3 NON-IONIZING RADIATION

it does not have sufficient energy to remove electrons from atoms. Examples include ultraviolet (UV), visible light, infrared, microwave and radio wave. Although non-ionizing radiation has lower energy, too much of it may still affect our health, e.g. lengthy exposure to UV radiation may cause sunburn.[2]

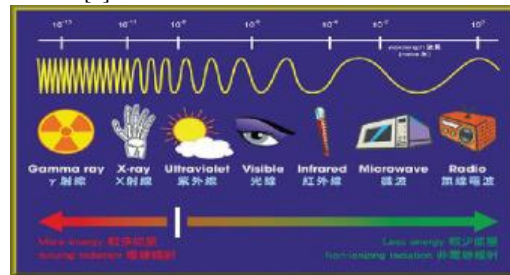


Figure 6: types of non-ionizing radiations

Source: http://www.hko.gov.hk/education/cyber_exh_hall/images/display_3.jpg

III. EMR IN MOBILE PHONES

The type of radiation emitted from mobile phones is electromagnetic radiation. It is present in mobiles because they use radio frequency (RF) waves to make and receive calls. Mobile phone radiation is classified as non-ionizing radiation. Every year, mobile phone companies introduced hundreds of thousands of new mobile phones into market. In India mobile telephony is growing very rapidly.

In India there are 1,034,253,328 numbers of mobile phones [3].

The statistic shows the mobile phone user penetration as share of the population worldwide from 2013 to 2019. In 2013, 56.5 percent of the global population used a mobile phone.

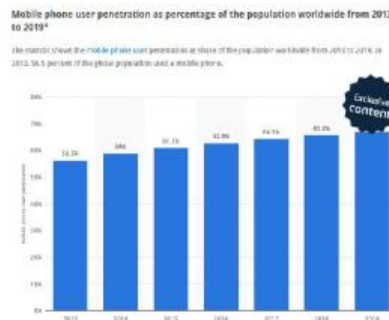


Figure 7: statics showing growth of mobile use among population of India

Source: <https://www.statista.com/statistics/470018/mobile-phone-user-penetration-worldwide/>

IV SPECTRUM ANALYZER



Spectrum analyzers are widely used within the electronics industry for analyzing the frequency spectrum of radio frequency, RF and audio signals. Looking at the spectrum of a signal they are able to reveal elements of the signal, and the performance of the circuit producing them that would not be possible using other means. Below is shown the experimental setup of spectrum analyzer in lab at MNIT jaipur.



Figure 8: instrument setup of spectrum analyzer in lab for respective readings

IV.1 RADIATION MEASUREMENT USING SPECTRUM ANALYZER EMITTED BY MOBILE PHONES IN DIFFERENT MODES

Earlier also many researchers have done a great job to present an idea of radiations using spectrum analyzer [4]. In this paper we use five different types of mobile phones. EMF Radiation of five mobiles carried out with SF8H Spectrum analyzer along with Antenna. The radiation determined at two different modes of operations of mobile phones at 800MHz frequency. to find the radiations from mobile phones we use start frequency as 800MHZ and ending frequency as 2600 MHZ. to find the radiations we used two modes of mobile phones as sleep mode, calling Mode.

Mobile/model	Indian Standard SAR Value	SAR Value of each mobile
Redmi1S/2013029	1.6 W/Kg	1.210 W/Kg (Max)
Samsung	1.6 W/Kg	1.13 W/Kg
Lenovo/VIBEK5NO TE	1.6 W/Kg	Head SAR=0.380 W/Kg Body SAR=0.963 W/Kg
HTC/526G+	1.6 W/Kg	Head SAR=0.995 W/Kg Body SAR=0.693 W/Kg
Micromax/Yuyureka	1.6 W/Kg	Head SAR=0.270 W/Kg Body SAR=0.560 W/Kg

Table 1: mobile models with Indian standard SAR value and SAR value of each mobile.

radiation from different mobile and their calculation using experimental setup shown in fig 8.

1. REDMI 1S/2013029

1.1 in sleep mode:

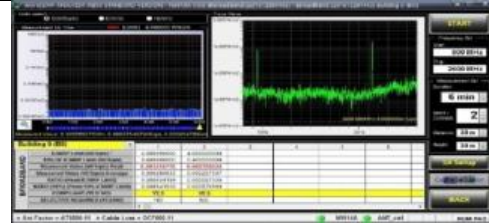


Figure 9: spectrum analyzer showing reading in sleep mode for redmi 1s/2013029

1.2 in calling mode:

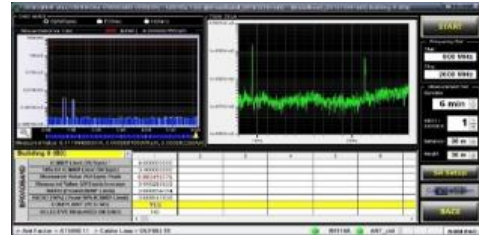


Figure 10: spectrum analyzer showing reading in calling mode for redmi 1S/2013029

1.3 radiation calculations Using Redmi 1S/2013029 mobile
 $.000350624 \text{ w/m}^2 = 0.000001467046025 \text{ mG}$ (in sleep mode)
 $.003416776 \text{ w/m}^2 = 0.0001429613389 \text{ mG}$ (in calling mode)

2. Similarly using a Samsung Mobile V13



Figure 11: spectrum analyzer showing results for Samsung mobile V13

$.000326577 \text{ w/m}^2 = 0.00001366430962 \text{ mG}$ (in sleep mode)
 $.002013525 \text{ w/m}^2 = 0.00008424790795 \text{ mG}$ (in calling mode)

3. Using Lenovo mobile (VIBEK5NOTE)

3.1 In sleep mode

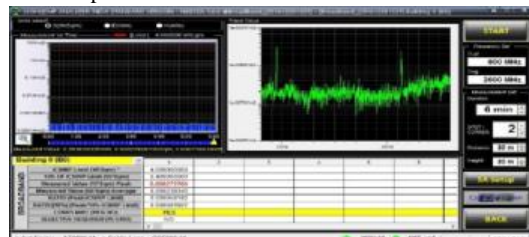


Figure 12: spectrum analyzer showing result for lenovo mobile (VIBEK5NOTE) in sleep mode

3.2 In calling mode

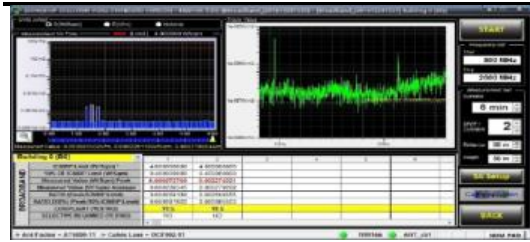


Figure 13: spectrum analyzer showing results for lenovo mobile(VIBEK5NOTE) in calling mode

.000272769w/m²=0.00001141292887mG (in sleep mode)
 .002274221w/m²=0.00009515569038mG (in calling mode)

4. Using HTC mobile

4.1 In sleep mode

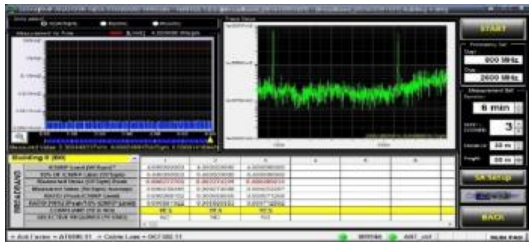


Figure 14: Spectrum Analyzer Showing Results For Htc Mobile In Sleep Mode

4.2 In calling mode

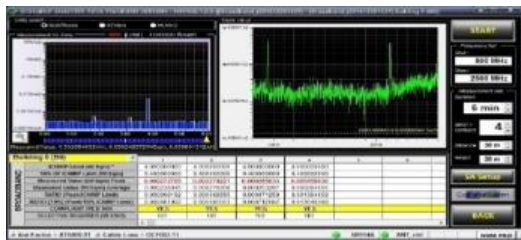


Figure 15: Spectrum Analyzer Showing Results For Htc Mobile In Calling Mode

.000285033w/m²=0.00001192606695mG (in sleep mode)
 .005458636w/m²= 0.0002283948117mG (in calling mode)

5. Using Micromax mobile

5.1 In sleep mode

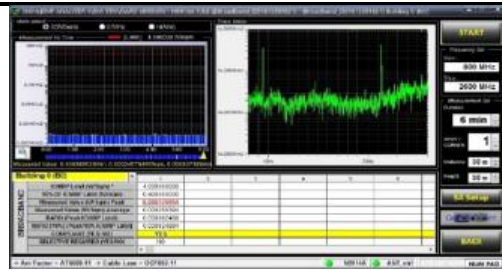


Figure 16: spectrum analyzer showing results for micromax mobile in sleep mode

5.2 In calling mode

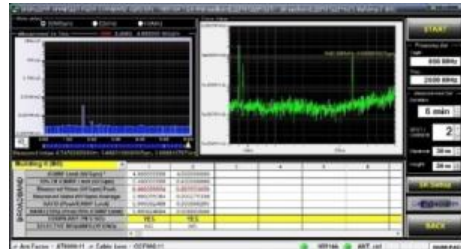


Figure 17: spectrum analyzer showing results for micromax mobile in calling mode

.000329954w/m²=0.00001380560669mG (in sleep mode)

.003553059w/m²= 0.0001486635565mG (in calling mode)

Mobile/ model	Device type	in sleep mode: measured value in (W/m2) peak	in sleep mode (value in mG)	in calling mode: measured value in (W/m2) peak	in calling mode (value in mG)
Redmi 1S/ 2013029	Smart phone	.000350624	0.00001467046025	.003416776	0.0001429613389
Samsung		.000326577	0.00001366430962	.002013525	0.00008424790795
Lenovo/V IBEK5N OTE	Smart phone	.000272769	0.00001141292887	.002274221	0.00009515569038
HTC/526 G+	Smart phone	.000285033	0.00001192606695	.005458636	0.0002283948117
Micromax /Yuyureka	Smart phone	.000329954	0.00001380560669	.003553059	0.0001486635565

Table 2: values of phone radiations in different modes

V EMR PRODUCED BY THE VARIOUS HOUSE HOLD APPLIANCES

Every Electrical and electronic appliances that are used in house produce toxic electromagnetic fields (EMFs). These field creates a harmful level of radiation. Because of use of these appliances kitchen is a hotspot for harmful EMFs, but other rooms are affected, too. An appliance has an electric



field when it is turned on or even when it is turned off. However, the EMFs emit from home appliances are considered extremely low frequency (ELF) that means the radiation flows at very low levels.

VI EMF PRODUCED BY HOUSEHOLD APPLIANCES

Different studies are already done and values are calculated shown in fig 18-19. In this paper we have done a survey in a residential building Florence situated in ajmer city.

SOURCE	mG up to 4 inches	mG at 3 feet
Blender	50-250	0.3-3
Clothes Washer	8-200	0.1-4
Coffee Maker	8-29	0.1
Computer	4-20	2-5
Flourescent Lamp	400-4,000	0.1-5
Hair Dryer	60-20,000	0.1-6
Microwave Oven	100-500	1-25
Television	5-100	0.1-6
Vacuum Cleaner	230-1,300	3-40
Airplane	50	

Figure 18: observations of radiation values approximately upto 4 inches and upto 3 feet
Source: <http://lan.pplreliablepower.com/faqs-emf.aspx>

Extremely Low Frequency	Very Low Frequency	Radio Frequencies	Microwaves	X-Rays
Power Lines Radio Lines Power Generation Electric substations Telephones Mobile phones Cell phones Computer terminals Video Display Office Equipment Battery power Small appliances	Induction heating (IH) Lithium Ion Batteries Pagers Telephones Cell phones Computer terminals Video Display Removable Storage Nuclear Reactors Security Systems	Mobile Radio / CB Broadcast AM/FM TV Radio, Reception Pagers Telephones Mobile phones Cell phones Computer terminals Video Display Mobile "Text" Webcams Cable Modem Satellite systems	Solar, ionization Microwave ovens Welding Industrial heat General heat	Sunlight Fluorescence X-RAY Gamma rays

Figure 19: classification of electronic gadgets according to their frequency ranges/ radiation type
Source: <https://www.safespaceprotection.com/emf-health-risks/emf-health-effects/emfs-in-the-home/>

Radiations calculated from household appliances and calculated as shown below

Experimental Procedure:

1. Locate electronic devices that are used normally in your home. Typical items are: desktop computer, flat screen or older monitor, laptop computer, tablet device, cell phone,

smart phone, printer, speakers, TV, remote control, lamp, refrigerator, coffee maker, modem.

2. Using an EMF measuring device, measure the radiation emanating from various household appliances and calculate the values.

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S.No.	List of appliances	EMR at 3 Feet Distance (mG)
1	Air Conditioner	0
2	Hair Dryer	0.2
3	microwave oven	4.25
4	Washing Machine	0.8
5	Iron	0.1
6	Computer	3.5
7	Refrigerator	0.33
8	Colour TV	0.8
9	Vaccum Cleaner	10.65
10	can opener	3.87
11	Clock	0.35
12	Portable Heater	1.38
13	Electric Shaver	0.2
14	Household wiring	1
15	LE CFL bulbs/Lights	1.5
16	LV Halogen Lights	2
17	Electric Oven	0.25
18	Uninterruptible power supplies (UPS)	2
19	Fans	3.5
20	Coffee machine	0.1
21	Tablet	1.5
22	Mobile/Smart Phone	0.87
23	DVD	1.25
24	Set-Top Box	1.25
25	Immersion Heater	2.5
26	Induction Hob	3
27	Power Drill	4.5
28	Blender/Mixer	1.65
29	Dishwashers	1.85
30	Fluorescent lamps	1.35
31	Laptop	1.5
32	Loudspeakers	4.25
33	Printers	1.31
34	Radio	0.5
35	Remote control devices for TV/DVD	<2
36	Routers, modems and network hubs and switches	1.5
37	Clothes Dryer	0
38	Digital Clocks	0
39	Battery Charger	0
40	Hi Fi / CD player / Tuner etc.	0
41	Fax machine	0
42	Toaster	0.24

Table 3: calculated EMR at 3 feet distance of various house hold items

In fact at present with increasing of this harmful radiations govt. of India is also paying great attention to this field and point and is trying to seek solution for this problem.



Figure 20: newspaper cutting, govt seeking attention to this harmful radiations

Taking this as reference we did a survey to find the amount of radiation present in air so that we can warn people and make them aware about the presence of these harmful radiations. thus, a survey was done by us in a residential building named FLORENCE with super build up area of 1585 sq. ft with 9 floors having total of 90 flats.

As in paper above readings were taken for mobile phones in the same way readings were taken for household appliances.

Images of our survey are enclosed below:

Figure 21: appliances used in different flats

Figure 22: survey sheet 2

The survey was done dated 11/2/2017 in residential complex at ajmer. From total flats above flats were occupied and some flats are on rent not permanent so readings can vary afterwards. These readings were taken on the spot at that moment. The total calculated radiation of building is 4328.54 mG.

From above readings approximate value of radiations were calculated with the help of standard values known to us.

VII HOW TO LOWER DOWN THE RADIATION

1. Using emf adapter we can neutralize harmful electromagnetic fields in our home. The EMF Adapter uses the building's electrical circuitry to send a corrective, harmonizing resonance signal through the wiring of the entire space. Just plug in one EMF Adapter to protect your entire home or office [5].

2. Don't linger near appliances when they're running. Even the best microwave ovens leak some of the radiation they use to heat the food, so stand at least four feet away from the front of the oven when it's running.

3. Towel-dry your hair. Hair dryers are among the most dangerous sources of magnetic fields because they use a lot of power and the motor/heater is held close to the head. Although using a low-fan and/or low-heat setting helps some, it's better to avoid hair dryers altogether. If towel-drying is not convenient, consider using a low-EMF hair dryer.

4. Get a new bedside clock. Old-style alarm clocks—analogue clocks with lighted dials—produce surprisingly high levels of electromagnetic radiation.

5. Safer computer use: Most computers give off electromagnetic radiation. If you use a desktop model, position it toward the back of your desk. Most monitors, which produce lower levels of electromagnetic radiation than computers, have conductive screens to block the ELF exposure. But it's still wise to position your monitor as far away from you as possible.

6. Hardwire the computer to the modem.

7. Turn off the router when it's not in use.

8. Disable Wi-Fi settings on your computer if you don't use a router. Otherwise, the computer—or any device that operates wirelessly, such as some printers—will constantly emit electromagnetic radiation as it tries to find the nearest wireless source. Shut down your computer when it's not in use to reduce ELF radiation in your home.

9. Never allow a child to use a cellular telephone or a cordless phone.

10. Never use an electric hair dryer on a child.

11. Stand at least one metre from an operating toaster, electric kettle, microwave oven, electric stove, electric oven or toaster oven when immediate attention is not required.

12. Remove cordless telephones from bedrooms and replace them with corded units and use battery operated clocks and



radios.

13. Pregnant women must be away from their use of cellular telephones, wireless devices, computers and kitchen appliances.

14. Avoid using wireless connections for computer equipment.

15. Never use a laptop on your lap while it is using AC power.

16. Substitute electrically operated devices with manual devices as much as possible, for example pencil sharpeners and can openers.

17. Prior to purchasing or renting a home have the neighborhood and building surveyed for high levels of electromagnetic and wireless radiation.

18. Avoid using a cellular phone in a vehicle without an external antenna.

19. Remove all electrical wires from under beds[6].

VIII. HARMFUL EFFECTS OF RADIATIONS

1. Even at low levels it can destroy and break down important cells and structures like the GI tract or the blood system. This is seen oftentimes in cancer treatment. The effects of radiation may even be carried out in the next generation in some instances

2. At exposure to 200 rems or more hair loss occurs. Hair follicles are very sensitive to radiation. The hair loss may be permanent or temporary depending on the amount of exposure a person endures. The scalp will be sensitive to exposure, becoming tender and pink. The scalp may feel as though it has been sunburned. After two to three weeks of exposure, the scalp will become dry and itchy.

3. Exposure to radiation kills nerves and small blood vessels, causing seizures and immediate death. At lower doses brain damage can still occur such as decreased intellect, memory problems and confusion, personality and mood changes

4. radiation damages the gastrointestinal tract lining causing nausea, bloody vomiting, abdominal pain and diarrhea. Radiation begins to destroy cells that multiply quickly at this point. These include the blood, the GI tract, reproductive system, hair cells and harms DNA and RNA.

IX. CONCLUSION

So in this paper we used different types of mobile phones to calculate radiations emitted by them using spectrum analyzer and similarly we used different household appliances and calculated radiations emitted by them by doing a survey. During survey we came across many types of questions asked by residential people and so introduced them to this harmful radiations and made them aware by describing the source of emission and safety measures that one can follow to keep himself away from these harmful rays. Also we came to know how much increased amount of these harmful radiations are present in air which may cause so many harmful effects if inhaled in higher amount and these effects can be incurable also especially for kids and pregnant women.

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