



Health Hazards of Electromagnetic Radiation and Preventive Techniques

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Abstract:

Electromagnetic radiation includes radio waves, microwaves, terahertz radiation, infrared radiation, visible light, ultraviolet radiation, x rays and gamma rays. Electromagnetic waves generated by different The Electro Magnetic Radiation generated by the electronic appliances such as desktop computers, laptops, personal grooming appliances, kitchen appliances, televisions, mobile phones and their towers wireless systems. These waves have many effects on the human body as well as our daily lives. The effects of electromagnetic waves cause many problems and diseases in the human body like cancer. Nowadays, types of the cancer caused by these waves have increased, because mobile users have increased. Because of the importance of human, this paper will address ways for humans to reduce the effects of electromagnetic waves and to reduce cancer. The proposal consists of many recommendations in wireless systems like mobile systems, guiding the users of wireless user's especially mobile users how to reduce these waves' effects. Furthermore, this project will describe methods to decrease electromagnetic waves and propose alternative techniques instead. Zero radiation emission cannot be achieved in the technological world. But by following safety measures protection from harmful radiation is possible.

Keywords: Electromagnetic radiation, televisions, cell phone, effect of cell phone radiation, reduction of cell phone radiation effect

1. INTRODUCTION

It is evident that electromagnetic waves generated by different wireless systems like mobile systems, satellite systems, and microwave systems facilitate communication throughout the world. These waves have many negative effects on the human body, on the environment, as well as on our daily lives. The electromagnetic spectrum (EM) contains an array of electromagnetic waves increasing in frequency from Extremely Low Frequency and Very Low Frequency (ELF/VLF), Radio Frequency (RF) and Microwaves, to Infrared (IR) light, Visible Light, Ultraviolet (UV) light, X-rays, and Gamma rays. Electromagnetic waves are emitted by many natural and man-made sources and play an important part in our lives. We are warmed by the electromagnetic emissions of the sun and we see using the part of the electromagnetic spectrum that our eyes detect as visible light. 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. Electromagnetic radiation 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 EM 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 X ray machine, television sets, computers, microwave oven, radar devices, laser devices, mobile phones etc, generates radiations of different frequencies which exists in our environment as electronic smog. Figure 1.1 is the graphical representation of the spectrum of electromagnetic

energy or radiation in ascending frequency (decreasing wavelength). The general nature of the effect is noted for different ranges.

2. PROBLEM IDENTIFICATION

Electromagnetic radiation is the emission of energy from any source. X-rays are an example of radiation, but so is the light that comes from the sun and the heat that is constantly coming off our bodies. When talking about radiation and cancer, many people think of specific kinds of radiation such as x-rays or the radiation made by nuclear reactors. But there are other types of radiation that act differently. Radiation exists across a spectrum from very high-energy (high-frequency) radiation to very low-energy (low-frequency) radiation. This is sometimes referred to as the electromagnetic spectrum. The high-energy radiation includes x-rays and gamma rays. They, as well as some higher energy UV radiation, are called ionizing radiation, which means they have enough energy to remove an electron from (ionize) an atom or molecule. This can damage the DNA inside of cells, which can result in cancer. If RF radiation is absorbed in large enough amounts by materials containing water, such as food, fluids, and body tissues, it can produce heat. This can lead to burns and tissue damage. Although RF radiation does not cause cancer by damaging DNA in cells the way ionizing radiation does, there has been concern that some forms of non-ionizing radiation might have biological effects that could result in cancer in some circumstances like of brain and nervous tissue, headache and memory loss.

3. ELECTROMAGNETIC RADIATION

3.1 CLASSIFICATION OF ELECTROMAGNETIC WAVES

According to their frequency and energy, electromagnetic waves can be classified as either ionizing radiations or non-ionizing radiations (NIR).

3.1.1 Ionizing radiations

Ionizing radiations are extremely high frequency electromagnetic waves (X-rays and gamma rays), which have enough photon energy to produce ionization by breaking the atomic bonds that hold molecules in cells together.

3.1.2 Non-Ionizing radiations

Non-ionizing (NIR) is a term for that part of the electromagnetic spectrum which has photon energies too weak to break atomic bonds. They include ultraviolet radiation, infrared radiation, radiofrequency and microwave fields. NIR cannot cause ionization however have been shown to produce other biological effects, for instance by heating, altering chemical reactions or inducing electrical currents in tissues and cells. There are four subgroups of electromagnetic radiation fields with frequency and intensity. This electromagnetic spectrum begins at a frequency of 1 Hertz (Hz), which is 1 wave per second.

3.2 STATIC ELECTRIC

Stationary electric charge that is built up on the surfaces and materials. Electric fields are associated with the presence of electric charge, magnetic fields result from the physical movement of electric charge. Human body can not feel less than 2000 volts of static discharge. Magnetic fields can exert physical forces on electric charges when charges are in motion. The magnetic flux density measured in teslas (T), is accepted as the most relevant quantity for relating to magnetic field effects. A summary of sources of exposure to static fields in Table.

Table 3.1 Classification and Sources of Electromagnetic Radiation Fields

Type	Frequency range	Source
Static	0 Hz	Natural Video MRI Industrial electrolysis
Extremely low frequency(ELF)	$(0 < f \leq 300 \text{ Hz})$	Power lines Domestic distribution Electric engines in cars, train and tramway
Intermediate frequency (IF)	$300 \text{ Hz} < f \leq 100 \text{ kHz}$	Monitors, Anti-theft devices in shops, Hands free access control systems, Card readers Metal detectors
Radio frequency (RF)	$100 \text{ kHz} < f \leq 300 \text{ GHz}$	Broadcasting and TV; Mobile telephony Microwave oven Radar Portable and stationary radio transceivers, Personal mobile radio.

3.3 EXTREMELY LOW FREQUENCY (ELF)

Extremely low frequency is a term used to describe radiation frequencies below 300 Hertz (Hz). ELF fields are oscillating fields and very important for public health because of the widespread use of electrical power at 50-60 Hz in most countries.

3.4 INTERMEDIATE FREQUENCY (IF)

Intermediate Frequency is a term to describe radiation frequency between 300 Hz and 100 kHz. There are experimental and epidemiological data from the IF range. Therefore, assessment of acute health risks in the IF range is currently based on known hazards at lower frequencies and higher frequencies. Proper evaluation and assessment of possible health effects from long term exposure to IF fields are important because human exposure to such fields is increasing due to new and emerging technologies. Typical examples are: computer and TV screens with use cathode ray tubes, compact fluorescent lamps, as well as radio transmitters, anti-theft devices in shops, hands free access control systems, card readers and metal detectors. It is also used in electro surgery.

3.5 RADIO FREQUENCY (RF)

RF includes the frequencies between 100 kHz and 300 GHz of the electromagnetic spectrum. An RF source is widespread used in whole world. Majority examples are mobile phones, broadcasting, medical and industrial applications. The RF sources are used in different frequency bands and subdivided in different categories.

3.5.1 Sources operated close to the human body

Main examples of this type are mobile RF transmitters. One of the examples is mobile phones; more than 1.5 billion people are using mobile phones worldwide. In addition to mobile phones, other wireless applications like cordless phones, e.g. DECT or WLAN systems are very common. The maximum peak power level of a DECT system is 250 mW, of a WLAN system 200 mW.

3.5.2 Sources operated far away from the human body

Such sources are fixed installed RF transmitters. An example is base stations that are an essential part of mobile communication networks.

3.5.3 Medical applications

Some medical applications use electromagnetic fields in the RF range. Therapeutic applications such as soft tissue healing appliances, hyperthermia for cancer treatment, or diathermy expose the patient well above the recommended limit values to achieve the intended biological effects.

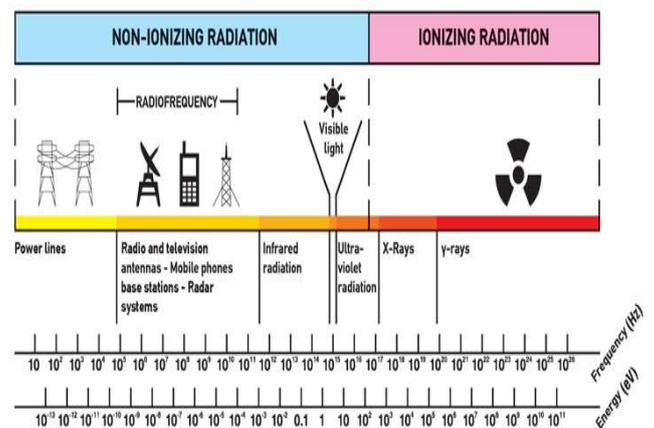


Figure 3.1 Classification of Electromagnetic Waves

3.6 RADIATION TYPES

The world suffers from electromagnetic contamination and electro smog (e-smog). E-smog refers to the huge amount of electromagnetic fields (EMFs) present on this planet. Electrical and magnetic equipment cause smog and produce

invisible EMFs and EMR that constantly attack the human body affecting its bio field. EMR is categorized by frequency and falls into two types: non-ionizing which is the low-level radiation “mistakenly” perceived as harmless to humans, and ionizing which has a potential for cellular and DNA damage.

EMFs fall into these types:

- ✓ Static electric fields caused by ions released from synthetic materials, and can make humans feel unwell.
- ✓ Residual magnetism that often occurs from metal in the bed and can change its magnetic field causing body discomfort.
- ✓ Power frequency fields from wall wiring, electrical outlets, extension cords, lighting and other electrical appliances.
- ✓ These may turn the body into an antenna and interfere with the ability of the cells to communicate with each other.
- ✓ Power frequency magnetic fields caused by faults in wiring, power lines running underground near the sleeping area, electrical panel boxes located on adjacent walls or even a refrigerator or TV located on the other side of a wall.
- ✓ Radio communication frequency fields that include a broad range of radio and TV, cordless phones, wireless devices, cell phones and communication towers.
- ✓ Radioactivity (and its by-product radon): This enters the home from building materials such as granite one-third of the granite in homes is radioactive, and radon gas is emitted from the ground.

4. SOURCES OF ELECTROMAGNETIC RADIATION

4.1 ELECTROMAGNETIC RADIATION FROM COMPUTERS

If we are a computer user, computer radiation may be our largest single source of electromagnetic radiation. 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 people get much closer to their PC's. Many of the people spend most of their days 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. The radiation coming from computer is known as Extremely Low Frequency (ELF) Electromagnetic radiation. This type of radiation is also emitted from power lines, Electrical sub-stations and Television. Another type of dangerous electromagnetic radiation found near computer is microwave radiation. Microwaves are used to provide radio communication between wireless networked equipment, including computers, printers, modems, routers and cordless or Wi-Fi devices. A typical computer user, who is not careful about equipment choice and placement are exposed to two type of radiation. They are Extremely Low Frequency (ELF) Electromagnetic radiation from computers and Microwave radiation from nearby devices. Each of these levels is individually far from safe. When they are taken together they create a serious health hazards.

Table 4.1 Electromagnetic radiation from computers

Sl.No	Type of radiation	Field strength
1.	Extremely Low Frequency (ELF) Electromagnetic radiation from computers	3-6 milligauss
2.	Microwave radiation from nearby devices	100-200 $\mu\text{W}/\text{m}^2$

Electromagnetic Spectrum

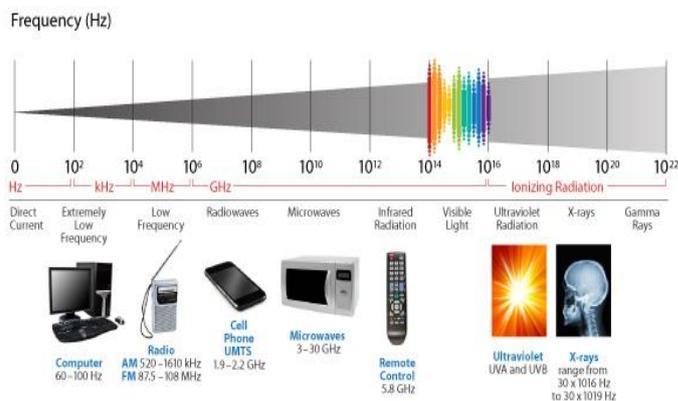


Figure 4.1 Electromagnetic radiation

4.2 ELECTROMAGNETIC RADIATION FROM LAPTOPS

Low frequency Electromagnetic radiation (EMF), High frequency Radio Frequency radiation and heat radiation are the three type of radiation emitted from laptop computers. These three radiations pose real danger to the health. Even though these radiations are emitted by desktop computers, Cell phones, Television and microwave oven but the exposure to this radiation is more intense in laptops because Laptops are operated directly in laps. If the Laptop is placed few feet then this radiation is harmless. Laptop or note book are having similar radiation and it is generally lower than from desktop PC's because the components are smaller, the laptop is battery operated and its screen is invariably LCD or LED. The problem with laptop radiation is that it is operated closely especially in the laps. Laptop radiation is 1 milligauss at 30cm, but as much as 20 milligauss at point blank range. This 20milligauss is having severe health effects.



Figure 4.2 Electromagnetic Radiations from Laptops

4.3 ELECTROMAGNETIC RADIATION FROM PERSONAL GROOMING APPLIANCES

Personal grooming appliances like hair dryers, Electric shavers, electric tooth brushes and similar personal grooming products have 20 – 200 milligauss of magnetic fields at their normal operating distance. To avoid this radiation use the devices for minimum duration, increase the distance of use as far as practicable. Most personal grooming devices are designed to be used only for a minute or two, so they should not add much to the daily EMF load, but people in high risk group should probably avoid them altogether.

4.3.1 Electromagnetic Radiation from Hair Dryers

Appliances that use the most electrical current, such as handheld hair dryers, emit the highest levels of ELF radiation. But even small appliances, such as coffeemakers, produce some. To test electromagnetic radiation around your appliances.

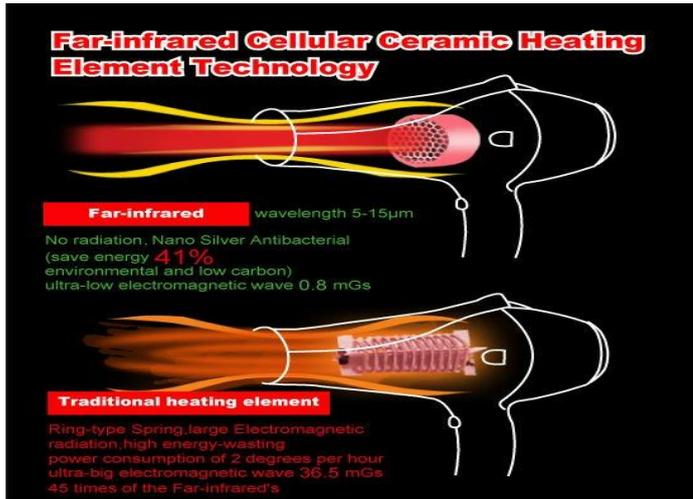


Figure 4.3 Electromagnetic Radiations from Hair Dryers

4.3.2 Electromagnetic Radiation from Electric shavers

These EMFs can come from a number of sources. Extremely low frequency EMFs (ELF-EMFs). Sources of ELF-EMFs include power lines, electrical wiring, and electrical appliances such as shavers, hair dryers, and electric blankets. Radio frequency radiation.

4.3. Electromagnetic Radiation from Electric Toothbrushes

Magnetic fields can represent a health problem, especially low frequency electromagnetic fields sometimes induced by electric current in metallic objects worn or used in or on the body (as opposed to high frequency electromagnetic fields that produce heat). Electric toothbrushes are widely used because of their convenience, but the electric motors that power them may produce electromagnetic waves. In this study, we showed that electric toothbrushes generate low frequency (1-2000 Hz) magnetic fields and induce electric current in dental appliances (e. g. orthodontic and prosthetic appliances and dental implants). Current induced by electric toothbrushes might be dependent on the quantity and types of metals used, and the shape of the appliances. Furthermore, these induced currents in dental appliances could impact upon human oral health, producing pain and discomfort.

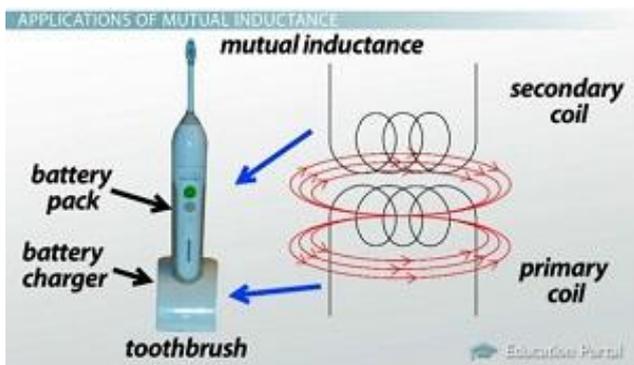


Figure 4.4 Electromagnetic Radiations from Electric Toothbrushes

4.4 ELECTROMAGNETIC RADIATION FROM THE KITCHEN APPLIANCES

Kitchens are the areas of high EMF radiation. Stoves, hotplates and hobs, Microwave ovens, serving trays and dishwashers are source of very substantial EMF's even at 30 - 60 cm. If a person is cooking in kitchen for one hour means he is exposed to EMF of 5-10 mille gauss. So if he does cooking for two to four hours means he crossed the suggested maximum daily EMF exposure of 20 mille gauss. The EMF radiations from kitchen appliances can be reduced by minimize cooking times and turn off the appliances when not in use. Don't stand next to oven and stove while we are not actually working there. Taking one pace away from an appliance will usually reduce EMF by one half or more. Refrigerators and freezers produce most of their EMFs close to the back of the unit and usually near the floor, where the motor is situated. So place the refrigerator and freezer with its back side facing the walls. Don't stand close to them for long. Vacuum cleaners, washing machines and dryers generally produce high EMF's. Don't stand too close to them for long. To avoid this radiation use the devices for minimum duration, increase the distance of use as far as practicable.

4.4.1 Electromagnetic Radiation from electrical Stoves

An electric stove or electric range is a stove with an integrated electrical heating device to cook and bake. Electric stoves became popular as replacements for solid-fuel (wood or coal) stoves which required more labor to operate and maintain. Some modern stoves come in a unit with built-in extractor hoods.

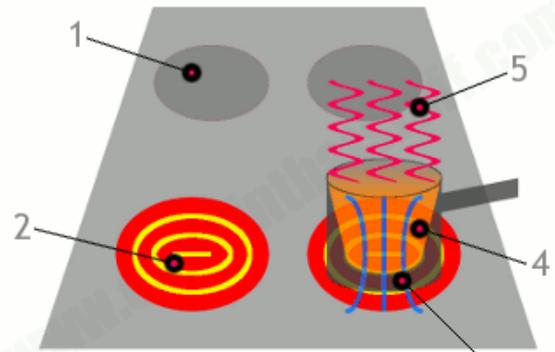


Figure 4.5 Electromagnetic Radiation from electrical Stoves

4.4.2 Electromagnetic Radiation from Microwave ovens

Water molecules vibrate when they absorb microwave energy, and the friction between the molecules results in heating which cooks the food. Unlike conventional ovens, microwaves are absorbed only in the food and not in the surrounding oven cavity.

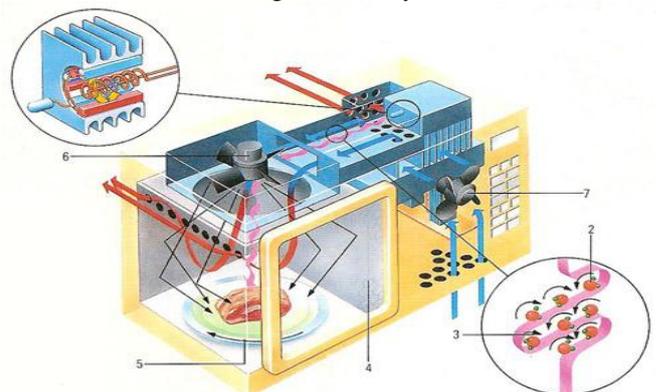


Figure 4.6 Electromagnetic Radiation from Microwave ovens

4.5 ELECTROMAGNETIC RADIATION FROM TELEVISION

Radiation from television is Low frequency Electro Magnetic Radiation. The EMF from TV is more because of the CRT monitors and it produces radiation of 20 milligauss at 30 cm and over 1 milligauss at 1.5 meter. So it is safe to sit at 1.9 meter away from it. It will help to protect human from EMFs and eye damage. Don't sit close to the sides and back of TV. TV radiation is just as high from these angles. LCD and LED TVs (flat screen TVs) produces much less radiation than CRT types and are preferred if possible to afford the extra cost. Modern flat-screen TVs, whether they are LCD, LED or Plasma types emit very little electromagnetic radiation, except at very close range. They are a big improvement over their older, cathode-ray tube (CRT) cousins. We should still discourage children from sitting or standing right next to a flat screen TV, because some parts of the screen do emit mains-related, low-frequency radiation. Actually it is not so much the screen as the electronic components behind the screen, such as the TV's power supply that create the EMF. In most modern TVs this EMF extends up to one or two feet in front of the screen. So as long as you are two feet or more away from your screen, you will be safe. And because the screens tend to be larger, we usually prefer to sit further away from them than two feet, for best viewing experience. Like all low-frequency EMF, the radiation from your TV cannot be effectively screened. It travels through any material, including your body, with ease. But fortunately it diminishes rapidly, which is why it has practically become immeasurable at a distance of two feet. (For the more technically-minded, the EMF strength is inversely proportional to the square of the distance from the source.)

In case you are wondering, the TV aerial itself is not a source of electromagnetic radiation because it does not broadcast a signal, merely picks up a signal already present. So it is not a health hazard. The same applies to satellite dishes. Metal objects (including aerials and satellite dishes) reflect most of the radio-frequency EMF that falls on them, so they can affect the EMF in the space around them – blocking radiation from reaching some spots, and concentrating it in others. But this EMF effect is tiny compared with that produced by a nearby radio-transmitting device such as a cellphone or wireless router. Smart TVs do not necessarily create radio-frequency radiation. It depends how they are set up. Because Smart TVs require an internet connection (usually through a router) they create an EMF hazard if that connection is a wireless one.

This is the same as with any electronic equipment that connects to a network. If you want a wireless connection, you will be exposed to high levels of radio-frequency electromagnetic radiation. Cable connections between Smart TV and Router allow the devices to talk to each other without creating any EMF.

The older box-shaped TVs containing a cathode ray tube produce very substantial EMF radiation. Even a viewing distance of 1.5 metres is not adequate protection from the average CRT Television. Sit at least 1.9m (6 feet) away. It's better for your eyes too. This is particularly important for children, who are more vulnerable to TV radiation than adults. Children should also keep well away from the sides and back of the TV as the EMF from these angles is often just as high as from the front. There are fewer of these TVs around these days, as more and more are being replaced with new flat screen televisions. The older CRT boxes were the cause of TVs getting a rather bad reputation for electromagnetic

radiation in the first place. But for those who still use them, they are perfectly safe provided you sit far enough away.

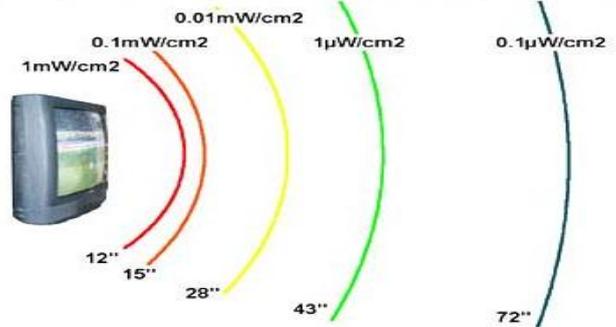


Figure 5.7 Electromagnetic Radiations from Television

4.6 ELECTROMAGNETIC RADIATION FROM MOBILE PHONES

EM radiations have two primary sources in case of mobile services:

- a) Radiations from Base Transceiver Station (BTS)
 - b) Radiations from mobile phone handsets both
- these radiations fall under the category of non-ionizing radiations as these are low energy waves and are unable to break the atoms into ions.

4.6.1 Radiations from Base Transceiver Station (BTS):

A BTS provides wireless communication link between the user and the network. It has a number of radio-transmitters which are combined and fed to Base station antenna through cables. So, the total radiated power will be equal to the sum of output from each transmitter. The maximum exposure to radiations will be at the peak hour when all the channels are used and the sector having the highest call traffic will have the highest exposure to EM radiations. Gain of antennas and transmission power levels also play a vital role in assessing the exposure of EM radiations from BTS. Omnidirectional antennas have higher gain than sector antennas which provide high efficiency and coverage but the risk of exposure also increases. The primary lobes exhibit the maximum radiations in horizontal direction. Radiations from secondary lobes range from medium to low [6]. The level of radiation starts decreasing as we move away from the line of antenna to its side lobes.

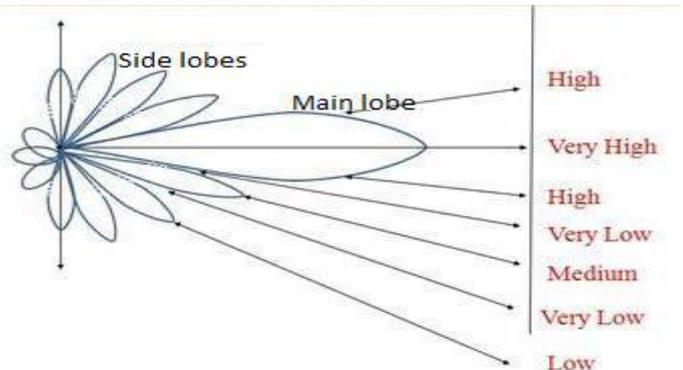


Figure 4.8 Radiation pattern of Base Station antenna

EM radiation depends on the following:

- Frequency / wavelength of RF signal being transmitted.
- Radio Frequency Power radiated from the antenna.
- Duration of Exposure of RF signal at a given distance from the antenna.
- Exposure from other antennas located in the area.
- Duration/ frequency of recurrent exposure.
- Temperature and humidity.

4.6.2 Radiations from mobile phone handsets:

EM radiations from mobile handsets are within limits and are about 1W. It operates within prescribed Specific Absorption Rate (SAR) which gives the amount of radio waves absorbed by body tissues while using mobile phones. SAR is defined as the rate at which energy is absorbed by human body when exposed to electromagnetic frequency (EMF). It expresses the power absorbed per mass of tissue and its units are Watts per Kilogram (W/Kg). In areas of low coverage and low field strength, the prescribed values of SAR can be reached [12]. However, it does not consider the specific transmission properties of each mobile handset. It shows only the maximum value and does not indicate the actual or average value. Although SAR is an important value to compare the maximum exposure to EM radiation but does not have sufficient information about practical EM exposure for reliable comparison of individual mobile phone handset models. The radiations from BTS as well as mobile handsets moves invisibly through human body and plays havoc on its biochemistry. A large number of studies have been done related to exposure to EM radiations which suggests increased risk of many diseases like Alzheimer, heart diseases, miscarriage, brain tumors, leukemia, stress, fatigue, depression, memory loss, sleep disorders, DNA damage, hormonal imbalance, etc.

Mobile phones use electromagnetic radiation in the microwave range. Mobile Phones emit radiofrequency energy, a form of non-ionizing electromagnetic radiation, which can be absorbed by tissues closest to where the phone is held. The amount of radiofrequency energy a cell phone user is exposed to depend on the technology of the phone, the distance between the phone's antenna and the user, the extent and type of use, and the user's distance from cell phone towers. Part of the radio waves emitted by a mobile telephone handset is absorbed by the body. The radio waves emitted by a GSM handset can have a peak power of 2watts and a US analogue phone had a maximum transmit power of 3.6 watts. Other digital mobile technologies, such as CDMA2000 and D-AMPS, use lower output power, typically below 1 watt. The maximum power output from a mobile phone is regulated by the mobile phone standard and by the regulatory agencies in each country. In most systems the Mobile phone and the base station check reception quality and signal strength and the power level is increased or decreased automatically, within a certain span, to accommodate different situations, such as inside or outside of buildings and vehicles. One well-understood effect of microwave radiation is dielectric heating, in which any dielectric material (such as living tissue) is heated by rotations of polar molecules induced by the electromagnetic field. In the case of a person using a Mobile phone, most of the heating effect will occur at the surface of the head, causing its temperature to increase by a fraction of a degree. In this case, the level of temperature increase is an order of magnitude less than that obtained during the exposure of the head to direct sunlight; the brain's blood circulation is capable of disposing of excess heat by increasing local blood flow. But if the temperature increases in magnitude above than that of the exposure of heat to direct sunlight, the brain cannot adjust the change and finally result in Brain Cancer However, the cornea of the eye does not have this temperature regulation mechanism and exposure of 2–3 hours duration has been reported to produce cataracts.

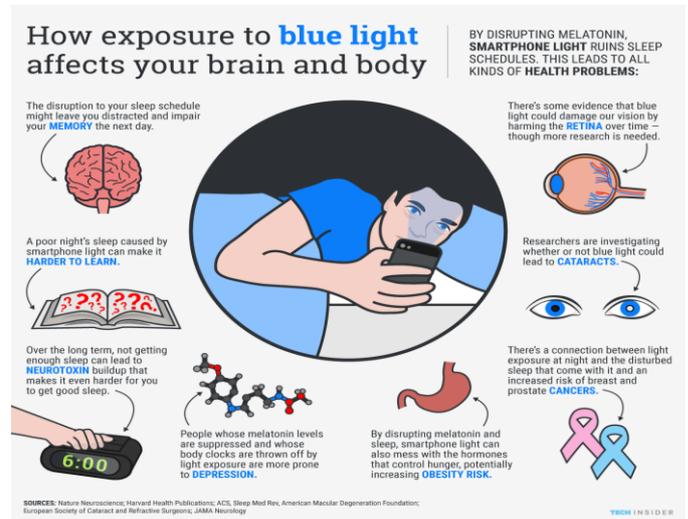


Figure 4.9 Electromagnetic Radiations from Mobile phones

4.7 ELECTROMAGNETIC RADIATION FROM MOBILE PHONE TOWERS

The area of concern is the radiation emitted by the fixed infrastructure used in mobile telephony, such as base stations and their antennas, which provide the link to and from mobile phones. This is because, in contrast to mobile handsets, it is emitted continuously and is more powerful at close quarters. On the other hand, field intensities drop rapidly with distance away from the base of transmitters because of the attenuation of power with the square of distance. One popular design of mobile phone antenna is the sector antenna, whose coverage is 120 degrees horizontally and about ± 5 degrees from the vertical. Because base stations operate at less than 100 watts, the radiation at ground level is much weaker than a Mobile Phone due to the power relationship appropriate for that design of antenna. Base station emissions must comply with safety guidelines.

In September 2012, the Government of India lowered radiation emission limits for mobile phone towers to 450 milli watts/sq m from 4,500. But even this is way above international norms. Several surveys have found a variety of self-reported symptoms for people who live close to base stations. However, there are significant challenges in conducting studies of populations near base stations, especially in assessment of individual exposure.



Figure 4.10 Electromagnetic Radiations from Mobile phones Tower

However the department of telecommunication or DoT has finally woken up to the fact that there may be a correlation between cancer and exposure to radiation from cell phone towers. A comprehensive study conducted by a DoT body has documented cases of cancer deaths in areas overexposed to telecom towers in Mumbai.

5. EFFECTS OF ELECTROMAGNETIC RADIATION

5.1 COMPUTER RADIATION HEALTH EFFECTS

ELF radiation can cause, or contribute to, various health problems ranging from sleep interference and allergic reactions, through to heart disease, cancer and Alzheimer's disease. Using CRT screens for long by pregnant women associated with higher rates of miscarriage and possibly birth defects.

In significant enough doses, computer radiation can have a myriad of negative effects on the body such as; fertility issues with both men and women, DNA fragmentation (irreversible changes to the genetic code), skin burns and rashes as well as other serious health conditions. The dangers from computer radiation come from both thermal and low-energy non-ionizing radiation, which stems from the computer's internal functions and Wi-Fi connection.

Exposure to heat radiation from computers poses a significant danger if it is excessive. As previously stated, prolonged use of laptop computers is common, and therefore dangers to one's health from computer radiation are quite real. Among the biggest risks is the possible damage to fertility if laptops are placed on a male's lap for hours per day. Extended exposure to thermal computer radiation may not only decrease sperm count, but it can also cause severe irritation of the skin. As far as other laptop radiant energy is concerned, electromagnetic radiation is the other primary focus for concerned individuals.

Exposure to large amounts of electromagnetic radiation can cause meaningful damage to healthy cells and chromosome damage. Dangers posed by computer radiation come from excess exposure to electromagnetic radiation and thermal computer radiation from internal computer components. Although there are competing studies as to how serious the dangers may be, tech users can never be too careful. In order to protect oneself from possible negative side effects of computer radiation, there are effective solutions such as the Defender Pad computer radiation shield that helps to minimize possible health damage.

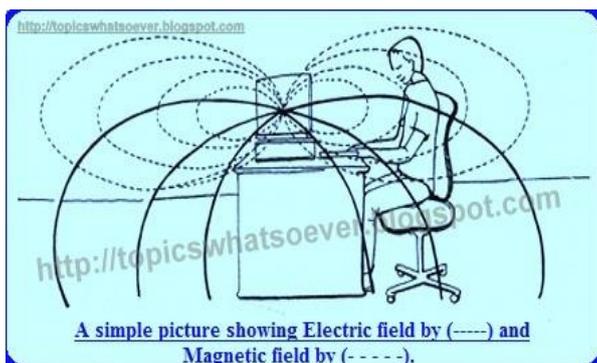


Figure 5.1 Computer Radiation Health Effects

5.1.1 Reason for Health Effects Due To Computer Radiation

- ✓ Normally we sit a foot away from computer screen, with a Central Processing unit and printer on the Desk

next to us, and a power supply that is an Uninterruptable Power Supply (UPS) near the feet, and we sit near all this for several hours every day, for many years, absorbing more ELF radiation which is greater than we sit near a high voltage power line.

- ✓ Computer contains power supplies, fans, drivers and other electrical units which generate ELF radiation strong enough to cause concern at distance up to about 60 cm. The desktop PC's produce computer radiation of 1 milligauss (borderline safe) at 60 cm, and it produces stronger radiation towards the rear of the unit. The magnetic portion of this Electromagnetic radiation is the dangerous part and it penetrates deep into the human. But this ELF radiation naturally falls away very quickly with increasing distance, because the radiation is from a low power source.
- ✓ CRT monitors produce computer radiation of 3 milli gauss at 30cm, measured from the front and 4 milli gauss at the same distance from sides. Computer monitors radiation is a health hazard in itself at this distance.
- ✓ UPS produces radiation of 20 milligauss at 30 cm and over 1 milligauss at 1 meter, even when apparently switched off but still connected to mains electricity and charging the battery.
- ✓ Small desktop computer printers generally produce less than 0.5 milligauss at 60 cm in standby mode and up to twice the amount when printing.
- ✓ Wi-Fi information networks, wireless routers, modems and other wireless devices emit Microwave and radio frequency Electro Magnetic Radiation. They are not safe and result in cell and DNA damage, Infertility and interfere with Biological process.
- ✓ Large sub – woofers that are used as part of computer's sound system emit 20 milligauss of ELF radiation at 0 cm, 3 milligauss at 60 cm, 0.5 milligauss at 90 cm even though it is not producing sound and it is only powered.

5.2 LAPTOP RADIATION HEALTH EFFECTS

All the three radiation are close to the genitals, skin and muscle. This radiation creates bodily reactions such as skin rashes, muscle soreness and Infertility. Heat and Electronic radiation exposure, particularly when prolonged at high levels, coincide with fatigue, dizziness, head ache, breathlessness and various type of cancer. When these radiations are exposed directly into the lap, more serious health conditions include cell and DNA damage, infertility and skin damage. Male fertility can be negatively affected by the heat because an increase in scrotal temperature decrease sperm count. Wi-Fi radiation leads to DNA damage and sperm motility.

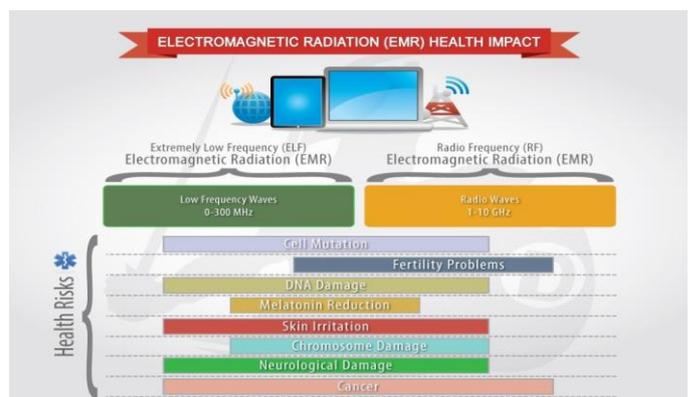


Figure 5.2 Laptop Radiation Health Effects

5.2.1 Reason for Health effects due to Laptop Radiation

- ✓ When converting energy to perform the various functions of the laptop, Electromagnetic Fields (EMFs) are created.
- ✓ These fields are in the low frequency range and radiate out of the outer shell of the computer from such sources as processor activity, hard drive operations, memory storage and other computing functions.
- ✓ To connect to the internet laptops, iPads and other computer devices use technologies such as Bluetooth, Wi-Fi and 4G.
- ✓ To make these connections, laptop is equipped with a receiver and a transmitter. The transmitter produces higher frequency Radio Frequency (RF) radiation, and when placed in lap, the laptop radiates the dangerous emissions directly into the body.
- ✓ Heat energy is radiated from the internal parts. Older laptops emitting the highest levels of heat radiation Laptops used directly in our laps expose us to more intense radiation that would be harmless otherwise if we were only a few feet away.

5.3 MOBILE PHONE RADIATION HEALTH EFFECTS

Burning and tingling sensation in the scalp, Fatigue, Sleep disturbances, dizziness, lack of concentration, ringing in ears finally result in hearing disorders, increased reaction time, indigestion, acute itchiness, increased heart rate, headache, loss of memory, cataracts, anxiety neurosis, glioma type of brain cancer, lung cancer and breast cancer.

5.3.1 Effects on Human Health:

Every individual respond in a different way to similar levels of EM radiations. There are various short-term and long-term effects from mobile radiations. Short-term effects may include sleep disorders, headaches, depression, memory loss, etc. while long-term effects can be brain tumor, cancer, DNA damage, etc.

5.3.1.1 Cancer

According to a study performed by doctors from German city of Naila, a newly-diagnosed cancer rate is three times higher for those living within 400 meters of mobile phone towers than those living far away. Breast cancer was one of the most observed while that of prostate, pancreas, bowel, skin, lung, and blood also increases. Children and teenagers, before the age of 20 are five times more likely to get brain cancer, as their brain is not fully developed and radiation penetration is much deeper. It is possible that today's young people may suffer an "epidemic" of the disease in later life.

5.3.1.2 Hormonal imbalance

Studies conducted by Charles Graham, PhD, physiologist at Midwest research Institute in Kansas City, shows that EM radiations imbalances the hormones. Women and men were exposed to higher levels of EM radiations for a night in the laboratory which increased their serum estrogen levels in women and decreased the testosterone levels in men.

The increased levels of estrogen develop the risk of cancer and decreased level of testosterone has been related to development of prostate and testicular cancers. Another hormone called, melatonin, secreted by pineal gland in brain and is responsible for sleep cycle is also effected by EM radiations. The level of melatonin is higher at night and is low during the day. It is produced almost 90 minutes after we fall asleep. When this hormone is inhibited by radiations many problems are caused like sleep disorders, insomnia, headaches, etc. The cells are repaired and rejuvenated while sleeping but lack of sleep can lead to development of cancer.

5.3.1.3 DNA damage

Studies by Carl Blackman have shown that weak electromagnetic fields release calcium ions from cell membranes. Leakage of calcium ions into the cytosol acts as a metabolic stimulant, that is responsible for growth and healing, and also promotes the growth of tumors. Loss of calcium ions causes leaks in the membranes of lysosomes releasing DNA's that causes DNA damage. Another possibility of DNA damage can be through increased free radical formation inside cells, which further causes cellular damage in the mitochondria.

5.3.1.4 Stress

Mobile phones can cause physical stress in the body in addition to mental interruptions. When the body experiences a stress event the "flight or fight" response is triggered. Certain stress hormones are released from the adrenal glands, the first of which is adrenaline. The effects of adrenaline include rapid heart rate, increased energy level, increased blood pressure, muscle contraction, rapid breathing, etc. These effects are not harmful if they only occur for a short period of time but can harm the body in case of long periods. Another chemical released by the adrenal gland is a hormone called cortisol. Cortisol is the body's natural form of cortisone. When the human body is chronically stressed higher amounts of cortisol are released. These high amounts of cortisol suppress the immune system, blood sugar levels rise and insomnia can occur. Finally, after long-term continual stress responses the adrenal glands become tired and fatigued. Symptoms like Irritability, fatigue, anger, road rage, high blood pressure, loss of blood sugar control, decreased thyroid function and weight gain can result from this condition.

5.3.1.5 Miscarriages and high Blood Pressure

Exposure to mobile phone radiations can increase blood. A German study, published in The Lancet, reported that the level of blood pressure was increased in a group of volunteers when mobile phones were randomly turned on and off without the participants knowledge. Another hazard linked to the EM radiations exposure is miscarriages. One of the studies conducted in this area shows a 180% increased risk for miscarriage when exposed to medium to low radiations

5.3.2 Reason for Health effects due to Mobile Phones radiation

The number of cell phone users has increased rapidly. The number of cell phone calls per day, the length of each call and the amount of time people use cell phones has increased. Cell phone technology has also undergone substantial changes. It is advisable to talk only for six minutes per day or two hours in six months in cell phones because it is the maximum amount of heat energy which the brain cell can dissipate if the limit exceeds means split in brain cell occur.

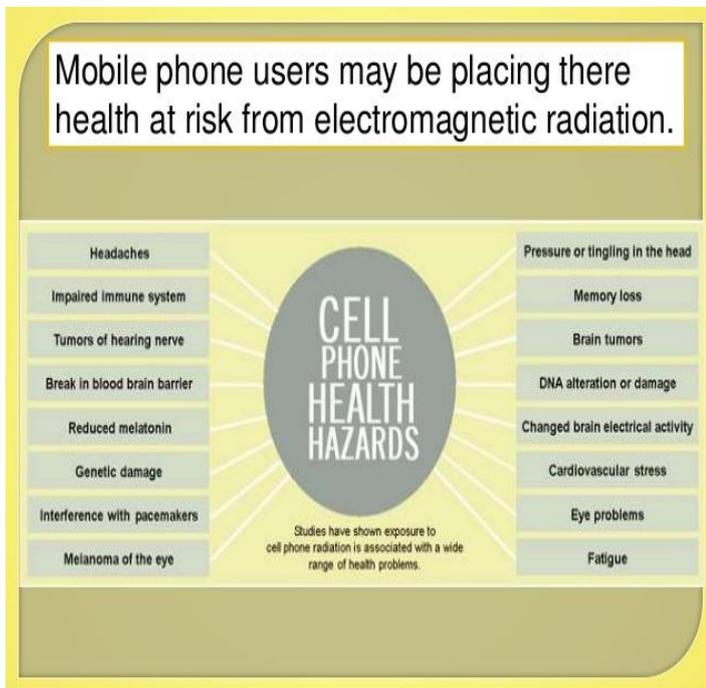


Figure 5.3 Mobile Phone Radiation Health Effects

6. MEASURES TO REDUCE RADIATION HAZARDS

6.1 MEASURES TO REDUCE COMPUTER RADIATION

- ✓ Fortunately there are simple measures to reduce Computer radiation.
- ✓ ELF radiation naturally falls away very quickly with increasing distance, because the radiation is from a low power source. So the simple solution is to position the computer as far away from us by means of cables (allow at least 60cm from us). Keep the CPU, Printer and other devices far away from us preferably on the floor.
- ✓ This is to minimize the radiation to the head and trunk. Computer monitor radiation can be avoided by replacing the CRT screen by LCD and LED screens. LCD and LED screens radiate EMF of 0.3 milli gauss at 30 cm, from the front or back and nothing at the sides. This is a much safer level.
- ✓ Connect UPS by means of cable and place it at a distance of 1.5 meters away from feet. Keep Desktop printers at a safe distance of more than 60 cm.
- ✓ Some corded desktop devices are particularly harmless, including keyboards, Mouse, small speakers, modems and telephone landlines.
- ✓ It can be kept close to humans. Large sub woofers must be kept at least 90 cm away from feet or body of humans. Otherwise it will deafen the ears.

6.2 MEASURES TO REDUCE LAPTOP RADIATION

- ✓ Keep the laptop off the lap and place it at a distance of 30 cm. Laptops may have been designed for convenient lap placement, but this is obviously not best for health. Instead, use laptop on a desk or get a specially designed laptop tray or Laptop mount.
- ✓ Also, use a wired internet connection when possible, as it appears the radiation emitted from Wi-Fi communications are particularly harmful to sperm.

6.3 MEASURES TO REDUCE MOBILE PHONE RADIATION

- ✓ Break the addiction. Use only a landline. Use it only for real emergencies. Never for conversations. If you must use a mobile phone, use text messages, **hands-free kits** and/or the **loudspeaker mode**.
- ✓ Use hands-free to decrease the radiation to the head because hand free increase the distance between the head of user and the phone. Keep the mobile phone away from the body. Don't allow children who are in the age group of 2-6 to use Mobile Phones.

6.4 MEASURES TO REDUCE MOBILE PHONE TOWER RADIATION

- ✓ Safe Space Products actually convert harmful electromagnetic fields around by setting up corrective resonances. One such safe space product is safe space geo resonator, by planting it around the home or office near mobile Phone towers it transform the electromagnetic stress fields in the atmosphere or soil.
- ✓ The way to reduce tower radiation is by reducing the transmitted power. It is done by means of the amplification of power in the cell towers be reduced by removing the power amplifier or by reducing the gain of the antenna.
- ✓ By reducing the power, coverage area will be reduced, which can be taken care of by using more cell towers or repeaters or in-building solutions. The height of towers should be increased. All towers in close proximity to schools and hospitals should be checked and removed, if too close.

7. PREVENTIONS FROM EM RADIATIONS

7.1 SAFETY GUIDELINES FOR PREVENTIONS OF HEALTH HAZARDS FROM THE EM RADIATIONS

There are wireless signals all around us and these are invisible. We cannot escape the radiations but we can follow safety guidelines given by various organizations to minimize the health hazards from these radiations. International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an independent body that studies the ill effects of non-ionizing radiations on human health. It comprises of experts from various fields such as Epidemiology, Biology, Do simetry and Optical Radiations, etc. As per ICNIRP guidelines, the safety levels are

Table 7.1 Safety Guidelines by ICNIRP

Frequency range (f)	Power density (W/m ²)
400 MHz – 2GHz	f/200
2GHz – 300GHz	10

In India, monitoring of the radiation emanating from the BTS is carried out by the Department of Telecommunications (DoT). The DoT has issued instructions regarding setting up of acceptable EMF radiation limits and the testing procedure to be followed. The Telecom Enforcement Resource & Monitoring (TERM) Cells, a unit of DOT, tests upto 10% of BTS sites selected randomly by them. Additionally, BTS sites, against which there are public complaints, are also tested by TERM Cells. In 2008, DoT has adopted the ICNIRP Guidelines and prescribed limits/levels for antennas (Base Station Emissions) for general public exposure. Safe radiation levels should be adopted as 0.01W/m² which will reduce the transmission power from

each mobile tower. More number of repeaters and fiber optic solutions should be installed. The installation of antenna should be in such a way that it should not be installed in the direction of houses/buildings. The antennas should be installed away from the densely populated areas.

7.2 TO AVOID POTENTIAL RISKS, SOME SIMPLE STEPS CAN BE EMPLOYED TO MINIMIZE EXPOSURE AND EFFECTS OF RF RADIATION

- ✓ The time spent by a person on using mobile phones should be reduced.
- ✓ If long conversations by mobile phone must be conducted on daily basis then distance should be placed between the body and the source of the EM radiations, which will help in minimizing the exposure level. For example, one can use headset with the mobile phone so that a distance can be maintained between the body and the mobile phone handset.
- ✓ Devices marketed under Cell/Wave Guard were found to reduce a significant amount of radio frequency emissions could be used to prevent these emissions from entering the body. While this represents a significant reduction it is not known if it is enough to guard against all potential effects. However, it is the best technology easily available today.
- ✓ Digital mobile phones can be used instead of analog phones as digital phones emit lower EM radiations, thus lowering potential adverse effects.
- ✓ Mobile handsets with lower SAR value should be preferred while purchasing as most mobile phone providers give information about the SAR values on the batteries of these phones.
- ✓ People with pacemakers should take some simple precautions to make sure that their cellular phones do not cause a problem. For example, they should hold the mobile phone to the ear on the opposite side of the body where the pacemaker is implanted. Some extra distance between the pacemaker and the phone should be maintained. Placing the mobile phone near pacemaker, i.e. in shirt pocket, should be avoided.

8. CONCLUSION

The Electro Magnetic Radiation generated by the electronic appliances such as desktop computers, laptops, personal grooming appliances, kitchen appliances, televisions, mobile phones and their towers, and their related health effects, reason for health effects along with the measures to reduce the radiation are proposed. This paper has also reviewed long-term and short-term effects of electromagnetic waves. Long-term usage of electromagnetic application causes of health hazards such as cancer, high blood pressure, miscarriages, DNA damage, hormonal imbalance etc. while their short-term uses can cause conditions like insomnia, depression, headaches, sleep disorders, etc. Zero radiation emission cannot be achieved in the technological world. But by following safety measures protection from harmful radiation is possible. To minimize the health issues related to the exposure of radiations the safety guidelines provided by various organizations such as ICNIRP should be followed. Following some simple habits to control the health hazards from the electromagnetic radiations.

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