

Research on the Effects of Mobile Phone Electromagnetic Radiations and its Prevention

¹Shivam Sharma, ²Nitin Kumar Sahu, ³Vivek Ranjan Mishra
¹Student, ²Assistant Professor, ³Assistant Professor
GL Bajaj Group of Institutions

Abstract - Now days, use of mobile phone has enlarged to a large extent. Mobile communication (MC) opened an absolutely new page in the possibilities of population communication, rendering assistance, operative communication etc. Mobile phone technology has several advantages and has grown rapidly in the last decade. In 2018, TRAI said in its telecom statistics report that India's total mobile subscriber base including active and inactive users has reached 1.2 billion and 461000 mobile towers, mounted with around 1.8 million base tower stations (BTSs), as of May 2018. Numbers of mobile phones and towers are increasing without considering its disadvantages. All over the world, people have been debating about associated health risks due to electromagnetic radiation from mobile phones and mobile phone towers. Previous research studies show no evidence of the impacts of mobile phones to human health. New studies suggest that mobile phone radiation might double the risk of developing cancer on the side of the head used, increase brain activity, and can cause damage to nerves around ears. This paper discusses various problems caused by the wireless communication technologies and expected methods to reduce the effects. Our conclusion shows that long-term exposure to EMF radiation from a mobile phone could cause serious health effects such as brain cancer, brain tumor, etc. More long-term studies and analysis are much needed.

keywords - Mobile tower, Specific Absorption Rate Mobile phone, electromagnetic field radiation, health effects, diseases.

1. INTRODUCTION

With the widespread use of mobile phones in the past decade, human exposure to low-energy radiation in the 800- to 2,000-MHz range (microwave) has increased dramatically [1]. The radiation absorbed by the human body is measured using Specific Absorption Rate (SAR) The SAR limit allowed over a volume of 1 gram of tissue is fixed as 1.6 W/kg, in India [2]. It is highlighted that microwaves from mobile phones may promote sleep and modifies brain activity. If mobile phone is ON it radiates electromagnetic field [3]. The studies reflected public concerns about childhood and adult cancers. The possibility that some individuals experience hypersensitivity or other symptoms in response to mobile exposure was a high priority for research [4]. With increasing number of mobile phones, the numbers of mobile towers have also increased multifold. The towers installed on the rooftops of houses and in densely populated areas are causing some serious health hazards. On May 31, 2011, International Agency for Research in Cancer (IARC), part of WHO (World Health Organization), designated mobile phones as "Possible Human Carcinogen" [5].

1.1 Electromagnetic radiations

Electromagnetic radiation is a form of energy that is produced by oscillating electric and magnetic disturbance, or by the movement of electrically charged particles traveling through a vacuum or matter and the electromagnetic radiation is described by the flow of photons in the space. Each photon contains a certain amount of energy, and the different types of radiations are defined by the amount of energy found in the photons [7]. The electromagnetic spectrum is the range of all types of EM radiation.

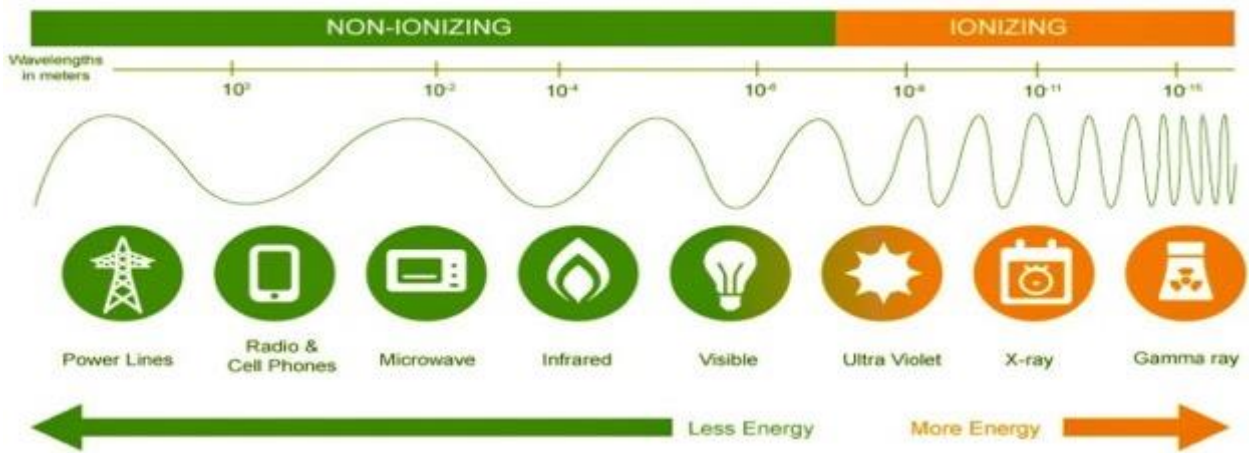


Fig.1 A diagram of the electromagnetic spectrum, showing various properties across the range of frequencies and wavelength.

There are two types of EM radiations:

1. Ionizing radiations: Ionizing radiation is radiation with enough energy so that during an interaction with an atom, it can remove tightly bound electrons from the orbit of an atom, causing the atom to become charged or ionized. Examples include ultraviolet rays, X-rays, gamma rays, cosmic rays, etc.

2. Non-ionizing radiations: Non-ionizing radiation is the term given to *radiation* in the part of the electromagnetic spectrum where there is insufficient energy to cause ionization [8]. These are low-frequency radiations. Examples are radio waves, microwaves, infrared waves, etc.

1.3. Effects of EM radiations

Effects of EMF radiation can be studied in two ways i.e. **bio-effects and health effects.**

Bio-effects are measured as responses to a change in the atmosphere and may not harm our health. Biological effects can be of two types i.e. **Thermal and Non-Thermal effects.**

a) Thermal Effects refers to the heat generated due to absorption of EM radiations. The heating effect can occur near head while using mobile phones which can increase its temperature. Using mobile phones for longer duration can increase the temperature of the body.

b) Non-thermal effects are effects that are not due to the increase of thermal energy of the material. Instead, the microwave energy itself directly couples to energy modes within the molecule or lattice. The main effect of the absorption of microwaves by most materials is heating; the random motion of the constituent molecules is increased. Non-thermal effects are effects that are not due to the increase of thermal energy of the material.

Health effects are the changes which may be short term or long term. These effects stress the system and may be harmful to human health.

1.2 Problem Formulated

Fig. 2(a) shows the scan image of a common human head before the usage of mobile phone. From this image we can observe that the temperature of this human is within the range of standard temperature.

Fig. 2(b) shows the scan image of a common human after the usage of mobile phone for 15 minutes. From this we can observe that heat generated inside the head is massive when compared to the previous image. This clearly shows that the interaction of EM radiation with human head is the fact behind the cause for this massive increase in temperature [6].

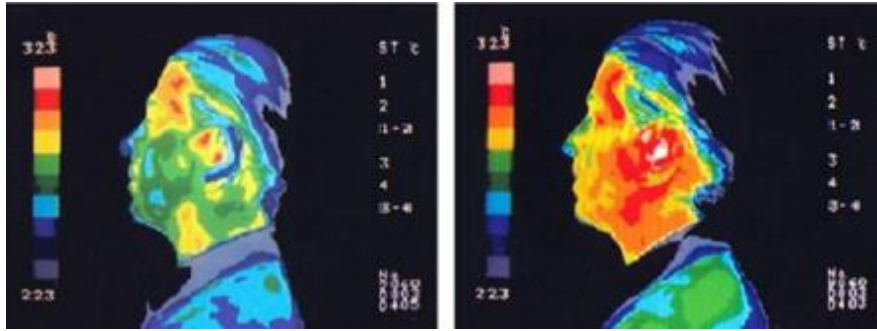


Fig.2 (a) before using mobile phone Fig.2 (b) after using mobile phone for 15 minutes

2. SOURCES OF EM RADIATION

2.1 Radiation from mobile phones

A mobile phone transmits 1 to 2 Watt of power in the frequency range of 824 to 849 MHz (CDMA), 890 to 915 MHz (GSM900), 1710 to 1780 MHz (GSM1800), 1920 to 1980 MHz (3G) and 2 to 8 GHz (4G). Radiation from mobile phone is defined by its SAR (Specific Absorption Rate) value. In USA, SAR limit for mobile phones is 1.6W/Kg, which is actually for 6 minutes per day use. It has a safety margin of 3 to 4, so a person should not use mobile phone for more than 18 to 24 minutes per day. This information is not commonly known to the people in India, so millions of people use mobile phones for more than an hour per day without realizing its associated health hazards. Majority of the people have reported that if they use mobile phones for more than 20 minutes, their ear lobes get warm, which is due to heating of blood by microwave energy of mobile phones.

The problem starts with a pain in the ear that gradually develops into tinnitus or a ringing sensation which finally leads to hearing loss and ear tumor. Also, overuse of mobile phones leads to drying of the skin and fluid in the eyes, sleep disorder, lack of concentration, memory loss, and even cancer [9].

2.2 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 [5]. The antennas may have electrical or mechanical down-tilt, so that the signals are directed towards ground level. Large numbers of these towers are mounted near the schools, hospitals, residential and office buildings to provide good mobile phone coverage to the users. These mobile towers transmit radiation 24x7, so people living within 100's of meters from the tower will receive 10,000 to 10,000,000 times stronger signal than required for mobile communication. In India, millions of people reside within these high radiation zones [9].

A GSM900 base station antenna transmits in the frequency range of 935 - 960 MHz frequency band of 25 MHz is divided into twenty sub-bands of 1.2 MHz, which are allocated to various operators. There may be several carrier frequencies (1 to 5) allotted to one operator with upper limit of 6.2 MHz bandwidth. Each carrier frequency may transmit 10 to 20W of power. So, one operator may transmit 50 to 100W of power and there may be 3-4 operators on the same roof top or tower, thereby total transmitted power may be 200 to 400W. In addition, directional antennas are used, which typically may have a gain of around 17 dB (numeric value is 50), so effectively, several KW of power may be transmitted in the main beam direction [10].

2.2.1 Radiated power density from the mobile tower

Power density P_d at a distance R is given by

$$P_d = \left(\frac{P_t \times G_t}{4\pi R^2} \right) \text{ Watt/m}^2$$

Where, P_t = Transmitter power in watts

G_t = Gain of transmitting antenna

R = Distance from the antenna in meters

For $P_t = 20 \text{ W}$, $G_t = 17 \text{ dB} = 50$, P_d for various values of R is given in Table 1.

Table 1 – Power density at various distances from the transmitting tower

Distance R (m)	Power density P_d in W/m ²	Power density P_d in μ W/m ²
----------------	---	---

1	79.6	79,600,000
3	8.84	8,840,000
5	3.18	3,180,000
10	0.796	796,000
50	0.0318	31,800

The power density values given in Table 1 are for a single carrier and a single operator. If multiple carriers are being used and multiple operators are present on the same roof top or tower, then the above values will increase manifold. However, radiation density will be much lower in the direction away from the main beam. One should know actual radiation pattern of the antenna (which unfortunately is not made public) to calculate exact radiation density at a point [9].

2.2.2 Radiation pattern of the antenna

The radiation pattern of antenna is a representation (pictorial or mathematical) of the distribution of the power out-flowing (radiated) from the antenna [7]. The primary lobe exhibits 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 fig 4.

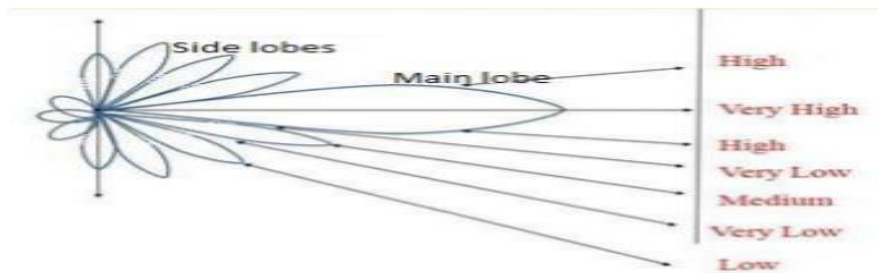


Fig.4 Radiation pattern of base station antenna

EM radiation depends on the following: -

- i. Frequency / wavelength of RF signal being transmitted.
- ii. Radio Frequency Power radiated from the antenna.
- iii. Duration of Exposure of RF signal at a given distance from the antenna.
- iv. Exposure from other antennas located in the area.
- v. Duration / frequency of recurrent exposure.
- vi. Temperature and humidity [5].

3. 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.

1. 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.

2. 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 [13].

3. Effect on Skin:

Radiation from mobile towers and mobile phones affects human skin. People who talk often on mobile phones have a higher concentration of the transthyretin protein than those who do not. Transthyretin is formed in the liver; it helps transport vitamin A in the body and plays an important role in nervous diseases such as Alzheimer's [4].

4. Sleep Disorders:

Electromagnetic fields have been shown to affect the brain physiology. Use of mobile phones disturbs Stage 4 sleep, the stage important for full recuperation of brain and body. Use of the handsets before bed, delays and reduces sleep, and causes headaches, confusion and depression. The findings are especially alarming for children and teenagers as they use mobile phones at night and also keep the phone next to their head; which may lead to mood and personality changes, depression, lack of concentration and poor academic performance.

4. STUDIES OF VARIOUS COUNTRIES

There have been several studies of people living near cell phone antennas in Spain, Sweden, Germany, India, Australia, France, etc. All these studies documents adverse health effects and exposures are orders of magnitude below the FCC or ICNIRP guidelines. Some of these studies are summarized below:

GERMANY (Eger H, 2004)

According to a study performed by doctors from German city of Naila [5], 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 [11].

SPAIN (Oberfeld 2004)

In Spain the population of the town of La Nora subjected to EMF influence since 1997/1998 was examined, the authors obtained statistically important health changes of the population which they associate with EMF influence. These changes were reduced to complaints about higher fatigability, irritability, headache, sickness, appetite reduction, and sleep disorder, tendency towards depression, discomfort feeling, memory reduction, vision disorder, dizziness, and appearance of cardio-vascular problems [14].

FRANCE (Santini, 2002)

The attempts have been taken to estimate BS EMF influence on population. French scientists have systematized complains of the population living near base stations. The estimation of complains of 530 people was performed who lived at different distances from BS (from 10 m to >300 m). On the basis of the obtained data the authors made a conclusion that the distance up to 300 m from BS is critical to some extent and it is undesirable to build kindergartens, schools, hospitals, living quarters for elderly people in this area [12].

SWEDEN

Sweden was one of the first countries to claim 100% mobile connectivity. Survey studies show that somewhere between 230,000 - 290,000 Swedish men and women out of a population of 9,000,000 are now electro-hypersensitive (EHS) and report a variety of symptoms when being in contact with electromagnetic field sources. Symptoms include - allergic reactions, redness of skin, memory loss, sleep disruption, headache, nausea, tingling, altered reflexes, buzzing in the head, palpitations of the heart, visual disorders, cardiovascular problems, respiratory problems etc. Severe symptoms like leukemia, brain cancer, and acoustic neuroma (tumor in the ear) have also been reported [10].

AUSTRALIA

The top floors of a Melbourne office building were closed down and 100 people were evacuated after a seventh worker in seven years was diagnosed with a brain tumor. The Australian Health Research Institute indicates that due to billions of times more in volume electromagnetic radiation emitted by billions of mobile phones, internet, intranet and wireless communication data transmission, almost one-third of world population (about 2 billion) may suffer from mobile Phone Cancer beside other major body disorders like heart ailments, impotency, migraine, epilepsy by 2020.

INDIA

Usha Kiran Building in Mumbai has reported 6 cancer cases in sequential floors as they were in the main beam of the transmitting tower antenna in the opposite building. In Andheri, 15 cancer cases have been reported due to heavy cluster of mobile towers. Mr. Bhagwant Deshpande of Solapur has reported 9 deaths due to cancer living within 91m from the two towers [9, 10].

Within 91 m from a mobile tower

Name of deceased	Year of death	Cause of death	Age at time of death
Radhabai Sathe	2005	Breast cancer	66
Deshpande	2006	Oesophagus cancer	48
Shubhangee Deshpande	2007	Rectum cancer	66
Pujaree	2008	Cancer	46
Gawai	2008	Breast cancer	52
Shah	2009	Cancer	48
Vidyadhar Dev	2009	Liver cancer	52
Ransube	2009	Throat cancer	73
Archana Malvadkar	2009	Spinal cord cancer	17

Source: L.B Deshpande, who studied the deaths in his Solapur locality since two towers were installed four years ago

Fig.5 Details of the dead people are given above

5. THE PRECAUTIONARY PRINCIPLE

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.

1. 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.
2. Digital mobile phones can be used instead of analog phones as digital phones emit lower EM radiations, thus lowering potential adverse effects.
3. The time spent by a person on using mobile phones should be reduced.
4. 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.
5. Transmitted power from each cell tower must be immediately reduced to maximum 1 to 2W, which will protect health of the people from harmful effects of mobile tower radiation. It will also protect birds, animals, plants, trees and environment.
6. Epidemiology studies must be initiated in various parts of the country. 20. Warning sign boards must be installed near mobile towers to warn people of the danger of radiation.

6. CONCLUSION AND FUTURE WORK

In this paper we reviewed and summarized some of the crucial research done to study the effects of mobile phone radiation. The work was motivated by the fact that the seriousness of the health hazards due to radiation from the mobile phones and mobile towers has not been realized among the common man. International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an international body which studies possible adverse effects on human health from exposure to non-ionizing radiation. Mobile operators continue to claim that there are no health issues. Even organizations like WHO, FCC, etc. have not recommended stricter safe radiation guidelines, whereas several countries have adopted radiation norms, which are 1/100th to 1/1000th of these values based on their studies [10]. Mobile phones are used widely throughout the world for easier connectivity and wireless communication. Mobile phones have a darker side also as these emit the electromagnetic radiations which cause many health risks. This paper has also reviewed long-term and short-term effects of mobile phones. Long-term usage of mobile phones cause 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. This does not mean that we have to stop living near these towers. We all know that automobiles create air pollution – have we stopped using them? Instead, solutions were found such as unleaded petrol, catalytic converters to reduce emission, CNG driven vehicles, hybrid vehicles, etc. If people in the mobile companies think there is no health hazard, then let them stand in front of their own transmitting tower at 1m distance in the main beam for 6 hours - are they willing to take the risk? Similar effect will be there at 10m distance in about 600 hours (25 days). If mobile companies accept that radiation causes serious health problems, will people stop using mobile phones? Not really, because the cell technology has its several advantages. However, then researchers/technocrats/entrepreneurs will come out with possible solutions, which may be expensive but that cannot be greater than the health risk faced by humans, birds, animals and environment [9].

7. REFERENCES

- [1] National Radiological Protection Board (2004) Mobile phones and health 2004. Report of the Board of NRPB. NRPB, Oxon.
- [2] IgSor Smirnov, "Comparative study of the effect of Microwave radiation neutralizers on Physiological state of human subjects", IEEE Magazine, Vol.14, and No.5: 29-44, USA.
- [3] Effect of Mobile Phone Radiation on EEG Wave D. S. Bhangari, A. C. Bhagali, R. V. Kshirsagar International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-8 June, 2019
- [4] Review Article Radiation Effects of Mobile Phones and Tablets on the Skin: A Systematic Review A.Keykhosravi,M. Neamatshahi,R. Mahmoodi, and E. Navipour Hindawi Advances in Medicine Volume 2018, Article ID 9242718, 5pages <https://doi.org/10.1155/2018/9242718>

- [5] Sukhdeep Kaur et al, International Journal of Computer Science and Mobile Computing, Vol.5 Issue.2, February- 2016, pg. 298-304.
- [6] Performance Analysis of Mobile Phone Radiation Minimization Through Characteristic Impedance Measurement S.PalanivelRajan, Dr.R.Sukanesh, T.Kamaleshwaren, R.Prasaanth, P.Thangaperumal IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 2, No 3, March 2012 ISSN (Online): 1694-0814 www.IJCSI.org.
- [7] Wikipedia, the free encyclopedia (online): Electromagnetic Radiation and health.
- [8] World Health Organization, "Electromagnetic Fields and public health-Mobile phones: Fact sheet" June 2011, No.193 <https://www.who.int/peh-emf/publications/facts/fs322/en/>
- [9] Dr. Girish Kumar (2010), "Report on Cell Tower Radiation", Submitted to Secretary, DOT, Delhi, [Online Available: <http://www.indiaenvironmentportal.org.in/files/file/Kumar-Cell-Tower-Radiation-Reportsent-to-DOT-Department-of-Telecomm.pdf>
- [10] Dr. Girish Kumar (2011), "Report on cell phone Towers Radiation Hazards" Submitted to West Bengal Environment Minister. http://www.iraj.in/journal/journal_file/journal_pdf/1-67-140419304201-05.pdf
- [11] EM Watch, [Online] Available: <http://www.emwatch.com/Cellmasts.html>.
- [12] Electromagnetic fields of mobile radio communication and danger estimation for the population Yu. G. GFUGOEVEV, RUSSIA SSC - Institute of Biophysics of RF MH, Russian National Committee for Non-Ionized Radiations Protection, e-mail: yugrigor@roL.ru
- [13] Braune S, Wrocklage C, Raczek J, Gailus T, Lucking C. "Resting blood pressure increased during exposure to a radiofrequency electromagnetic field", Lancet 1998; 351:1857-1858.
- [14] Oberfeld, G. et al. 2004. The microwave syndrome-further aspects of a Spanish study. Biological Effects of EMFs, KosGreece, October 2004 http://www.powerwatch.org.uk/pdfs/20040809_kos.pdf

