

Chapter 3

NONIONIZING RADIATION

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"If there must be trouble, let it be in my day, that my child may have peace."
Thomas Paine

"A man chooses, a slave obeys."

3.1 INTRODUCTION

Microwaves and lasers are forms of nonionizing radiation. Mobile or cellular phones which transmit and receive information in the microwave part of the Electro-Magnetic EM spectrum have become a \$100 billion a year industry. About 650 million phones were sold to consumers in 2005, and over 1.5 billion people around the world use them.

The most advanced form of this technology utilized by the military is referred to as phase arrays where destructive and constructive interference is optimized such that the splaying or spreading of the EM field is reduced and the directionality is maximized like a laser. Essentially creating a highly focused and very concentrated narrow beam of microwaves.

According to Wikipedia:

"Ultraviolet light can cause burns to skin and cataracts to the eyes. Ultraviolet is classified into near, medium and far UV according to energy, where near and medium ultraviolet are technically non-ionizing, but where all UV wavelengths can cause photochemical reactions that to some extent mimic ionization (including DNA damage and carcinogenesis)."

Current plans are to place small 5G cell towers about every 300 meters in every street across the country. These 5G 'small cell' antennas will result in continuous exposure to everyone living nearby and everyone walking down the street. The increased exposures are expected to increase risk of cancer and other diseases such as electro-hypersensitivity.

The World Health Organization's (WHO) International Agency for Research on Cancer (IARC) classified the risk of the EM fields as:

"Possibly carcinogenic to humans. Given the potential consequences for public health of this classification and findings, it is important that additional research be conducted into the long-term, heavy use of mobile phones. Pending the availability of such information, it is important to take pragmatic measures to reduce exposure such as hands-free devices or texting."



Figure 1. Sources of exposure to Radio Frequency RF radiation.

Preliminary findings by the National Toxicology Program in the USA released in 2016 suggested a "low incidence" of brain and heart tumors in male rats exposed to doses of radiofrequency radiation totaling up to nine hours a day over a two-year period. The study awaits scrutiny by other scientists, a process known as peer reviewing, which is generally considered an essential stage of evaluating research.

A court in April 2017, in Ivrea, Italy agreed that a man's brain tumor was linked to his mobile phone use. It awarded Robert Romero 500 euros or \$535 per month in compensation. He had claimed that using his business mobile phone for three or four hours a day, over a period of 15 years, led to the growth of the benign tumor. The money will be paid by a body established to compensate people for work-based injuries [1].

The extensive use a cellular phone for at least an hour is reported to lead to a risk of developing a brain tumor, such as an acoustic neuroma or a glioma that is 240 percent higher than a person who never uses one. Electrical hypersensitivity, which is claimed to affect 1-4 percent of the population, is blamed on unpleasant symptoms in mobile phone users, including migraine, dizziness and tingling.

The technology is relatively new and is evolving so rapidly that it is outstripping the analysis of any potential impacts on health. Some research suggests radio frequency fields could interfere with biological systems but it has not been possible to carry out human based long-term studies. Third Generation (3G) phones, which emit higher rates of radiation than earlier models are now marketed all over the world. For people who have used for more than 2,000 hours in their lifetime, the risk of getting a brain tumor may have risen by 270 percent, particularly children and teenagers. Studies suggesting mobile phones can cause non malignant brain tumors, cognitive impairment or DNA damage in humans may be inconclusive but should not be dismissed.

3.2 BACKGROUND

Cellular phones emit electromagnetic radiation in the microwave part of the electromagnetic spectrum. The energy of a photon of electromagnetic radiation is expressed as:

$$E = h\nu \text{ [eV]} \quad (1)$$

where h is Planck's constant [eV/sec] and ν is the frequency of the electromagnetic radiation, given by:

$$\nu = \frac{c}{\lambda} \text{ [Hz], [sec}^{-1}\text{]} \quad (2)$$

where c is the speed of light [cm/sec] and λ is the wave length [cm] of the radiation.

The energy of the photon is expressed in electron Volts [eV], which is the kinetic energy acquired by an electron upon being accelerated through a potential drop of 1 Volt.

Since microwaves have a longer wave length and consequently a lower frequency than x or gamma rays, the energy they carry is considerably less. Whereas x and gamma rays with their high energy in the range of kilo to million of electron volts (keV-MeV) can break molecular bonds and cause the creation of ions or ionization, microwaves do not carry enough energy to cause ionization.

Cellular phones use frequencies in the range of 900 Hz corresponding to about a 1 ft wavelength. Radiofrequency is in the 1-10 meters wavelength compared with visible light which is $\frac{1}{2}$ a millionth of a meter, whereas ionizing radiation is at a 10 billionth of a meter wavelength.

Microwave radiation from cellular phones is classified as non ionizing radiation, so its effects are considered as less serious than ionizing radiation such as x and gamma rays, electrons, protons, alpha particles and neutrons. However, cellular phones antennas emit when in use microwaves that deposit energy in vital organs particularly the brain as well as the eyes. Radiation is emitted not just during active usage, but also during the standby mode, since a cellular phone is continuously polling for the location of the nearest cellular tower.

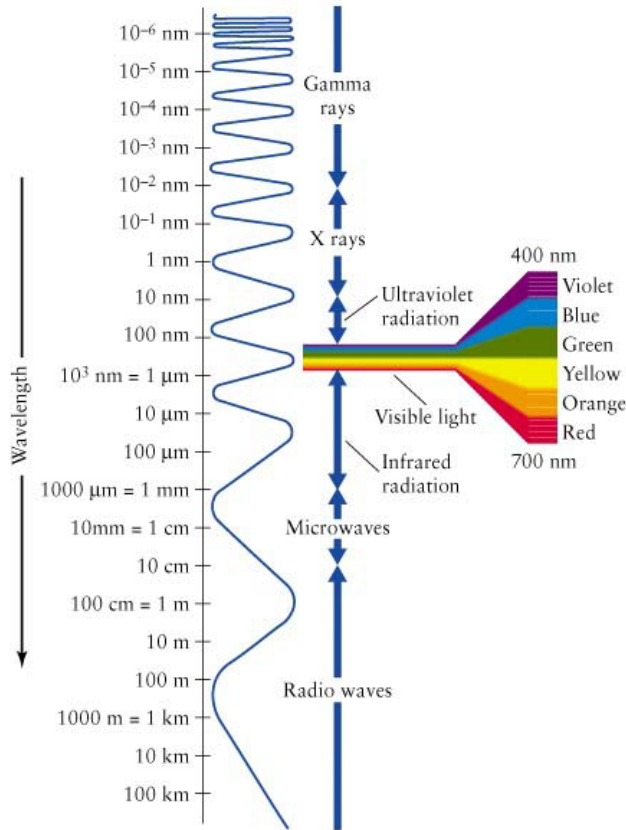


Figure 2. Microwaves cover the wave length range from about 1 mm to 10 cm in the electromagnetic spectrum.

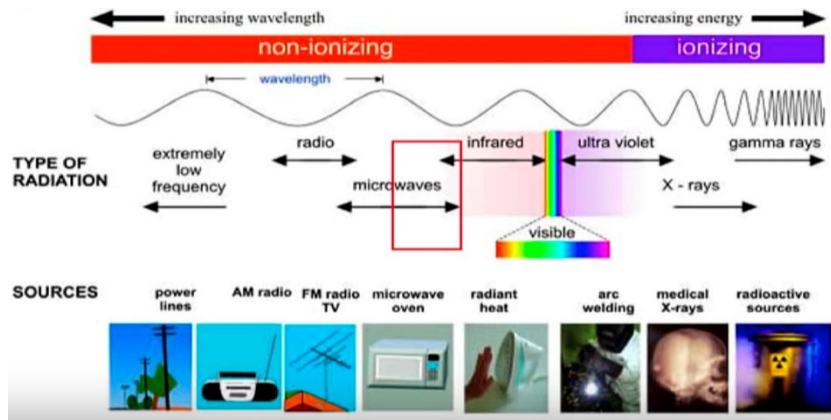


Figure 3. Devices using different radiation wave lengths [2].

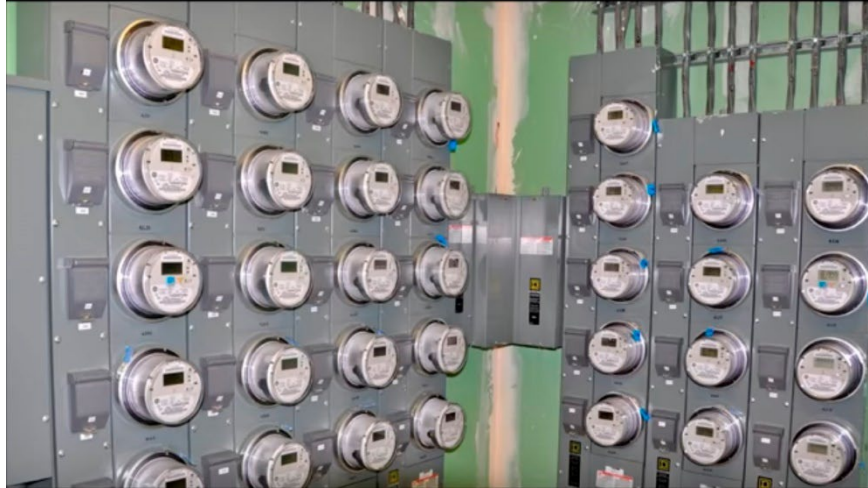


Figure 4. Bank of wireless smart meters at an apartment complex.

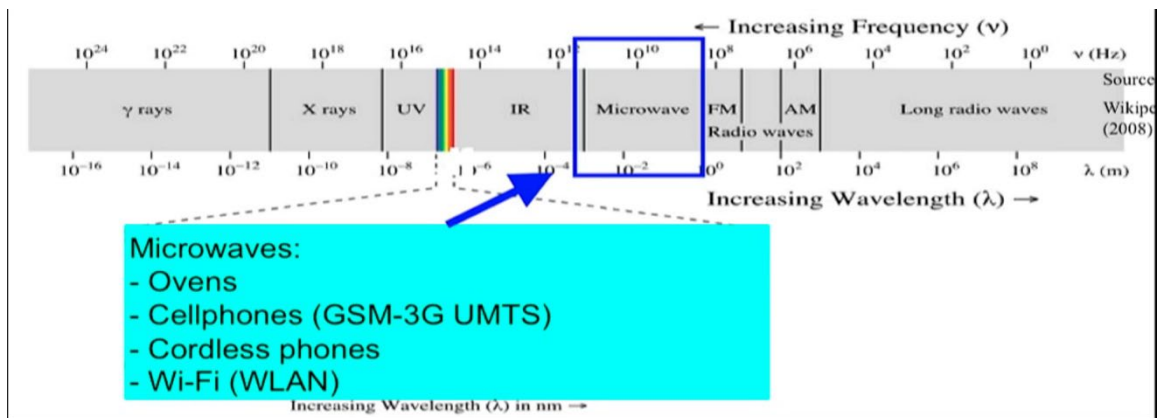


Figure 5. Devices operating in microwaves region [2]. A nanometer is one billionth of a meter, which is one millionth of a millimeter and one millimeter is about the diameter of the lead in a pencil. A hair on the head is around 75 microns or 75,000 nm in diameter. A human red blood cell is 6,000-8,000 nm across. Microwave ovens work because the frequency is precisely tuned to make water molecules resonate.

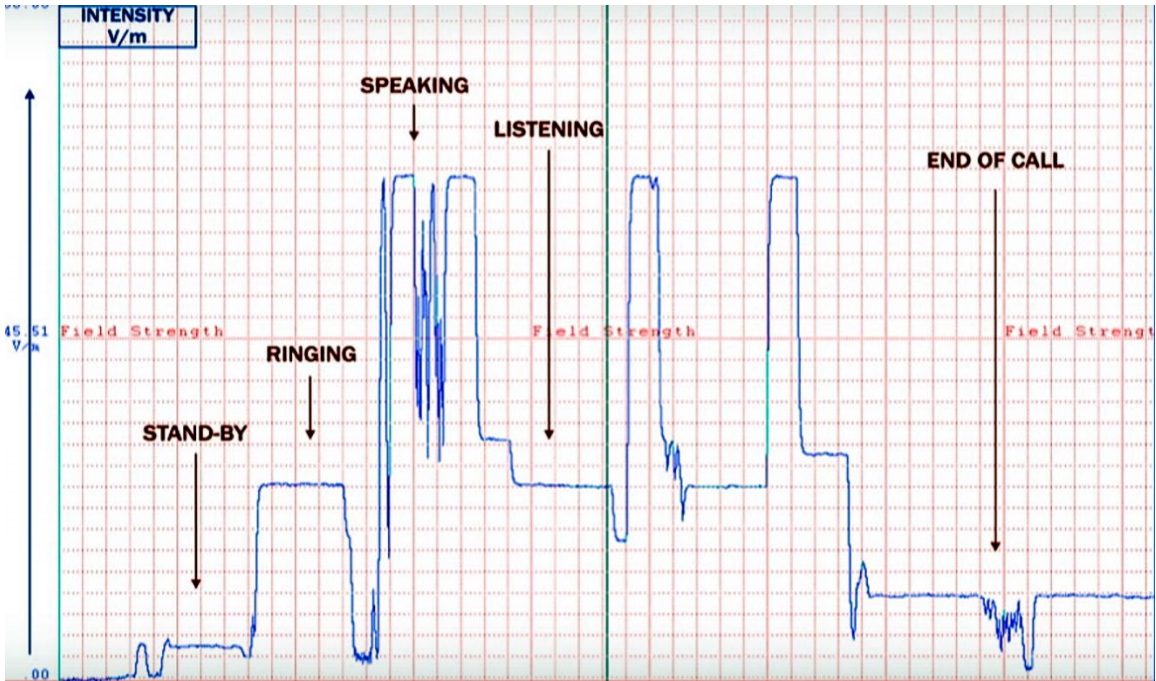


Figure 6. Pulsating power levels of cellular phone during different times, including standby [2].

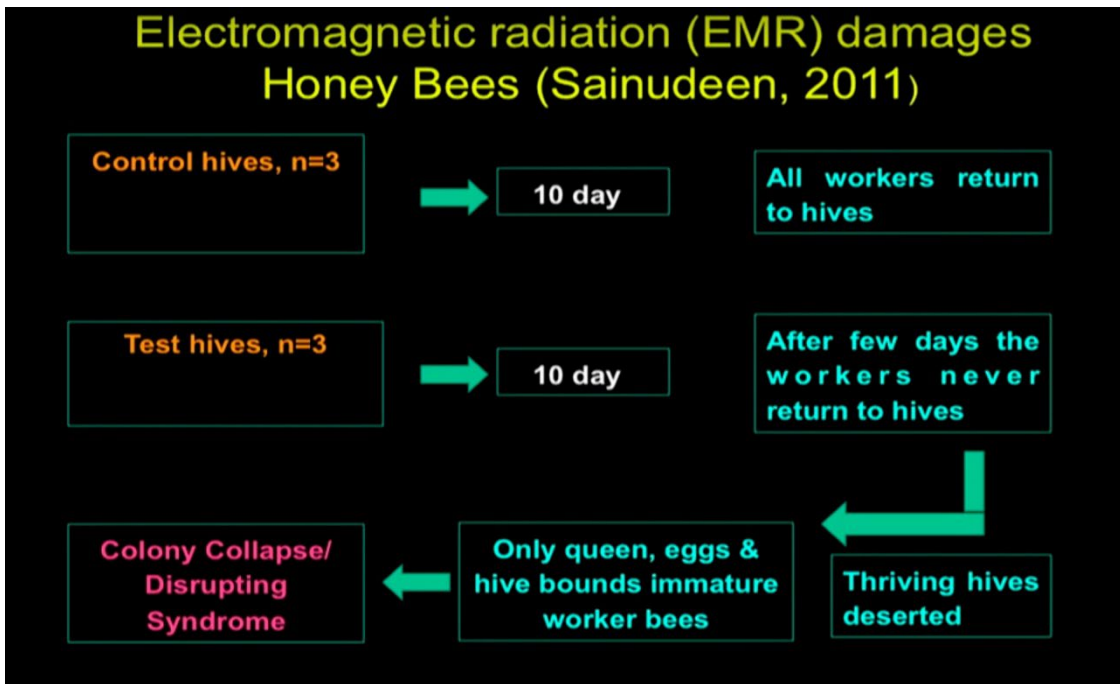


Figure 7. Effect of exposure to wireless radiation 10 minutes daily on honey bees' nervous system and Colony Collapse Syndrome, CCS [2].

Microwave towers themselves, with their geographical spread subject neighboring people in stationary objects such as offices and homes and mobile objects such as cars to

microwave radiation. Microwave energy absorption is measured in terms of the Specific Absorption Rate (SAR), where:

$$\begin{aligned}
 SAR &= \frac{\text{Energy absorbed [Joules]}}{\text{Organ Mass[kgs].Irradiation time[secs]}} \\
 &= \frac{\text{Power [Watts]}}{\text{Organ mass [kgs]}}
 \end{aligned}
 \tag{3}$$

Most cellular phones emit radio signals at the level between 0.5-1.0 [Watts/kg]. SAR has a unit of specific power is a measure of the rate of radio energy absorption or power absorption per unit weight of body tissue. The SAR specific radiation dose rate exposure limit recommended by the International Commission on Non-Ionizing Radiation Protection is 2 [Watts/kg].

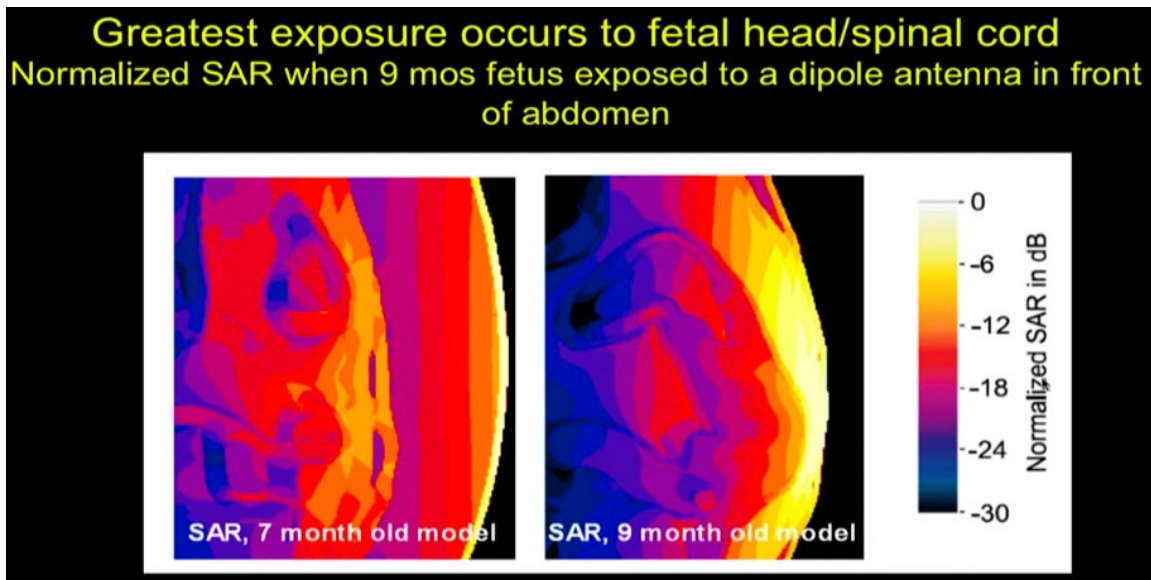


Figure 8. Exposure to head of fetus at end of pregnancy [2].

The Federal Communications Commission (FCC) and the Federal Drug Administration (FDA) regulate cell phones in the USA. The FCC requires that all cell phones sold in the USA have an SAR of 1.6 [Watts/kg] or less.

what the SAR really measures is the heat that is generated and absorbed by the body from a cell phone. Some scientists attending the cell phone and health conference say that is a meaningless measurement since they believe damage to a cell's DNA could occur at very low temperature levels, which would not even register on the SAR scale.

Critics assert that the current standards are inadequate and misleading. Heating of tissue does not mean anything. A certain amount of energy is needed to cause a change in DNA, but that energy could be spent even before the temperature goes up and can be measured. People are led to believe that these standards say something, but they do not.

Even if the SAR were the right metric to measure the safety of cell phones, several scientists suggest that the current standards used by the FCC are not good enough to protect consumers.



Figure 9. Exposure to head of infant [2].

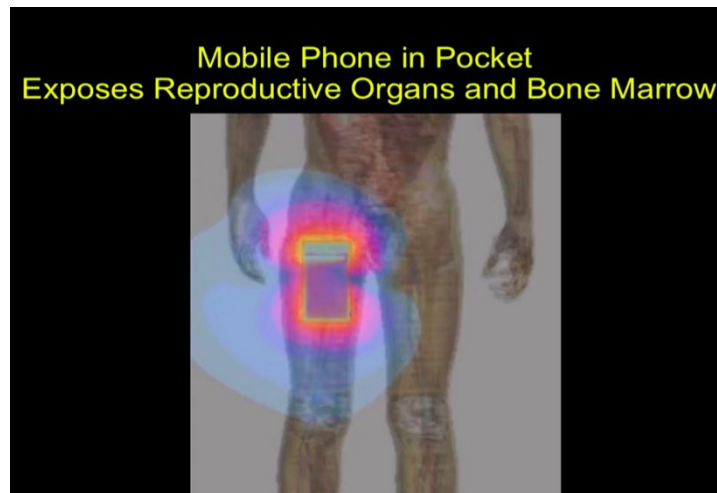


Figure 10. Exposure to gonads from phone in pocket [2].

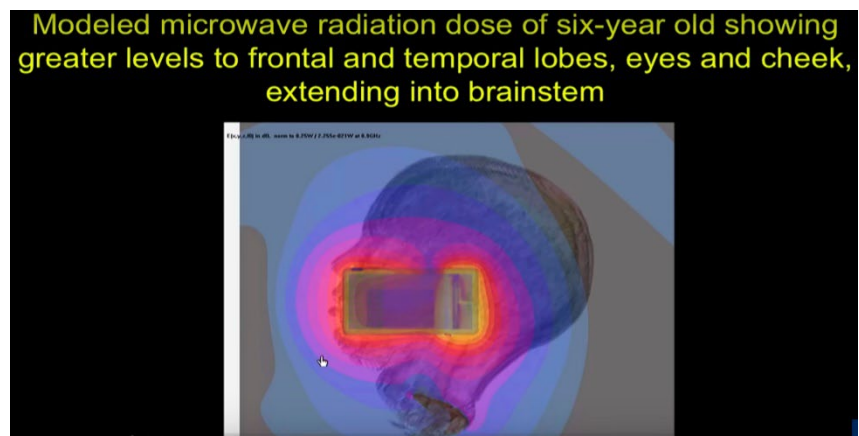


Figure 11. Exposure to head of six year old [2].

3.3 REFLEX EUROPEAN STUDY

Radio waves from mobile phones harm body cells and damage DNA under laboratory conditions, according to a study conducted by European Union, researchers. The Reflex study, conducted by 12 research groups in seven European countries, did not prove that mobile phones are a definite risk to health but concluded that more research is needed to see if effects can also be found outside a lab.

The \$100 billion a year mobile phone industry asserts that there is no conclusive evidence of harmful effects as a result of electromagnetic radiation. About 650 million mobile phones are expected to be sold to consumers per year, and over 1.5 billion people around the world use one.

The research project lasted for four years and was coordinated by the German research group Verum and headed by Franz Adlkofer. It studied the effect of radiation on human and animal cells in a laboratory setting.

After being exposed to electromagnetic fields that are typical for mobile phones, the cultured human and animal cells showed a significant increase in single and double strand DNA breaks. The damage was sometimes permanent and could not always be repaired by the cells. The concern arises from the fact that DNA carries the genetic material of an organism and its different cells.

There was remaining damage for future generation of the cultured cells. This means that the change had procreated. Mutated cells are seen as a possible cause of cancer.

The radiation used in the study ranged in levels between a Specific Absorption Rate (SAR) of between 0.3 and 2 [Watts/kg]. The study also measured other harmful effects on cells.

Because of the laboratory setup, the study did not prove any health risks on humans. However, the genotoxic and phenotypic effects would require further studies on animals and human volunteers. Further research would need five years to reach a conclusive result.

Previous independent studies into the health effects of mobile phone radiation have found it may have some effect on the human body, such as heating up body tissue and causing headaches and nausea.

3.4 BRITISH NATIONAL RADIOLOGICAL PROTECTION BOARD (NRPB) REPORT

A report issued in January 2006 by the UK's National Radiological Protection Board (NRPB), an independent advisory group, recommended a precautionary approach, because there is still no hard evidence that the health of the public in general has been adversely affected by the use of mobile phone technologies. The Mobile Operators Association in Britain, which represents operators on health and planning, supported the report. According to the NRPB, children might be more vulnerable to the effects of microwave radiation because their brain and nervous systems are still developing. They have a greater absorption of energy in the tissues of the head and they would have a longer lifetime exposure than adults.

3.5 SWEDISH STUDY

According to a Swedish study headed by Kjell Mild, published in the “International Archives of Occupational and Environmental Health” in April 2006, extensive use a cellular phone for at least an hour a day leads to a risk of developing a brain tumor that is 240 percent higher than a person who never uses one. The definition of extensive use is over 2,000 hours of cell phone use, spread over many years.

The results of the study contradicted another recent one carried out in the UK and published in January, 2006, which suggested that cell phone use is safe for humans.

The researchers found that the location of the tumor, for extensive cell phone users over many years, tends to be on the side of the head where the phone is frequently used. They examined cell phone use among 905 people who had a malignant brain tumor and compared them to a control group of 905 healthy people. All the volunteers were aged 20-80 years. Of the 905 people, 85 who had a malignant tumor were high users of cell or mobile phones: they started using mobile phones a long time ago, and have used extensively, on average for about an hour a day.

3.6 NORWEGIAN STUDY

A Danish study reported in December 2006 by Joachim Schuz of the Danish Cancer Society showed no rise in cancer among people who have used cell phones for 21 years. The study included more than 420,000 Danes who got their first cell phone between 1982 and 1995. Some of those people kept their phones as long as 21 years. On average, they had cell phone service for 8.5 years. It tracked cancers among the cell phone users from the start in 1982-1995 through 2002. During that period of time, the group had 14,249 cancers, slightly less than Denmark's expected cancer rate for the general population. The data showed no increase in brain cancer, leukemia, or tumors of the eyes or salivary glands among cell phone users.

3.7 BRITISH MOBILE TELECOMMUNICATIONS AND HEALTH RESEARCH (MTHR) STUDY

The UK's largest investigation into the safety of mobile phones found no evidence that they damage health. However it was impossible to rule out the possibility that ill effects including cancers could emerge in long-term users of over 10 years in the future.

Children particularly could be at risk because their brains are more vulnerable, and the advice to limit children's use of mobiles should remain.

The findings from the Mobile Telecommunications and Health Research (MTHR) program, released in September 2007 and which was launched six years earlier suggests that the worries about the effects of mobile phones on the brain and on biological processes, indicated in some earlier research, had been tested and found to be baseless.

The research is evenly co funded by the UK government and the mobile phone industry but is independently run, included 28 studies, of which 23 are complete. It reported no association between short-term mobile phone use and brain cancer and studies

on volunteers showed no evidence that brain function, including memory and reaction times, was affected.

The program included the largest and most robust studies of electrical hypersensitivity, which is claimed to affect 1 per cent to 4 per cent of the population. The results showed no link between the unpleasant symptoms reported by sufferers, including migraine, dizziness and tingling, and mobile phone use.

However, according to Professor Challis an emeritus professor of physics at the University of Nottingham: "It all sounds pretty reassuring and that is good. But we cannot rule out the possibility that cancer could appear in a few years. The epidemiological evidence is not good enough and most cancers take longer than 10 years to develop."

There was a "faint hint" from two studies that use of mobile phones might be linked with malignant brain tumors and acoustic neuromas. Although the findings were of borderline statistical significance and were likely to be due to chance, they needed following up.

Children were more vulnerable to other agents such as cigarette smoke, lead and radiation and the same could be true of mobile phone signals.

3.8 ACOUSTIC NEUROMAS

Acoustic neuromas are slow growing cancers that only affect the function of the ear and can lead to loss of hearing and balance. They do not metastasize to other parts of the body.

There is public concern that use of mobile phones could increase the risk of brain tumors. If such an effect exists, acoustic neuromas would be of particular concern because of the proximity of the acoustic nerve to the handset."

Scientists at the Institute of Cancer Research in London have found that cellular phones do not increase the risk of cancer of the nerve that links the ear to the brain, during the first decade of cell phone use.

Data from 678 people with the benign tumor: acoustic neuroma of the nerve that connects the ear to the brain, and 3,553 people without it, were examined. The data came from people living in four Nordic countries and the UK, in which cell phones were introduced particularly early

No correlation was found between the number of calls, the duration of calls, or someone's lifetime cumulative hours of cell phone use and the risk of developing such a tumor.

There is a higher risk of developing a tumor on the same side of the head that people use their cell phones, after at least 10 years of use. However, the researchers conceded that there is little information on which long term effects can be judged.

Whether there are longer term risks remains unknown, reflecting the fact that this is a relatively recent technology.

3.9 GLIOMAS INCIDENCE

Gliomas are the most common type of brain tumors. A Swedish study suggested that there was an increased risk of contracting brain cancer among rural cell phone users. It also found increased incidence of brain tumors on the side of the head where people

reported using their mobile phones. Early mobile phones tended to use stronger analog signals than more recent ones.

Researchers from the Universities of Leeds, Nottingham, and Manchester, and the Institute of Cancer Research in London, conducted a four year study between December 1, 2000, and February 29, 2004, on 966 adults diagnosed with glioma. A group of 1,716 healthy volunteers was used as a control group.

They found there was no correlation between the risk of glioma and the time since the adults' first use of a cell phone, the number of years they had been using a cell phone, the number of calls they made, and the hours of mobile phone usage.

However, the researchers did find a significantly increased risk for tumors that developed on the same side of the head as where the adults said they held their cell phones and a paradoxical decreased risk of tumors on the other side of the head.

A possible explanation is that people with glioma brain tumors might be over reporting their use of the phone on the same side as where the tumor developed, and under reporting their usage on the other side of their heads.

The researchers acknowledged their own study was limited in predicting the long term effects of cell phone use since mobile phones have only been popular in the UK since the late 1990s, although they have been available in the UK since 1985.

Cell phone makers have been making efforts in recent years to reduce the amount of radiation emitted from phones and listing the amount of radiation they can measure in their Specific Absorption Rate (SAR) ratings.

The study received criticism from advocacy groups such as Powerwatch, a British group that is examining the links between electromagnetic fields and health risks. It pointed out that 49 percent of the 966 brain tumor patients in the study were not interviewed by the researchers.

The University of Leeds, which helped carry out the study, received funding from various British mobile phone carriers, such as O2, Orange, T-Mobile, Vodafone, and 3, to support the research. However, they signed contractual agreements to ensure the independence of the scientific investigators.

Various mobile phone industry groups, such as the GSM Association and the Mobile Manufacturer Forum, provided funds for a larger 13 country Interphone study, of which the British study is one part.

3.10 EFFECT OF HEAD SIZE

Research indicates that cell phone radiation penetrates the heads of children much more than it does adults for a variety of reasons, including the fact that children have smaller and thinner skulls.

The FCC set standards for the amount of radio frequency that can be emitted by a cell phone based on models of a 200 pounds man's head talking with a phone to his ear for 6 minutes.

The FCC tests one device supplied by the manufacturer and then assigns the SAR number and does not randomly test samples of the device in the market. This could be a problem because even devices within the same model number may emit different levels of radiation. The manufacturers admit there is a 2:1 variability in terms of the SAR in devices of the same model number.

3.11 WORLD HEALTH ORGANIZATION (WHO) INTERNATIONAL AGENCY FOR RESEARCH ON CANCER, IARC STUDY

The World Health Organization (WHO) has conducted a 10 year survey from 2000 to 2010 of nearly 13,000 people across 13 countries. The WHO's International Agency for Research on Cancer (IARC) determined that most cell phone use did not lead to an increased risk of either meningioma, a common but typically benign form of cancer, or glioma, a rare but more dangerous type of brain cancer.

The study results did see “suggestions” that using cell phones for long periods of time on the same side of the head could lead to an increased risk of glioma, especially around the temporal lobe. However, the authors acknowledged that possible biases and errors from those participating in the survey meant that these results were not conclusive enough to directly blame cell phone radiation for such tumors. For example, people were asked to try to keep track of how often they used their cell phones and on which side of the head over a period of 10 years.

To conduct the study, 21 scientists from around the world came together in 2000 to form the Interphone International Study Group under the auspices of the IARC. Among the many people interviewed were those who had brain tumors: 2,708 individuals with glioma and 2,409 with meningioma; so the researchers could gauge their cell phone activity to see if there was a direct correlation with their cancers.

With a definitive answer still lacking, the IARC concludes that further study is needed, especially since cell phone use has increased dramatically since 2000, particularly among younger people.

3.12 EFFECT ON BRAIN ACTIVITY

A study from the National Institutes of Health suggests that cellular phones may alter brain activity, and it could be potentially damaging in the long term.

Researchers found that less than an hour of cellular phone use can cause brain activity to speed up in the area that is closest to the antenna.

The study was published in The Journal of the American Medical Association, AMA. The study documents that the human brain is sensitive to the electromagnetic radiation that is emitted by cellular phones. It also highlights the importance of conducting studies to address the question of whether there are, or are not, long-lasting consequences of repeated stimulation, of getting exposed over five, 10 or 15 years.

Participants in the study had a cell phone strapped to both ears and then underwent two 50-minute Positron Emission Tomography, PET scans, which measure brain activity by monitoring metabolism. In one scan, both cell phones were turned off; in the second, the right cell phone was turned on and played a recorded message, but with the sound muted so there would be no auditory interference.

The PET scans showed a 7 percent increase in activity in the part of the brain closest to the antenna. The researchers said the increased activity was unlikely to be associated

with heat from the phone, because it happened near the antenna instead of where the phone touched the head.

The study shows that there are other physiological effects beyond tissue warming, however. Researchers not involved in the work think that the study suggests different pathways for cancer and other health problems to develop, including the formation of free radicals and tissue swelling. There are some studies showing cellular phone radiation associated with other events, like sleep disturbances.

This particular study does not enlighten us in terms of whether this is detrimental or if it could even be beneficial. It just tells us that even though these are weak signals, the human brain is activated by them.

Some other studies even suggest that electromagnetic radiation could be beneficial. In one study from 2010, University of South Florida researchers were surprised to find electromagnetic radiation from cell phones actually boosted the memories of young mice, and even reversed Alzheimer's symptoms in old mice. Other research suggests that electromagnetic waves could be used for other therapeutic purposes.

3.13 LOCAL LAWS

The city of San Francisco passed the first law in the USA requiring mobile phone retailers to display the amount of radiation they give off. The city's mayor, Gavin Newsom, hailed the law as a victory for the public's right to know what their mobile phones are doing to them even though some critics say there is no significant scientific evidence that they are hazardous to health.

The city council, known as the board of supervisors, voted 10-1 in favor of the law, which requires retailers to place information on the amount of radio waves absorbed by a mobile phone user's body next to each device to allow shoppers to choose between them.

A similar measure proposed in the California legislature was killed off amid heavy lobbying by the mobile phone industry. A law in Maine to require health warning labels on mobiles, similar to those on cigarette packets, also failed in part because the impact on health of sustained use of mobile phones remains a matter of scientific debate.

Some European countries take the risk of brain cancer more seriously. In France, legislation was passed to require cell phones to be sold with an earpiece or headset, to forbid advertising to children under 14 or to give a cell phone to a child under six, and to require warning labels.

3.14 RAMAZZINI INSTITUTE STUDY

Researchers with the Ramazzini Institute (RI) in Italy announced that a large-scale lifetime study of lab animals exposed to environmental levels of cell tower radiation developed cancer. A \$25 million study of much higher levels of cell phone radiofrequency (RF) radiation, from the USA National Toxicology Program (NTP), has also reported finding the same unusual cancer called Schwannoma of the heart in male rats treated at the highest dose. In addition, the RI study of cell tower radiation also found increases in malignant brain (glial) tumors in female rats and precancerous conditions including Schwann cells hyperplasia in both male and female rats.

“Our findings of cancerous tumors in rats exposed to environmental levels of RF are consistent with and reinforce the results of the US NTP studies on cell phone radiation, as both reported increases in the same types of tumors of the brain and heart in Sprague-Dawley rats. Together, these studies provide sufficient evidence to call for the International Agency for Research on Cancer (IARC) to re-evaluate and re-classify their conclusions regarding the carcinogenic potential of RFR in humans.”

The Ramazzini study exposed 2,448 Sprague-Dawley rats from prenatal life until their natural death to “environmental” cell tower radiation for 19 hours per day (1.8 GHz GSM radiofrequency radiation (RFR) of 5, 25 and 50 V/m). RI exposures mimicked base station emissions like those from cell tower antennas, and exposure levels were far less than those used in the NTP studies of cell phone radiation.

“All of the exposures used in the Ramazzini study were below the US FCC limits. These are permissible exposures according to the FCC. In other words, a person can legally be exposed to this level of radiation. Yet cancers occurred in these animals at these legally permitted levels. The Ramazzini findings are consistent with the NTP study demonstrating these effects are a reproducible finding,” “Governments need to strengthen regulations to protect the public from these harmful non-thermal exposures.”

Ramazzini Institute investigators have completed nearly 500 cancer bioassays on more than 200 compounds, and their study design is unique in that animals are allowed to live until their natural deaths in order to allow detection of late-developing tumors. Eighty percent of all human cancers are late-developing, occurring in humans after 60 years of age. This longer observation period has allowed the RI to detect such later-occurring tumors for a number of chemicals, and their published research includes studies of benzene, xylenes, mancozeb, formaldehyde and vinyl chloride.

The Ramazzini research results come in the wake of similar findings from the USA National Toxicology Program (NTP) large-scale experimental studies on cell phone radiation. Both studies found statistically significant increases in the development of the same type of very rare and highly malignant tumor in the heart of male rats—schwannomas.

More than a dozen countries recommend reducing radiofrequency radiation exposure to children, and countries such as China, Italy, India and Russia have far more stringent cell tower radiation regulations in place when compared to the United States FCC.

3.15 ULTRAVIOLET RADIATION



Figure 12. Ultraviolet radiation disinfection of bus in Shanghai, China, March 2010.

Ultraviolet (UV) radiation has a shorter wavelength than microwave radiation, just below x-rays in the electromagnetic spectrum, and hence is more energetic, yet still considered as nonionizing. UV Light Technology is a company that provides disinfecting equipment to hospitals, pharmaceutical companies and food manufacturers across the UK [3].

Sunlight contains three types of UV radiation [3]:

1. UV-A makes up the vast majority of the radiation reaching the Earth's surface. It is capable of penetrating deep into the skin and is thought to be responsible for 80 percent of human skin ageing, from wrinkles to age spots. It is suspected to initiate skin tumours.
2. UV-B can damage the DNA in human skin, leading to sunburn and eventually skin cancer. It can be effectively blocked out by sun creams.
3. UV-C consists of shorter, more energetic wavelength of light. It is particularly good at destroying genetic material, whether in humans, bacteria or viral particles. It is luckily filtered out by ozone in the atmosphere long before it reaches human bodies.

Scientists discovered that they could harness UV-C to kill microorganisms. Since the finding in 1878, artificially produced UV-C has become a staple method of sterilization used in hospitals, airplanes, offices, and factories every day. It is used in the process of sanitizing drinking water since some parasites are resistant to chemical disinfectants such as chlorine.

UV-C can be used against corona viruses, such as SARS. The radiation warps the structure of their genetic material and prevents the viral particles from making more copies of themselves. In the fight against COVID-19 in China, whole buses were lit up by its blue light each night. UV-C-emitting robots have been cleaning floors in hospitals. Banks have even been using the light to disinfect paper money.

UV-C is really hazardous, and people should avoid exposure to it. It can take hours to get sunburn from UV-B, but with UV-C it takes seconds. If the eyes are exposed, the retina can be damaged. To use UV-C safely, specialist equipment such as goggles and gloves and special training are paramount.

In the developing world, sunlight is a popular means of sterilizing water and is recommended by the World Health Organization (WHO). The technique involves pouring the water into a clear glass or plastic bottle and leaving it out in the sun for six hours. The UV-A in sunlight reacts with dissolved oxygen to produce unstable molecules such as hydrogen peroxide, which can damage pathogens.

In Brazil, it was observed that influenza cases tend to increase during the burning season, when smoke dilutes the UV radiation. The longer the influenza particles in air were exposed to sunlight, the less likely they were to remain infectious. Once a virus invades the human body, no amount of UV is going to have an impact.

HAVANA SYNDROME, DIRECTED MICROWAVE AND SONIC RADIATION

A mystery illness suffered by USA diplomats in Havana, Cuba in 2016-2017 was most likely caused by directed microwave radiation, according to a USA report by the National Academies of Sciences that said research into the effects of pulsed radio frequency energy was carried out by the Soviet Union more than 50 years ago. The study was carried out by a team of medical and scientific experts who examined the symptoms of about 40 government employees. Many have suffered longstanding and debilitating effects:

"The committee felt that many of the distinctive and acute signs, symptoms and observations reported by (government) employees are consistent with the effects of directed, pulsed radio frequency (RF) energy."

"Studies published in the open literature more than a half-century ago and over the subsequent decades by Western and Soviet sources provide circumstantial support for this possible mechanism."

It noted there had been "significant research in Russia/USSR into the effects of pulsed, rather than continuous wave [radio frequency] exposures". It said that military personnel in "Eurasian communist countries" had been exposed to non-thermal radiation.

Staff and some of their relatives complained of symptoms ranging from dizziness, loss of balance, hearing loss, anxiety and something they described as "cognitive fog". It became known as the "Havana syndrome".

The USA accused Cuba of carrying out "sonic attacks", which it strongly denied, and the incident led to increased tension between the two nations.

A 2019 USA academic study found "brain abnormalities" in the diplomats who had fallen ill, but Cuba dismissed the report. Canada also cut its embassy staff in Cuba after at least 14 of its citizens reported similar symptoms. Cuba was not the only posting where USA diplomats have reported the unusual symptoms. In 2018, the USA removed several officials from China after employees working in the southern city of Guangzhou reported

"subtle and vague, but abnormal, sensations of sound and pressure". One USA official was diagnosed with mild traumatic brain injury (MTBI).

Types of sonic nonlethal weapons used for crowd control:

Infrasound, < 20 Hz

At frequencies too low for humans to hear.

Very loud sound can cause vertigo, vomiting or uncontrollable defecation.

Would need huge racks of speakers to be effective

Ultrasound, > 20 kHz

Easier to target,

Possible to direct sound through walls.

Risk of affecting people other than those targeted, including person carrying out attack.

HIGH POWER MICROWAVE HPM AND ELECTROMAGNETIC PULSE EMP WEAPONS

Weaponizing microwaves extended beyond the end of the Cold War. From the 1990s, the US Air Force had a project codenamed "Hello" to see if microwaves could create disturbing sounds in people's heads, one called "Goodbye" to test their use for crowd control, and one codenamed "Goodnight" to see if they could be used to kill people.

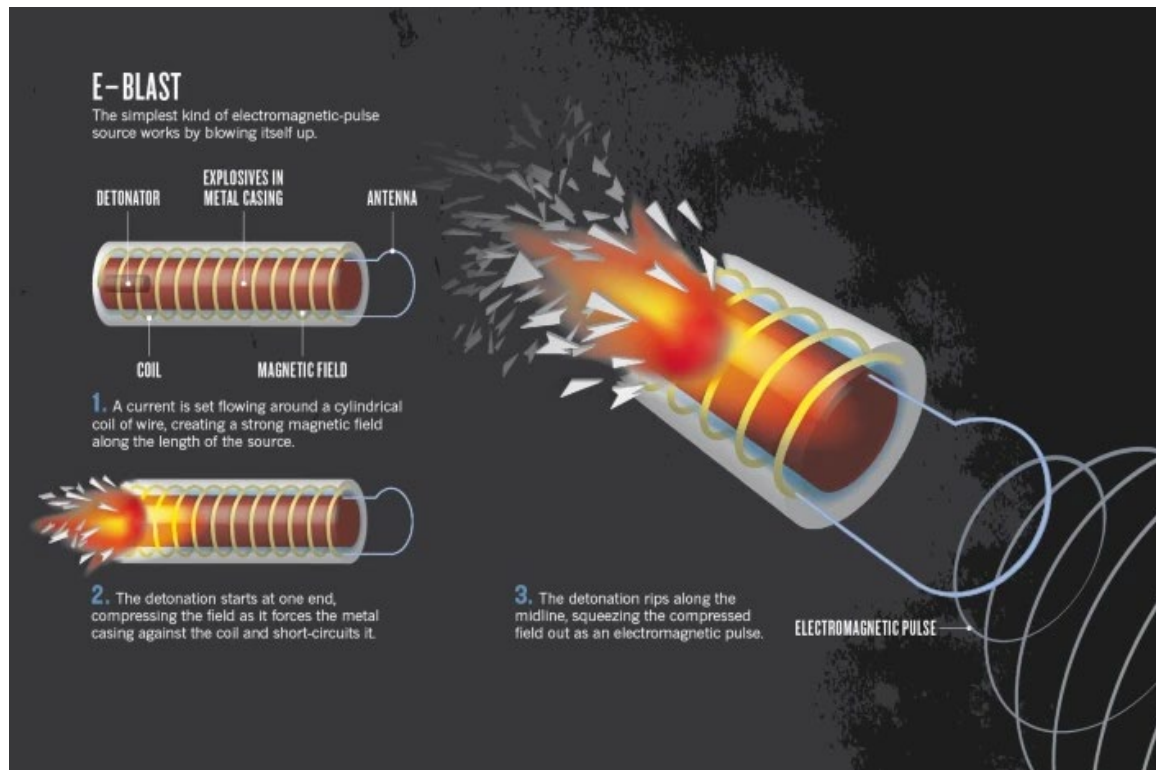


Figure 13. Electromagnetic pulse explosive generation.



Figure 14. Starfish Prime 1962 1.4 MT of TNT equivalent air burst caused an aurora event and an Electromagnetic Pulse, EMP over Hawaii. Source: LANL.

In October 2007 a beam of microwave radiation energy that causes searing pain was tested in Quantico by the USA Air Force's Active Denial System: a prototype non-lethal crowd-control weapon that emits a beam of microwaves at 95 gigahertz. Radiation at that frequency penetrates less than half a millimeter into the skin, so the beam was supposed to deliver an intense burning sensation to anyone in its path, forcing them to move away, but without causing permanent damage.

The quest to build an electromagnetic weapon or e-bomb was sparked on 8 July 1962, when the USA carried out Starfish Prime, the largest high-altitude nuclear test that had ever been attempted. The 1.4-megaton thermonuclear warhead detonated 400 kms above the central Pacific Ocean at 9 seconds past 11 p.m., Hawaii time, blasted huge swarms of charged particles outwards along Earth's magnetic field. Their gyrations generated a pulse of microwave energy that drove measuring instruments off the scale. Artificial auroras lit up the night across swathes of ocean. And in Honolulu, more than 1,300 kms from the detonation point, the pulse set off burglar alarms, knocked out street lights and tripped power-line circuit breakers. On August 1963, the Partial Test Ban Treaty outlawed nuclear explosions anywhere but underground.

A battery-powered device by the USA Air Force and Boeing can generate an HPM pulse but producing the kind of highly concentrated power needed to destroy electronics typically requires detonating a conventional explosive inside a device that destroys itself in the act of pulsing in single-use missiles. The Counter-electronics High-power Microwave Advanced Missile Project (CHAMP) is an experimental cruise missile designed to take out electronic targets such as production sites for weapons of mass destruction.

It is possible to make a microwave generator compact enough for a missile. Engineers at Texas Tech University in Lubbock have developed an experimental explosive-based source less than 2 meters long and 16 centimeters in diameter (M. A. Elsayed et al. Rev. Sci. Instruments. 83, 024705; 2012). Physical limits are to maximize the microwave power while keeping the system small by increasing the internal electrical field. The result can be a catastrophic failure of the system's insulating materials that short-circuits it before the system can build up much power.

In the late 1980s, a device called Gypsy successfully took out a bank of personal computers during the Air Force's first unclassified test of a microwave weapon. Countermeasures that an adversary might use could be as elementary as surrounding sensitive electronics with a Faraday cage similar to the aluminum mesh used to shield microwave ovens.

In 2001, the USA Air Force publicly announced that it had made substantial progress in developing microwave weapons that target people as the Active Denial System. In the 1990s the Air Force's explored the biological effects of microwaves. A project code-named Hello studied how to modulate the clicking or buzzing sounds produced by microwave heating in the inner ear, to produce psychologically devastating 'voices in the head'. 'Goodbye' explored the use of microwaves for crowd control. And 'Good Night' looked at whether they could be used to kill people. The pulse generator was so big that it had to be carried on its own utility vehicle and before use the system superconducting magnet coils had to be cooled down to 4 kelvin over a 16 hours period. The device was built by defense contractor Raytheon of Waltham, Massachusetts.

The Air Force Research Laboratory developed an HPM system called MAXPOWER to detonate roadside bombs remotely, but it was the size of an articulated lorry — too unwieldy to be deployed in Afghanistan. The Joint Improvised Explosive Device Defeat Organization, the defense department's bomb-fighting agency, declined to discuss the system, citing classification issues. Russia, China and Iran are pursuing HPM programs, and the UK Defense Science and Technology Laboratory at Fort Halstead is sponsoring a classified car-stopping program.

RADIOACTIVE ANTI-5G DEVICES

Necklaces and accessories claiming to protect people from 5G mobile microwave networks have been found to be radioactive. The Dutch authority for nuclear safety and radiation protection (ANVS) issued a warning about ten products it found gave off harmful ionizing radiation. It urged people not to use the products, which could cause harm with long-term wear.

The World Health Organization WHO says 5G mobile networks are safe, and not fundamentally different from existing 3G and 4G signals. Mobile networks use non-ionizing radio waves that do not damage DNA. Despite this, there have been attacks on transmitters by people who believe they are harmful.

The products identified included an "Energy Armor" sleeping mask, bracelet and necklace.



Figure 15. Energy Armor sleeping mask, bracelet and necklace. Source: ANVS.



Figure 16. A necklace and bracelets for adults and children were found to be emitting radiation. Source: ANVS.

A bracelet for children, branded Magnetix Wellness, was also found to be emitting radiation. The sellers in the Netherlands known to the ANVS have been told that the sale is prohibited and must be stopped immediately, and that they must inform their customers about this.



Figure 17. Radioactive quantum pendant. Source: ANVS.



Figure 18. Radioactive Basic Nero arm band. Source: ANVS.

Conspiracy theories have fueled a market of anti-5G devices that are typically found to have no effect. In May 2020, the UK's Trading Standards sought to halt sales of a £339 USB stick that claimed to offer protection from 5G.

Anti-radiation stickers have also been sold on Amazon. Stickers that claim to protect users against electromagnetic fields (EMF) from phones remain for sale on Amazon. The UK's Advertising Standards Authority (ASA) criticized the claims on the makers' website. The ASA found that Global EMF Solutions Ltd had made unsubstantiated claims on the Energydots website that EMF were harmful and that its stickers offered protection.

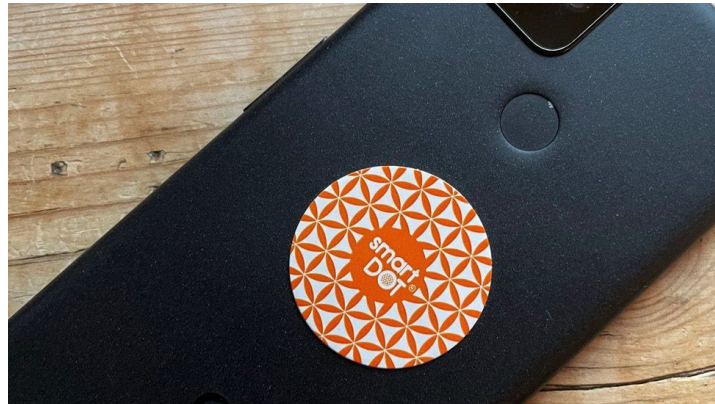


Figure 19. Phone anti-radiation sticker.

FIFTH GENERATION 5G AVIATION INTERFERENCE

In the USA the new C-Band 5G networks operate at 3.7-3.98 GHz frequency. Radio altimeters in aircraft use the 4.2-4.4 GHz range to measure height from the ground when landing. A narrow guard band separates the two frequency ranges.

In the USA, the radio frequencies being used for 5G are in part of the spectrum known as C-Band. These frequencies are close to the ones used by radio altimeters on airplanes, which measure the height of the aircraft above the ground, but also provide data for safety and navigation systems.

The concern is that interference from 5G transmissions could stop these instruments from working properly, and cause safety problems, particularly when aircraft are coming in to land. In late 2020, the RTCA - a USA organization which produces technical guidance on aviation issues - published a report on the subject. It said there was "potential for broad

impacts to aviation operations in the United States, including the possibility of catastrophic failures leading to multiple fatalities, in the absence of appropriate mitigations".

More recently, the USA aviation regulator, the FAA, warned that 5G interference could lead to problems with several different systems aboard the Boeing's 787 Dreamliner. These could make it difficult to slow the plane down on landing, causing it to veer off the runway. Planes won't be allowed to use radio altimeters in circumstances where there could be a risk of serious interference. But that will restrict the ability of some aircraft to land, for example, in poor visibility.

Airlines for America, which represents 10 major carriers, has warned that this could lead to more than 1,000 flights being delayed or cancelled in bad weather and mean at times "the vast majority of the travelling and shipping public will essentially be grounded". It has also suggested a large part of the USA aircraft fleet will be "deemed unusable" because of restrictions on their operation.

In the EU, networks operate at lower frequencies than those which USA providers are planning to use - reducing the risk of interference. 5G masts can also operate at lower power. In France, there are "buffer zones" around airports where 5G signals are restricted, while antennas have to be tilted downwards to prevent potential interference.

In the USA, the FAA has established temporary buffer zones around 50 airports, where 5G providers will limit their activities. But these are much smaller than the zones already being used in France, and USA transmitters will operate at significantly higher power levels. It has also begun identifying which altimeters can be used safely in areas where 5G has been deployed - and which are not reliable enough and will need to be replaced. It has also identified airports where GPS systems can be used to guide approaching aircraft rather than radio altimeters.

The airlines insist this is not enough: they claim the 5G network should not be activated at all within two miles of affected airports. The USA wireless industry body CTIA accused the aviation industry of "scaremongering", and warned that delaying the introduction of 5G would cause real economic harm.

G5 RADIATION NETWORK IN THE USA

A study in the World Academy of Sciences Journal measured levels of radiofrequency radiation (RFR), from wireless networks including 5G, in the city of Columbia, South Carolina and found the highest RFR levels in areas where the cell phone base station antennas were placed on top of utility poles, streetlamps, traffic lights or other posts near to the street. Wireless installations called "small cells" often encapsulate cell antennas in cylinders on short poles and are designed not to be noticeable. The paper included several graphics showing how the RFR is emitted out from the antennas and exposes people walking down the street.

Most likely the study measured combined radiation from 88MHz to 5GHz which includes high power FM and TV transmitters. TV and FM transmissions are CW or Continuous Wave which means that they are constantly transmitting. Cell tower transmissions are pulsed which means their effective transmission power is less. TV and FM transmissions are far less attenuated because they transmit at lower frequencies. The bottom line is that you are exposed to far more radiation from TV and FM transmitters than any cell tower transmitters.

On the whole, 3,943 single measurements were conducted all over the downtown area over five days in 2021 with the aim of measuring public exposure from the city's RF infrastructure. When the study's authors compared their findings to a 2019 published review on the mean outdoor exposure level of European cities (0.07 to 1.27 V/m) to the mean of Columbia, South Carolina (1,240 V/m), it placed Columbia on top of the European scale. In Europe, they reverse the use of the period and the comma, which suggests an error in the reporting. The reported 1,240 V/m is possibly 1.240 V/m.

The Columbia, S.C. study concluded that the highest exposure areas were due to two reasons: cell phone base antennas on top of high-rise buildings provide "good cell coverage reaching far away, but creating elevated exposure to the radiofrequency electromagnetic fields at the immediate vicinity; and cell phone base station antennas installed on top of utility poles have placed the radiation source closer to humans walking on street level."

The conclusion continued, "RF exposure levels from mobile phone base stations antennas near the street level reached high levels. It is thus recommended that all such close proximity transmitters should be labeled with relevant signs to warn of high RF exposure in the area. The study pointed to a the New Hampshire State Commission Report on 5G which has 15 recommendations including that warnings that be posted near antennas.

The Columbia, S.C. study conclusion continued, "Cell phone base station antennas should be distinct and noticeable so that people who need to limit their exposure, have been given a chance to do so by distancing themselves from the RF sources. Considering the current trend of cell phone service providers expanding their 5G network, more utility pole base station antennas are expected. Consequently, the public exposure is also likely to increase in coming years."

When asked about this and prior studies, Lennart Hardell, M.D. (co-author of this study,) stated "Our published research has concluded that RF radiation is a human carcinogen. We recommend that 5G is not rolled out since the full consequences for human health and the environment have not been adequately investigated. Studies are urgently needed." Hardell is an oncologist and professor and is also with the Environment and Cancer Research Foundation Sweden. Hardell also served in an expert working group of the World Health Organization International Agency for Research in Cancer in reviewing radiofrequency radiation and health.

Dr. Hardell is one of the more than 400 scientists and physicians who have signed the European Union 5G Appeal which states, "5G will substantially increase exposure to radiofrequency electromagnetic fields (RF-EMF) on top of the 2G, 3G, 4G, Wi-Fi, etc. for telecommunications already in place. RF-EMF has been proven to be harmful for humans and the environment."

Over 3,500 medical doctors signed onto a 2020 Consensus statement that wireless RF has been proven to damage biological systems at intensities below government limits. "The proliferation of "small cells" is increasing public exposure to cell tower RF radiation. The Court ruling in our successful lawsuit against the FCC confirms that the research has not been adequately reviewed and government limits for RF exposure are not science based. The Environmental Health Trust continues to call on the government to thoroughly review all of the recent, peer-reviewed research that demonstrates harm from wireless radiation," said Devra Davis, Ph.D., epidemiologist and president of the EHT. Davis has spoken before

Congress on the science of cell phone radiation. “The FCC is using studies that were done back when most of the public still had flip phones. It’s far outdated.”

3.16 DISCUSSION

Researchers in the field of exposure of nonionizing wireless device assert that new evidence suggests that the brain cancer risk is not just possible but “probable” albeit with a delayed period of 10-40 years.

In Brussels, Belgium, the core of the bureaucracy in the EU legally prevented 5G from being installed in their city. Wi-Fi is banned from Nursery Schools in France.

5G was pushed to give us fast Internet speeds and big bandwidth to allow our smartphones to do big size videos to amuse us. It also can link machine controls fast enough for integrated factory production lines or make self-driving vehicles possible. A low-energy technology is replaced with a technology that wastes so much energy that people are devising antennas to harvest the ambient energy in cities to run low-power gadgetry.

In Hong Kong, where consumers tend to spend more time talking on a mobile phone than in Europe, a German company, G-Hanz has been marketing a new type of mobile phone which it claims had no harmful radiation. It uses military radar technology which emits shorts burst of radiation at different frequencies to avoid detection and subsequent targeting. Using short pulses instead of continuous operation is suggested as minimizing, but could not exclude the radiation exposure.



Figure 20. Unwarranted babies in crib exposure to Radio Frequencies emissions from two-way tablets and laptop devices [2].

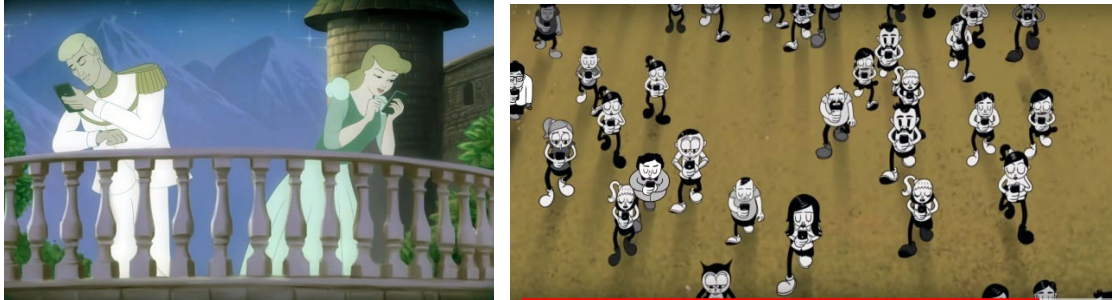


Figure 21. Mad world of cellular phones. Source: Steve Cuts.

There is a need for the monitoring of base station towers, including new Third Generation 3G stations and Terrestrial Trunked Radio (TETRA), used by police and taxicab companies. These towers are in such high demand in European cities, that churches rent their steeples to be used as radio towers as an extra source of income. The use of a mobile phone when an alternative fixed line phone is available using the low frequency 60 Hz of ordinary electric current, and the use of a headset connected to a cellular phone whenever possible; are two recommended measures.

Cellular phone users can limit their exposure to cell phone radiation by keeping their devices as far away from their bodies as possible. This includes using a wired headset instead of holding a phone to their ear. Researchers differ in their opinion on whether a wireless Bluetooth headset poses a risk. Some scientists said it could be a problem, while others do not. But they all agree a wired headset is best.

Using a speaker on the phone or texting instead of talking is another good way to limit exposure. Users should avoid using a cell phone when the signal is poor, since phones emit more radiation energy when they are looking for a nearby signal tower. The Environmental Working Group recommends people make and take calls when the cell phone signal is strong.

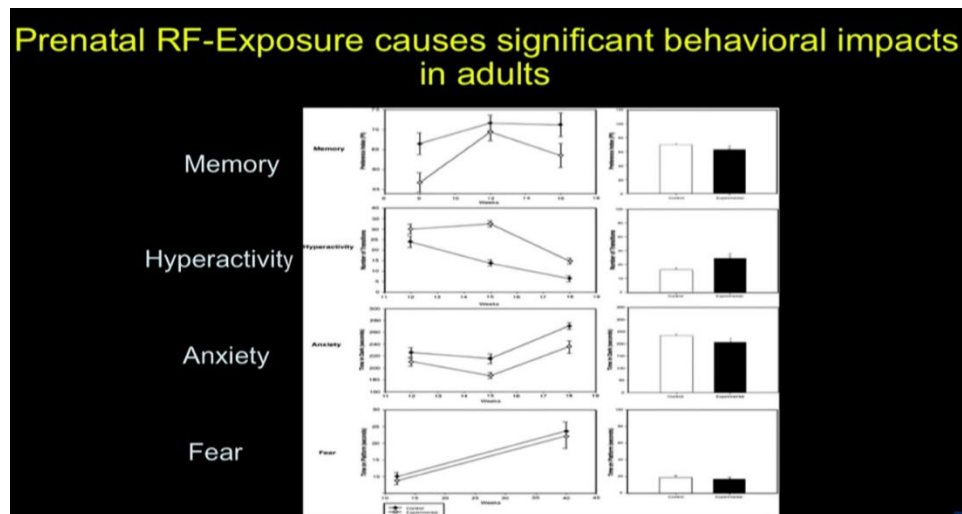
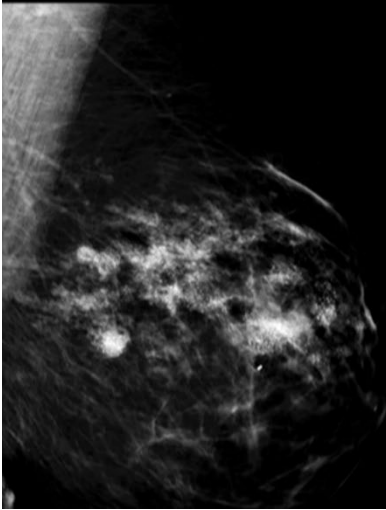


Figure 22. Memory decreases, hyperactivity increases, anxiety and fear decrease in adulthood in prenatally-exposed mice [2].

Caveat - first case report, 2009



Invasive multiple primary tumors in 34 year old, avid runner Chinese-American woman who used cell phone 4 hours a day in her bra for 10 years

—reported by Robert Nagourney, MD, PhD

Figure 23. Invasive multiple primary tumors in breast tissue of female runner [2].

Case Reports - 21 yr old multi-focal tumors tied with cellphones kept in bra

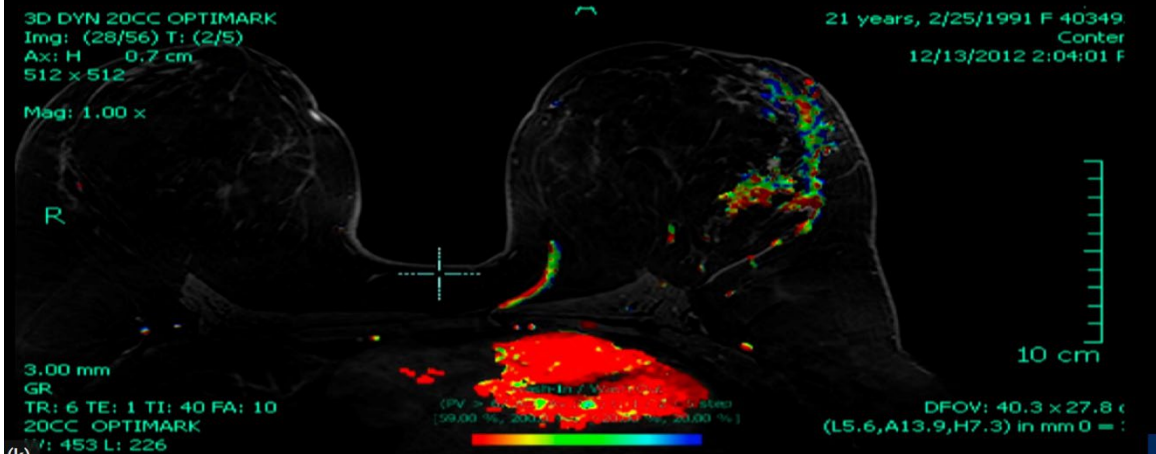


Figure 24. MRI showing metastatic breast cancer under phone antenna [2].

Increased Glioma risk 3 found in all case-control studies published since IARC 2011

	Interphone (2010)	Interphone (App. 2) (2010)	Hardell (2013)	CERENAT (2014)
1640+ hours	1.40*	1.82*	1.75*	2.89* (896+ hrs)
10+ yrs	0.98	2.18*	1.79*	1.61
20+			4-8*	3+

*those beginning to use phones as teens have greatest risks

Figure 25. Brain cancer risk from microwave radiation [2]. Effect from one call per week for six months appears after a 10 years delay. Hardell: Sweden 2013, Cerenat: France 2014.

Some studies have found effects from 5G (e.g., loss of insects and birds on the Greek island of Samos) that were independent of field strength. The mere presence of the radiation at any strength had an effect. 5G is modulated differently from earlier technologies and released untested for biological effects. Havas & Tsiang (2021) reported a correlation between millimeter-band 5G and Covid-19 cases and fatalities.

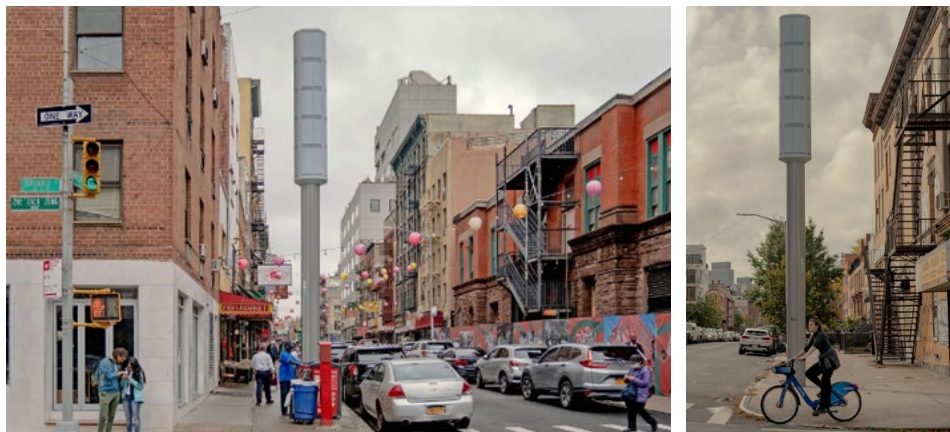


Figure 26. 5G microwave towers are part of a deal that New York City has with CityBridge and LinkNYC, who is installing 2,000 of the towers in the city over the next several years.

LinkNYC, is part of an international project owned by Intersection (CityBridge consortium), Qualcomm and CIVIQ Smartscapes, with the latter having been contracted for government and defense projects. One needs to be at least 1/4 mile from a 5G tower to not get damaging effects. Many of the towers are taking the place of where old payphones

used to be. Other towers are going to be placed on top of traffic lights and streetlamps. Ninety percent of the towers will be in "neighborhoods in the Bronx, Brooklyn, Queens, Staten Island and above 96th Street in Manhattan". They will provide residents with free access to digital calling and Wi-Fi. Carriers like AT&T and Verizon will also be able to use the towers to complement existing infrastructure. Verizon uses several spectrum bands for its 5G offerings. 5G Ultra Wideband, Verizon's millimeter wavelength (mmWave)-based 5G, operates at frequencies of about 28 GHz and 39GHz.

Young adults are advised to use mobiles phones for as short a time as possible, since their brain and eyes tissues are still in a formative stage and are consequently more vulnerable to the effects of radiation. Using text messaging and a phone with a low SAR value are also recommended. Turning off the phone when not in use, is also the most effective protection measure. To reduce the risk, the use of hands-free cellular phones is advisable.

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