



## Health and Safety considerations for 5G

Mobile phones are now ubiquitous throughout our society and many companies, industries, organisations and individuals rely upon this improved connectivity. Since the advent of mobile telephony, the industry has worked to provide a more reliable, more efficient and more available service. A series of revisions and developments has occurred whereby mobile telephony is now on a par with the download speeds offered by fixed line broadband services and with the advent of 5G the capabilities of mobile telephony will expand even further.

In order to provide a wider reaching service with greater abilities generations of mobile telephony have concentrated upon improvements to manage capacity, broadcast range and data use. 5G presents a huge opportunity to expand connectivity for the individual users but also to expand into the Internet of Things (IOT). In essence IOT will allow the connectivity of machines and users to navigate and operate in a more efficient way. This may be something as simple as controlling your heating system remotely to autonomous vehicles, interconnected industrial machinery and robotics used in logistics, medicine, manufacturing, agriculture, health care services, the list is ever expanding.

In order to prepare the UK for this connectivity revolution 5G is being deployed throughout the country. Initially the deployment will be in cities and towns and along major transport routes but eventually 5G will be deployed to the whole of the UK. Throughout the history of mobile telephony there have been concerns raised with regards to the Health and Safety of the systems. A great deal of research has been undertaken throughout the world into the effects of electromagnetic radiation and radio signals and to date there has been no evidence to indicate that the systems so far operated and those intended to be operated have caused any manifest adverse health effects. Recently Public Health England ([www.gov.uk](http://www.gov.uk)) has provided guidance on this matter ([5G technologies: radio waves and health](#)) and the overall summary is that 5G does not represent an increase in any risk:

*“...the overall exposure is expected to remain low relative to guidelines and, as such, there should be no consequences for public health”.*

*5G technologies: radio waves and health PHE 3rd October 2019*



The World Health Organisation (WHO) undertakes a constant analysis of scientific papers and reviews into the use and operation of mobile phone transmissions. Throughout their analysis and studies WHO have made several conclusions and statements:

In relation to radio frequency exposures and wireless technology and health, the general conclusion from the World Health Organization (WHO) is;

*“Despite extensive research, to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health”*

*WHO - About Electromagnetic Fields – Summary of Health Effects Key Point 6*

In relation to wireless networks and health, the conclusion from the WHO is;

*“Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects.”*

*Source WHO Backgrounder on base stations and wireless technologies*

On mobile phone safety the World Health Organization advises,

*“A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use.”*

*“While an increased risk of brain tumors is not established, the increasing use of mobile phones and the lack of data for mobile phone use over time periods longer than 15 years warrant further research of mobile phone use and brain cancer risk. In particular, with the recent popularity of mobile phone use among younger people, and therefore a potentially longer lifetime of exposure, WHO has promoted further research on this group. Several studies investigating potential health effects in children and adolescents are underway”*

*WHO Fact Sheet 193 June 2014 - Electromagnetic fields and public health: mobile phones*

## RESEARCH INTO 5G AND HEALTH

All mobile telephony uses parts of the electromagnetic frequencies, in particular 5G uses part of the radio frequency spectrum which has been extensively researched in terms of health impacts for decades. Details below have been taken from various references including from the University of Aachen's EMF-Portal.

Over 50 years of scientific research has already been conducted into the possible health effects of the radio signals used for mobile phones, base stations and other wireless services including frequencies planned for 5G and mmWave exposures.

The data from this research has been analysed by many expert review groups. When considering the whole body of science, there is no evidence to convince experts that exposure below the guidelines set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) carries any known health risks, for adults or children. All mobile base stations operated by EE and Three are certified to be within the limits set by ICNIRP.

The EMF-Portal (<https://www.emf-portal.org/en>) is an open-access extensive database of scientific research into the effects of EMF, including studies on the effects of RF on health. It is managed by the RWTH Aachen University, Germany and linked from the WHO website. EMF-Portal contains more than 25,000 published scientific articles on the biological and health effects of EMF and 2,500 studies on mobile communications.

In terms of research specifically on 5G frequencies, the database lists approximately 350 studies on mmWave EMF health related research. Extensive research on mmWave and health has been conducted on radar, microwave and military applications.

The current research on mmWave frequencies is focused on the alignment of the human exposure guidelines at frequencies below and above 6 GHz where the measurement parameter changes from Specific Absorption Rate (SAR) below 6 GHz to Power Density above 6 GHz. For more on SAR see <http://www.sartick.com/>.

The research is also focused on the dielectric properties of human skin to ensure that the power density levels and averaging area across the skin align with the temperature values that are the basis of the human exposure guidelines. This is in reference to the use of the mobile device directly rather than the broadcast from the antennas. ICNIRP governs the levels of transmissions and all sites operated in the UK manage their transmissions well within the specific ICNIRP guidelines.

## 5G DEVICES AND TRANSMITTER POWER

All 5G devices will automatically minimise the transmission power to the lowest level in order to complete a satisfactory communication with the network.

Such automatic power control has existed in previous generations of mobile technologies (2G, 3G and 4G) and helps to minimize interference, prolong battery life and also has the effect of limiting the EMF exposure of the user. The transmit power of the device is controlled by the network. As such the base station antennas will effectively manage their power emissions in line with the demand placed upon the base station. With less users the base station will broadcast at a lower power level. When demand increases the base station manipulates its power control to manage the demand. Consequently, the broadcasts power rates of a base station fluctuate to ensure that only the most effective and appropriate level of power is used.

5G networks are designed to be more efficient and will use less power than current networks for similar services.

With the introduction of new technologies, there may be a small increase in the overall level of radio signals due to the fact that new transmitters are active. Based on the transition from previous wireless technologies we can expect that the overall exposure levels will remain relatively constant and a small fraction of the international exposure guidelines.

## WHAT TYPES OF BASE STATIONS ARE USED FOR 5G?

Base stations used for 5G will consist of various types of facilities including small cells, towers, masts and dedicated in-building and home systems.

Small cells will be a major feature of 5G networks particularly at the new mmWave frequencies where the connection range is very short.

To provide a continuous connection, small cells will be distributed in clusters depending on where users require connection, and this will complement the macro network 5G base stations. The initial rollout of 5G involves upgrading and installing new equipment on the macro base stations. Small Cells will form part of the wider network but will only be used once 5G proves that it is commercially viable and where demand requires or not-spots and partial not-spots have been identified.

5G networks will work in conjunction with 4G networks. In many cases, existing 4G base stations will be used for additional 5G equipment.

## DO 5G BASE STATIONS AUTOMATICALLY MINIMISE TRANSMITTER POWER?

Yes. 5G networks are specifically designed to minimise transmitter power, even more so than existing 4G networks. 5G networks use a new advanced radio and core architecture which is very efficient and minimises transmissions consistent with service requirements which results in optimised EMF levels.

The network also controls the power level of the device to the lowest level in order to complete a satisfactory communication with the network.

## WHAT WILL BE THE SIZE OF COMPLIANCE ZONES AROUND 5G NETWORK ANTENNA SITES?

The technical standards for the 5G networks and devices are continuing to be under development, however, it is expected that the size of the compliance zone for 5G antennas will be similar to that of other mobile technologies using similar transmitter powers.

Mobile network antennas are typically directional. Compliance zones extend in front of the antenna and a small distance above, below and to a lesser degree behind.

Mobile networks are designed to use only the power needed to provide quality services. Too much power would cause interference and affect all users. One of the goals of 5G is a substantial increase in network energy efficiency.

Where 5G is added to an existing site with other mobile technologies, the existing compliance zone may increase due to the addition of the 5G technology, however, this will depend on the site design and network configuration.

## IS 5G SIMILAR TO THE ACTIVE DENIAL SYSTEM USED BY THE MILITARY?

No. Active Denial Systems developed by the military use very high powered mmWave directional signal, sometimes called a 'heat ray' in the 90 GHz band designed to heat the surface of targets such as the skin of a human, and through the heat, control or restrict access. 5G and other mmWave radio communications use different frequencies and a fraction of the power. The human exposure limits for mobile communications technology prevent heating occurring.

Additional information on ADS systems is available here:

[\(http://jnlp.defense.gov/About/Frequently-Asked-Questions/Active-Denial-System-FAQs/\)](http://jnlp.defense.gov/About/Frequently-Asked-Questions/Active-Denial-System-FAQs/)

Mobile or cellular phones are now an integral part of modern telecommunications. In many countries, over half the population use mobile phones and the market is growing rapidly. In 2014, there is an estimated 6.9 billion subscriptions globally. In some parts of the world, mobile phones are the most reliable or the only phones available.

Given the large number of mobile phone users, it is important to investigate, understand and monitor any potential public health impact.

Mobile phones communicate by transmitting radio waves through a network of fixed antennas called base stations. Radiofrequency waves are electromagnetic fields, and unlike ionizing radiation such as X-rays or gamma rays, these radio waves can neither break chemical bonds nor cause ionization in the human body.

## Exposure levels

Mobile phones are low-powered radiofrequency transmitters, operating at frequencies between 450 and 2700 MHz with peak powers in the range of 0.1 to 2 watts. The handset only transmits power when it is turned on. The power (and hence the radiofrequency exposure to a user) falls off rapidly with increasing distance from the handset. A person using a mobile phone 30–40 cm away from their body – for example when text messaging, accessing the Internet, or using a “hands free” device – will therefore have a much lower exposure to radiofrequency fields than someone holding the handset against their head.

In addition to using "hands-free" devices, which keep mobile phones away from the head and body during phone calls, exposure is also reduced by limiting the number and length of calls. Using the phone in areas of good reception also decreases exposure as it allows the phone to transmit at reduced power. The use of commercial devices for reducing radiofrequency field exposure has not been shown to be effective.

## Are there any health effects?

A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use.

### Short-term effects

Tissue heating is the principal mechanism of interaction between radiofrequency energy and the human body. At the frequencies used by mobile phones, most of the energy is absorbed by the skin and other superficial tissues, resulting in negligible temperature rise in the brain or any other organs of the body.

A number of studies have investigated the effects of radiofrequency fields on brain electrical activity, cognitive function, sleep, heart rate and blood pressure in volunteers. To date, research does not suggest any consistent evidence of adverse health effects from exposure to radiofrequency fields at levels below those that cause tissue heating. Further, research has not been able to provide support for a causal relationship between exposure to electromagnetic fields and self-reported symptoms, or “electromagnetic hypersensitivity”.

### Long-term effects

Epidemiological research examining potential long-term risks from radiofrequency exposure has mostly looked for an association between brain tumours and mobile phone use. However, because many cancers are not detectable until many years after the interactions that led to the tumour, and since mobile phones were not widely used until the early 1990s, epidemiological studies at present can only assess those cancers that become evident within shorter time periods. However, results of animal studies consistently show no increased cancer risk for long-term exposure to radiofrequency fields.

Several large multinational epidemiological studies have been completed or are ongoing, including case-control studies and prospective cohort studies examining a number of health endpoints in adults. The largest retrospective case-control study to date on adults, Interphone, coordinated by the International Agency for Research on Cancer (IARC), was designed to determine whether there are links between use of mobile phones and head and neck cancers in adults.

The international pooled analysis of data gathered from 13 participating countries found no increased risk of glioma or meningioma with mobile phone use of more than 10 years. There are some indications of an increased risk of glioma for those who reported the highest 10% of cumulative hours of cell phone use, although there was no consistent trend of increasing risk with greater duration of use. The researchers concluded that biases and errors limit the strength of these conclusions and prevent a causal interpretation.

Based largely on these data, IARC has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), a category used when a causal association is

considered credible, but when chance, bias or confounding cannot be ruled out with reasonable confidence. Other substances within this category can be seen to be products such as; diesel, gasoline, bitumen, dry cleaning products, coconut oil, melamine and other carpentry products, metals such as nickel and lead, pickled vegetables, salted fish and talcum powder. The causal links have not been proven for radiofrequency electromagnetic fields to cancers and as the list above indicates RF transmissions at the levels used by the mobile industry provide a similar precautionary approach as to a large number of common household products and processes.

## Exposure limit guidelines

Radiofrequency exposure limits for mobile phone users are given in terms of Specific Absorption Rate (SAR) – the rate of radiofrequency energy absorption per unit mass of the body. Currently, two international bodies (<sup>1</sup>, <sup>2</sup>) have developed exposure guidelines for workers and for the general public, except patients undergoing medical diagnosis or treatment. These guidelines are based on a detailed assessment of the available scientific evidence.

## WHO response

In response to public and governmental concern, WHO established the International Electromagnetic Fields (EMF) Project in 1996 to assess the scientific evidence of possible adverse health effects from electromagnetic fields. WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2016. In addition, and as noted above, the International Agency for Research on Cancer (IARC), a WHO specialized agency, has reviewed the carcinogenic potential of radiofrequency fields, as from mobile phones in May 2011.

WHO also identifies and promotes research priorities for radiofrequency fields and health to fill gaps in knowledge through its research agendas.

WHO develops public information materials and promotes dialogue among scientists, governments, industry and the public to raise the level of understanding about potential adverse health risks of mobile phones.

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(1) International Commission on Non-Ionizing Radiation Protection (ICNIRP). *Statement on the "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)"*, 2009.

(2) Institute of Electrical and Electronics Engineers (IEEE). *IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz*, IEEE Std C95.1, 2005.