

# Radio wave safety workshop: questions and answers

In this document, your questions and answers for the radio wave safety workshop are published. Faulty answers are not published.

*Q: What kind of health problems are caused by the biological reactions in cells that are not explained by the warming up of tissues.*

A: If understood the question correctly, biological effects that cannot be explained by the warming of the tissues are most likely from the ionizing radiation sources. Effects of ionizing radiation are usually mutations in a sub-cell level. Those mutations can lead to cancer and birth defects. (<https://www.arpana.gov.au/understanding-radiation/what-is-radiation/ionising-radiation/health-effects>)

*Q: What is a fatal SAR value for human?*

A: No source for a fatal SAR value was found, as there is probably not a scientific study conducted for humans to figure this out. The document by STUK gives out the maximum value of 50-100 W/kg for local exposure, which can cause tissue burn. Values above these and if the exposure is to the whole body rather than local can be considered possibly fatal.

*Q: Compared to radio waves, what's the severity of exposure for thermal radiation, Visible light and UV radiation? Does that exceed the safety limit value?*

A: I think all kind radiations by waves can be assessed by SAR. The main difference of UV and radio wave is the difference of radiation kinds. The UV may cause ionize radiation while the radio wave just causes heating.

*Q: As we know most significant RF exposure is the result of appliances coming to contact with the body, for instance, mobile phones, so my question would be how hazardous would the exposure be when the person speaking on a mobile is charging its battery at the same time?*

A: Charging battery does not increase the RF exposure.

*Q: As the document says, the antennas in base stations that are installed on high masts possess no threat to the people around and underneath, but how would the local people rely on that information when there's some fault in the station and no one knows about it for quite a long time?*

A: The base station uses highly advanced technology and it's real-time monitored. When there's some fault the people who works in the station will know it immediately.

*Q: The document talks about keeping the radiating device far from the baby. But, what about the exposure of the pregnant women to the high-power radio waves? Does it harm the developing cells of the baby's body?*

A: Yes, it harms the developing cells of the baby and pregnant women should not be exposed to high-power radio waves. This is because the developing baby in the stomach has thinner skull bones and faster cell division which makes it have a lower immunity to radiation and exposure to radiation emitted by high-power radio waves is harmful and can result in birth defects. Reference: Kitowski, P. (2017, July 14). Pregnancy and Radiation Exposure. Retrieved February 24, 2019, from <https://muditalab.com/pregnancy-and-radiation-exposure-bb41f7d2ad9d>

*Q: The transmitting power of the mobile phone is reduced when a base station is nearby. Is it good to have more base station antennas after every certain distance in order to have less power radiation or does it increase the chance of being exposed to the radiation highly?*

A: At the ground level, the intensity of radio frequency radiation from base stations are less than one thousandth of those from mobile phones and are generally much less than those from the local radio and television stations. As such, having more base stations does not increase the chance of being exposed to radiation highly but a factor to consider to having more base stations is that it could be costly and unnecessarily needed as a mobile phone does not emit much radiation in the first place. Reference: Hoong, N. K. (n.d.). Radiation, Mobile Phones, Base Stations and Your Health. Retrieved February 24, 2019, from <https://www.who.int/peh-emf/publications/en/mcmcradiationmobilephonebk.pdf>

*Q: Do LTE and the coming 5G techniques differ from 3G and WiMAX techniques regarding the exposure to radiation?*

A: As the new technologies also use microwave frequencies there is not big difference in the exposure to the radiation. However, new technologies often use more antennas and thus also output more power. This has some effect on the radiation exposure.

*Q: How does the location of the antenna inside the mobile phone affect the SAR value?*

A: The effects of location of the antenna to the SAR value depend on the usage of the mobile phone. When speaking to the phone, antennas at the bottom of the phone have lower SAR values as the antennas are further away from the body. However, antennas type affects the SAR values much more significantly than the location of the antennas. Source: Tsiaras, A. 2014. SAR Evaluation in Multi-Antenna Mobile Handsets. Lund University.

*Q: Most of the people are scanned by MRI at least once in their lives. How much radiation is a person exposed to in MRI scanner?*

A: Although MR scanner do not use radioactivity, can we say that is without risk to exposed persons? This technology uses radio wave and electromagnetic field. "The static magnetic field of MRI scanners in routine clinical systems is generated by permanent magnets, superconducting magnets and combinations thereof in the range of 0.2 - 3 T." "Physical movement within a static magnetic field in which the strength changes by more than 2000 mT in a given direction (magnetic field gradient) can induce sensations of vertigo and nausea". MRI scanner is not dangerous for patients due to the temporary exposure but there may be a safety concern for workers performing operations using MRI. Source : [https://www.greenfacts.org/en/static-fields/l-2/3-static-magnetic-field-mri.htm#0\\_2](https://www.greenfacts.org/en/static-fields/l-2/3-static-magnetic-field-mri.htm#0_2).

*Q: To exposure to radiation can be more dangerous for a child than an adult. Is there a limit which is different than 2W/kg for exposure to radiation for children?*

A: The limit of the exposure is 2W/kg only in Europe and 1,6 W/kg in USA. This limit value has been calculated to guarantee the safety of everybody, included children of course. Scientists have defined

a critical threshold as the level of exposure from which we will be able to observe temporary thermic effects on the body. A security factor of 50 has been added to this threshold to obtain the limit value of exposure in order to consider scientific uncertainties. Precautions are made to ensure that this value limit can be applied for everyone. Source: <http://www.radiofrequences.gouv.fr/exposition-du-public-a70.html>

**Q: How was the exposure limit calculated?**

A: The SAR values are calculated based on the electrical conductivity of the material that is being exposed to RF radiation (human tissue in this case), the electrical field, the sample density and the volume of the sample. In order to measure the amount of radiation produced by a mobile phone that is absorbed by the human body, it is used representation models of human parts to expose them to the radiation, then the measurements are made. As it is know, this type of radiation can heat water and, since our body as a lot of it, warming up of tissue will occur due to the exposure to this radiation. The limits then are measured depending on the reaction of the tissues to the temperature. (I didn't find any information of how this specific limits were measured, but this how you do it) Sources: [https://en.wikipedia.org/wiki/Specific\\_absorption\\_rate](https://en.wikipedia.org/wiki/Specific_absorption_rate) <https://www.ncbi.nlm.nih.gov/pubmed/9771585> <http://www.michigan-rad.org/radiation-safety/MRSafetyWriteup1.pdf>

**Q: Do we have to develop the technology that uses radio radiation since we do not know the whole effects on health?**

A: Personally I don't think so, at least until the full effects on human health due to RF exposure are known. Since we don't know the effects, we also don't know what to develop, otherwise we would be aiming some new technology for nowhere. I guess that all the technologies that use this type of radiation already try to use the minimum amount of it, even for efficiency purposes so, I think that decreasing the levels of radiation would not be feasible too.

**Q: What was the main point of the article?**

A: The article was about radio wave safety and how different applications using radio wave frequencies affect the exposure to RF radiation. [1]

[1] Radio waves and our environment, STUK Radiation and Nuclear Safety Authority, 2009

**Q: One uses laptop that is connected to Wifi and wireless headphones. Which one cause more radiation exposure?**

A: The wifi connected laptop causes higher exposure. [1]

[1] Radio waves and our environment, STUK Radiation and Nuclear Safety Authority, 2009

**Q: In this paper, it explains that when the power from base station is weak, the mobile phone itself will transmit larger power, for example, in a moving car or train may be dangerous. Why not set a threshold transmitting power of mobile phones, when designing antennas.**

A: According to Federal Communications Commission, the amount of power emitted from the phone is generally 0.75 to 1 W. It is considered as safe as the SAR is just 1.6W per kilogram. If a lower threshold transmitting power is set, the performance of the mobile phone will be much poorer. Users will always complain about the poor connection.

**Q: The paper gives Security of exposure (SAR) of many single device to show it is safe. However, in our daily living rooms, (may be) we have base on the top of building, wifi router in the room, microwave**

***oven in the kitchen, laptops, mobiles, pads around the room. I just curious about if it's sensible to measurement them in a sum?***

A: Yes, definitely. The SAR will add up if there are different sources of radio wave transmission. Therefore, it is not safe anymore if there are so many devices near you.

***Q: What is the minimum height that the antenna has to be in order for us to avoid exposure (approximately)?***

A: I could not find the exact answer for the minimum height of antenna in order to avoid exposure. However, i tried my best to answer the question depending upon what I have understood. The height of an antenna depends upon the type of antenna being as different antennas have different radiation patterns. Also, it depends upon the amount of power it radiates; an antenna that radiates high power are installed at higher places or masts (why? - better explained in second question). The antennas are placed such that people have no direct access to its main lobe. The exposures are usually less than one thousandth or some ten thousandth parts, and even at the most, only a few percents of the exposure limits (from the document provided). It is generally recommend to be at least at certain distance form the certain type of antenna with certain power level. The minimum distance for different types of antennas can be found in the reference given below in page 43. [https://www.cpw.com/sites/default/files/research/7.\\_Protective\\_Measures\\_for\\_RF\\_Radiation.pdf](https://www.cpw.com/sites/default/files/research/7._Protective_Measures_for_RF_Radiation.pdf)

***Q: How does the height of the antenna affect exposure?***

A: As per the Friis' formula, the power density is inversely proportional to the square of distance from the receiver antenna. This is valid for both horizontal and vertical direction. Hence, the power density is very high near an antenna and decrease with the increase in distance from the antenna.

***Q: What kind of exposure does the THz imaging produce?***

A: According to article [1], 0,12 THz radiation for 24 h has no significant effect on human cells, but controversial results also exists. In another study [2], it is stated that typical terahertz imaging systems are safe according to the current guidelines.

[1] "Twenty Four-Hour Exposure to a 0.12 THz Electromagnetic Field Does Not Affect the Genotoxicity, Morphological Changes, or Expression of Heat Shock Protein in HCE-T Cells" <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4997479/> 28.2.2019

[2] "Do in vivo terahertz imaging systems comply with safety guidelines?" <https://lia.scitation.org/doi/10.2351/1.1585079> 28.2.2018

***Q: Why there is no references to any studies?***

A: I guess STUK should be a reliable source, but I agree that references would make a better article.

***Q: In the document, it is said that the third generation (3G) phones cause lower exposure levels than the older GSM phones, due to the more advanced power control. Does this still hold for the newer generations (4G and 5G), despite the increased operating frequency?***

A: 4G uses the same power system as 3G and 5G uses a bit advanced technology compared to 4G. In both case (4G & 5G) the exposure is so low that there is no evidence that it might be harmful to human health. For more information you can check: -4G : <http://www.emfexplained.info/?Page=25526>  
-5G : <http://www.emfexplained.info/?ID=25914>

***Q: Will the radiation exposure from the base stations be significantly higher in the future as higher frequencies require a very dense base station network?***

A: There is lot of research enabling that the base station will work in higher frequency in the future. The exposure in other hand is something that people are trying to minimize.

***Q: If in everyday life, we are surrounded by radio waves wherever we are, and since the usage of this technologies tends to increase as time goes by, why are such a lack of information about the effects of the exposure to these waves on our body? This question refers to this paragraph: "Some studies indicate that doses close to the limit values may induce biological reactions in cells that are not explained by the warming up of tissues. At present we do not know enough to estimate if these reactions have any effect on health and therefore further studies are necessary." And some other mentions about this topic on the document.***

A: The main answer, why we don't know about other aspects of radio waves on human body other than heating is because humans don't live in a controlled environment, where we can expose it to RF and monitor it (we're not lab rats). Secondly, RF communication is so new and long time exposure wasn't tested so much and there is not too much data to work on. So, in general, if you want to test what RF does to our body, you need to keep a person in a controlled environment, where you specifically know everything what happened to that person and at what scale. But this is not going to happen. Not anytime soon.

***Q: In the document, it is mentioned that when exposed to the combined effect of the specific absorption rate (SAR) of multiple devices, a person can potentially be at risk of being exposed above the SAR limit. Is there a SAR measurement device that is readily available for households so that people can measure the combined effect of the SAR at various spots in their house?***

A: There is not direct tool to measure SAR value at home since many equipment are needed to measure the SAR value of only a phone ("Mobile Cell Phone Radiation SAR Testing", 2011); nevertheless, we can measure the RF radiation per m<sup>2</sup> in our houses with the help of a radio frequency meter and also some of them has a colorful spectrum that shows safe and dangerous values

***Q: In the document, it is mentioned that a person should try not to keep their cell phones in the pocket for long. How long can a person keep their cell phone in their pockets before it starts to become hazardous to the body?***

A: The SAR limit for mobile phones is 1.6W/kg according to FCC ("Specific Absorption Rate (SAR) for Cellular Telephones", 2016). According to the document, it is known that 2W/kg SAR value causes increasing temperature approximately +0.3°C in long-term exposure and this value is not harmful for human health. Hence, it can be thought that carrying a mobile phone in your pocket for a long time will not cause any harm to your body but the research on this topic still continues since it is not proved that mobile phones have no harm to human body.

***Q: How much impact on blocking the radio waves do various household objects have? (Like a wall, table, window, your jacket.)***

A: The amount of the blocking depends on material of the household items. Metal household items will reflect the radio waves. However, dry wood is nearly transparent to radio waves.

***Q: 4G and 5G impact on humans, because the article was older only covered 3G.***

The impact of the 4G and 5G are less than 3G. 4G and 5G have more base stations and smaller cell size. Thus, the transmission power will be less. The beam steering in mobile phones will also enable to steer the antenna beam towards the base station hence decreasing the exposure to RF radiation. After all, the impact on humans is small.

***Q: What sort of biological reactions happen in cells when they are exposed to doses of radio waves close to limit values?***

Cells can heat when exposed to radio waves close to safety limits. Thus, it is important to compute SAR-limit and not to exceed it.

***Q: How is the combined radiation from many different sources simultaneously investigated?***

Only closest radiation source affects to radiation exposure significantly. Only sources that are located close to body have the highest effect. [1, p. 11-12] Source: [1] Radio waves and environment

***Q: What is the relationship between the time exposed to the radio waves and the heating effect?***

A: It is not clearly stated anywhere about the relationship between the time exposed to the radio waves and the heating effect but one can easily guess that longer the exposure, longer the heating effect is. For instance, people who are accidentally exposed to large amounts of RF radiation from radar equipment have developed severe burns but it is not yet clear if exposure to lower levels of RF radiation, even over long time period, can have harmful effects. Source: <https://www.cancer.org/cancer/cancer-causes/radiation-exposure/radiofrequency-radiation.html>

***Q: In the document, it claims that using hands-free device to talk on the phone can reduce the exposure to the radiation. However, some devices for example Bluetooth earphone emits radio waves. Why will it be better?***

A: I don't think Bluetooth is highly recommended as a hands-free device in this document. However, it claims that the Bluetooth has very low power and operate in ranges of one meter, ten meters or one hundred meters, where SAR values of the longest range is about 0.5 W/kg at most when there is a contact between the antenna and the body. This means radiation due to Bluetooth is not that significant. Nevertheless, the document has recommended other safer means, for example, keeping phone on a table or using wired earphones while speaking on phone to maintain a distance that help prevent the radiation significantly. Source: <https://www.cancer.org/cancer/cancer-causes/radiation-exposure/radiofrequency-radiation.html>