



PHYSICIANS TO SAFE TECHNOLOGY

Conversion Chart, World Exposure Limits, Human Exposures
EMR/EMF Physicians for Safe Technology.



Updated 10/24/23

Scroll down for articles on human and occupational exposures



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Conversion Chart Microwave Radiofrequency (RF) Electromagnetic Radiation (EMR) = (EMF)

Our exposure to wireless radiation is steadily increasing. This radiofrequency (RF) radiation is currently classified as a Group 2B Possible Human Carcinogen by the International Agency for Research on Cancer at the WHO as of 2011. Many scientific experts who work in the field of EMR feel there is clear evidence of harm from long term, low level exposure to this artificial pulsating and penetrating non-ionizing radiation which warrants an upgrade to the IARC classification to a Group 1 Known Carcinogen (Hardell and Carlsberg 2018).

It is important to be able to read the scientific literature, however, it can be confusing as there are different units of power density measurements ($\mu\text{W}/\text{cm}^2$, $\mu\text{W}/\text{m}^2$, W/m^2 , V/M) for RF transmitters as well as Specific Absorption Rate (SAR) measurements for portable wireless devices such as cell phones and tablets. In addition, harm from radio frequency exposure varies with power, distance, device, modulation (pulsations and wave design), polarization and length of exposure. Wall et al demonstrated that with a weak reception cell phone signal radiation is magnitudes higher. The peak power and pulsation, rather than the averaged power, are the important features causing cellular and membrane injury. All types of EMF can have biological effects (Wireless RF, Electricity, magnetic fields). On this page we are focusing on radiofrequency fields from wireless devices. ELF and Magnetic fields, which can be measured, have also been classified by WHO as "possibly carcinogenic" in 2001. Dirty Electricity caused by high-frequency voltage transients can also be measured.

FCC Safety Guidelines for Human Exposure to Radiofrequency Radiation (RF): Power Density vs SAR

The Federal Communications Commission (FCC) is required by the National Environmental Policy Act of 1969 to evaluate the effect of emissions from FCC-regulated transmitters on the quality of the human environment. The FCC receives recommendations for human exposure to RF electromagnetic fields from organizations such as the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers, Inc. (IEEE), and the National Council on Radiation Protection and Measurements (NCRP). As noted in the FCC Radio Frequency webpage, these standards are essentially the same as those set in 1992 by the American National Standards Institute and the Institute of Electrical and Electronics Engineers (ANSI/IEEE C95.1-1992), for frequencies above 1500 MHz. Despite increasing evidence of harm from this type of radiation to not only humans, but wildlife as well, the standards have not been updated to include non-thermal biological effects, vulnerable populations and non human species. This has been successfully challenged in court.

Radio and cell antenna transmission are measured by field strength and power density or power flow per unit area. Maximum Permissible Exposure limits for the transmitters operating at frequencies of 300 kHz to 100 GHz have been set and are in the conversion tables below. There is some variation with different frequencies and public versus occupational exposures. Exposures limits are set for an average time less than 30 minutes for the public and less than 6 minutes for occupational exposure. For portable or handheld wireless devices used in close proximity to

the body the FCC uses a measurement called Specific Absorption Rate (SAR). SAR corresponds to the relative amount of radiofrequency energy absorbed in the head or body from the source being measured. The FCC limit for public exposure from cellular telephone operating below 6GHz is a SAR level of 1.6 watts per kilogram (1.6 W/kg) as averaged over one gram of tissue. Above 6GHz power density is used. These safety guidelines are based only on the heating of tissues, not on complex biologically injury found at lower exposures. The FCC discussed health concerns here.

Different Countries Have Different Exposure Standards

It is important to keep in mind that the current thermal (heat) RF exposure standards vary in different countries. The biologically toxic (oxidative/membrane) RF exposure levels, shown to produce harm at non-thermal levels, are far below current U.S. RF guidelines (See BioInitiative Report). More lenient current U.S. FCC standards put large populations at risk for a diverse array of long term health issues. We list several exposure standards and limits along with the short conversion chart to enable easier reading of the scientific literature. The Austrian Medical Association Guidelines of 2016 are also posted below. Scientific references on exposure measurements are listed at the end (Ambient, Children, Skin and Body Exposures, Occupational)

Industry Standardization Worldwide?

Industry is trying to standardize all countries to allow higher levels of RF that are consistent with current IEEE & ICNIRP guidelines (Same as US and Canada) which do not take into account non thermal biological effects, only heat. Here is a slide presentation that helps to understand industry strategy. If this moves forward countries who wish to use lower precautionary limits will be unable to do so. TIA-MWF PowerPoint for FCC Labs and OET Meeting

Russia set lower standard than the U.S. and have not raised them. It is interesting to find that Russian researchers looked at RFR exposures and immune dysfunction over 2 decades ago and because of these robust studies which were replicated in 2006-2009 they set their upper limit of RFR at 10 $\mu\text{W}/\text{cm}^2$.

SAR Standards Need To Be Lowered

A 2021 article discusses health based standards and advises updating SAR standards for wireless devices to be 40 times lower than current standards. Development of health-based exposure limits for radiofrequency radiation from wireless devices using a benchmark dose approach. (2021) Uche UI & Naidenko's OV. Environmental Health. 20, Article number: 84 (2021). <https://ehjournal.biomedcentral.com/articles/10.1186/s12940-021-00768-1>

EMF / RF Exposure Guidelines. Safe Living Technologies has summary lists of precautionary guidelines from Building Biology Institute, International Exposure Limits, Austrian Medical Association Guidelines 2012, and EUROPAEM EMF Guidelines 2016. <https://safelivingtechnologies.com/emf-exposure-rf-exposure-guidelines/>

Telecom Discusses 5G

Here is a thorough discussion from the telecom industry, Preparing for 5G: Evolution of RF Compliance Standards and Regulations for Mobile Devices.

The History of Industry RF Standards

In an older yet thorough and honest review article, *The Origins of U.S. Safety Standards for Microwave Radiation* (1980), authors Steneck, Nicholas H., Harold J. Cook, Arthur J. Vander, and Gordon L. Kane analyze the scientific research and funding, as well as the political influences behind the 1996 RF standards. An important read to understand why the levels in the U.S. are so high. They highlight, from the beginning of radar, a communication gap between the technical military community and the public in order to reduce public anxiety. The authors point out the inadequacies and flaws of RF studies leading to an invalid standard after 7 years of committee work. There was no research on pulsed vs continuous radiation or non-thermal biological effects, and frequently research was not reproduced. With calls for more accurate research he asked, "Why was the standard set just when scientific research was beginning to reveal how much work remaining to be done?" Paul Brodeur, a critic of the standards policy, stated many people who were involved in setting the standard "felt obliged to protect the 10mW level at all costs and to ignore, deny, or if worst came to worst, suppress any information about adverse effects of low-intensity microwave radiation," due to the belief that any lower standard would interfere with national defense. There was much debate in the rush to adopt a standard in 1966. The article notes that the Raytheon Company attempted to thwart military sponsorship on the Iowa cataract research. Colonel Knauf, at the Fourth Tri-Service Conference dedicated to microwave standard setting, commented that *"the 10mW/cm² guideline had been selected to please operations rather than to ensure safety. ...Those who set the standard in 1966 still viewed microwaves as a military and industrial problem."* *The Origins of U.S. Safety Standards for Microwave Radiation*. Science. Vol 208, no. 4449: 1230–37. June 13, 1980. <https://www.jstor.org/stable/1683969>

The Lancet Publishes Article on Planetary RF Exposures in 2018

A December 2018 article on planetary radio frequency (RF) exposures was published in the prestigious medical journal, *The Lancet*. Titled [Planetary electromagnetic pollution: it is time to assess its impact](#), the authors discuss the flaws in current exposure guidelines, and show a graph indicating the changes in exposure levels of different frequencies over time. They call for this topic to be included with other critical issues related to planetary health, including climate change and rising levels of chemical toxins.

How to measure Radiofrequency (RF) fields

How to use the "Safe and Sound Pro II" RF meter to measure Radiofrequency Fields – In this video EMF Test Engineer Michael Neuert explains the difference between Peak, Max Peak and Average levels of radiation from wireless devices, cell phones, antennas and cell towers and how to use a meter to measure them.

<https://www.youtube.com/watch?v=ZgJ8x4CkUBM>

How to Measure Magnetic Fields

Alpha UHS Gaussmeter Instructions: How to measure magnetic fields using the Alpha UHS Meter. EMF Test Engineer Michael Neuert explains how to measure magnetic fields from power lines, electrical wiring, electric panels and anything that runs on electricity, i.e. computers, TV's, LED's as electrical devices create a magnetic fields when they are turned on. Occasionally metal water pipes can carry stray electricity as well. He also explains how to separate magnetic fields from VLF emitted from electronic devices and LED's. <https://www.youtube.com/watch?v=2wgggysXWQ0>

See Also: Safe Living Technology EMF/RF/Magnetic Field full conversion charts [here](#)

Scroll down for : **Worldwide Exposure Limits* **Current Heat-Based Guidelines* and **Scientific References on Measured Human and Children's Exposures*

Levels of Concern and Exposure Limits

Key to Chart: * ** *** and Current Limits in U.S.

* [Low Concern](#)– Building Biologists benchmark for long term exposure (0.00001 W/cm^2)

** [BioInitiative Limits](#)- No observable effect on humans ($0.0003\text{-}0.0006 \text{ } \mu\text{W/cm}^2$) [BioInitiative Report](#)

*** [Extreme Concern](#)- Building Biologists benchmark for long term exposure ($0.1 \text{ } \mu\text{W/cm}^2$) [Building Biologist EMR Exposure Guidelines are here](#)

Current Limits in U.S. are in Red highlights and are up to $1000 \text{ } \mu\text{W/cm}^2 = 1 \text{ mW/cm}^2 = .001 \text{ W/cm}^2 = 10,000,000 \text{ } \mu\text{W/m}^2 = 10,000 \text{ mW/m}^2 = 10 \text{ W/m}^2 = 61.4 \text{ V/m} = 64,100 \text{ mV/m}$

Conversion Chart EMR = EMF

Power equivalents— $1 \text{ } \mu\text{W/cm}^2 = 10,000 \text{ } \mu\text{W/m}^2 = 0.01 \text{ W/m}^2$

Watts/Square Meter (W/m^2)	microWatts/Square Meter ($\mu\text{W/m}^2$)	microWatts/Square Centimeter ($\mu\text{W/cm}^2$)
0.000,000,000,000,1 W/m^2	0.000,000,1 $\mu\text{W/m}^2$	0.000,000,000,01 $\mu\text{W/cm}^2$
0.000,000,000,001 W/m^2	0.000,001 $\mu\text{W/m}^2$	0.000,000,000,1 $\mu\text{W/cm}^2$
0.000,000,000,01 W/m^2	0.000,01 $\mu\text{W/m}^2$	0.000,000,001 $\mu\text{W/cm}^2$
0.000,000,000,1 W/m^2	0.000,1 $\mu\text{W/m}^2$	0.000,000,01 $\mu\text{W/cm}^2$
0.000,000,001 W/m^2	0.001 $\mu\text{W/m}^2$	0.000,000,1 $\mu\text{W/cm}^2$
0.000,000,01 W/m^2	0.01 $\mu\text{W/m}^2$	0.000,001 $\mu\text{W/cm}^2$
<u>0.000,000,1 W/m^2 *</u>	<u>0.1 $\mu\text{W/m}^2$ *</u>	<u>0.000,01 $\mu\text{W/cm}^2$ *</u>
<u>0.000,001 W/m^2 **</u>	<u>1(3-6) $\mu\text{W/m}^2$ **</u>	<u>0.000,1 (0.0003-6) $\mu\text{W/cm}^2$ **</u>
0.000,01 W/m^2	(3-6)10 $\mu\text{W/m}^2$	0.001 $\mu\text{W/cm}^2$
0.000,1 W/m^2	100 $\mu\text{W/m}^2$	0.01 $\mu\text{W/cm}^2$
<u>0.001 W/m^2 ***</u>	<u>1,000 $\mu\text{W/m}^2$ ***</u>	<u>0.1 $\mu\text{W/cm}^2$ ***</u>

0.01 W/m ²	10,000 µW/m ²	1 µW/cm ²
0.1 W/m ²	100,000 µW/m ²	10 µW/cm ²
1 W/m ²	1,000,000 µW/m ²	100 µW/cm ²
10 W/m ²	10,000,000 µW/m ²	1,000 µW/cm ²
100 W/m ²	100,000,000 µW/m ²	10,000 µW/cm ²
1000 W/m ²	1,000,000,000 µW/m ²	100,000 µW/cm ²

Conversion Chart Volts per meter (V/m) to µW/cm²

Using Acoustameter RF-10- Peak RF-EMR Emissions are in Volts/meter (V/m) which translates to power density in (µW/m²). Note Peak levels more important than average levels.

Volts per Meter (V/m) to milli Volts per meter (mV/m) to microWatts per meter squared (µW/m²) to microWatts per centimeter squared (µW/cm²)

- 0.000,194 V/m = 0.194 mV/m = 0.000,1 µW/m². = 0.000,000,01 µW/cm²
- 0.000,614 V/m = 0.614 mV/m = 0.001 µW/m². = 0.000,000,1 µW/cm²
- 0.001,94 V/m = 1.94 mV/m = 0.01 µW/m² = 0.000,001 µW/cm²
- 0.006,14 V/m = 6.14 mV/m 0.1 µW/m² = 0.000,01 µW/cm² * Low concern
- 0.019,4 V/m = 19.4 mV/m = 1 µW/m² = 0.000,1 µW/cm² ** Bioinitiative NOE
- 0.061,4 V/m = 61.4 mV/m = 10 µW/m² = 0.001 µW/cm²
- 0.194 V/m = 194 mV/m = 100 µW/m² = 0.01 µW/cm²
- 0.614 V/m = 614 mV/m = 1000 µW/m² = 0.1 µW/cm² *** Extreme concern BB
- 1.94 V/m = 1,942 mV/m = 10,000 µW/m² = 1 µW/cm²
- 6.14 V/m = 6,140 mV/m = 100,000 µW/m² = 10 µW/cm²
- 19.4 V/m = 19,416 mV/m = 1,000,000 µW/m² = 100 µW/cm² -Current U.S. guidelines
- 61.4 V/m = 61,400 mV/m = 10,000,000 µW/m² = 1,000 µW/cm²- Current guidelines
- 194 V/m = 194,164 mV/m = 100,000,000 µW/m² = 10,000 µW/cm²
- 614 V/m = 614,003 mV/m = 1,000,000,000 µW/m² = 100,000 µW/cm²
- 1942 V/m = 1,941,648 mV/m = 10,000,000,000 µW/m² = 1,000,000 µW/cm²

Note: Current FCC Guidelines

- 19.4 V/m = 19,416 mV/m = 1,000,000 µW/m² = 100 µW/cm²
- 61.4 V/m = 61,400 mV/m = 10,000,000 µW/m² = 1,000 µW/cm²

Note: Building Biologists Extreme Concern for Long Term Exposure

- 0.614 V/m = 614 mV/m = 1000 µW/m² = 0.1 µW/cm²

Note: Bioinitiative Limit for No Observable Effects

- $0.019,4 \text{ V/m} = 19.4 \text{ mV/m} = 3\text{-}6 \text{ } \mu\text{W/m}^2 = 0.0003\text{-}0.0006 \text{ } \mu\text{W/cm}^2$

Building Biology Precautionary Guidelines (2015) for Sleeping Areas

Power density	No Concern	Slight Concern	Severe Concern	Extreme Concern
microWatts per square meter $\mu\text{W/m}^2$	< 0.1	0.1 - 10	10 - 1000	> 1000
microWatts per square cm $\mu\text{W/cm}^2$	< 0.000,01	0.000,01 - 0.001	0.001 - 0.1	> 0.1
milliWatts per square meter mW/m^2	<0.000,1	0.000,1 - 0.01	0.01 - 1	> 1
Signal strength				
Volts per meter V/m	< 0.006,14	0.006,14 – 0.061,4	0.061,4 – 0.614	> 0.614

Modern Homes Full of Microwave Radiation

This news video, from Safe Living Technologies, shows some of the sources of wireless radiation in the home. The measurements are done by a Building Biologist who acknowledges these levels are within the legal guidelines but not precautionary. Modern Homes Full of Microwave Radiation

Wireless Exposure Limits in Different Countries

The limits are for frequencies between 300Mhz-300GHz in microwatts/cm²

Limit guidelines in U.S. are from 200 uW/cm^2 to 1000 uW/cm^2 (2 W/m^2 to 10 W/m^2) for RF radiation depending on frequency. Countries developed different standards based on either *Thermal Effects *Non-Thermal Effects or *Precautionary Considerations. The values below are at 900MHz but vary with frequency and are as up to date as possible. EU standards have changed and there may be mandated lower limits.

Japan	600 microwatts/cm ²
U.S.A.	450 microwatts/cm ²
Canada**	450 microwatts/cm ²
Australia	450 microwatts/cm ²
Austria	[450] microwatts/cm ²
France	450 microwatts/cm ²
Germany	450 microwatts/cm ²
Hungary	450 microwatts/cm ²

Ireland	450 microwatts/cm ²
Luxembourg	450 microwatts/cm ²
Portugal	450 microwatts/cm ²
Spain	450 microwatts/cm ²
India	45 microwatts/cm ²
China	40 microwatts/cm ²
Russia and	10 microwatts/cm ²
Italy	10 microwatts/cm ²
Bulgaria	10 microwatts/cm ²
Poland	10 microwatts/cm ²
Lichtenstein	10 microwatts/cm ²
Switzerland <u>**</u> and <u>***</u>	10 microwatts/cm ²
Belgium	[2.4] microwatts/cm ²
Ukraine <u>**</u>	2.5 microwatts/cm ²
Cosmic Background -Evolutionary	<0.0000000001 μW/cm ²

Cosmic EMR background we evolved from <0.0000000001 μW/cm²

- Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields.
<https://www.ncbi.nlm.nih.gov/books/NBK304630/>
- Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. (2009) Nittby H et al. 2009 Aug;16(2-3):103-12.
<https://www.ncbi.nlm.nih.gov/pubmed/19345073>. <https://www.emf-portal.org/en/article/16986>
- International Guidance Levels-Powerwatch. <https://www.powerwatch.org.uk/science/intguidance.asp>

Comparison of International Policies on Electromagnetic Fields. National Institute for Public Health and Environment Netherlands 2013- New- [here](#)

Poland Set Limits on 5G Millimeter Waves. 2020

[Protection of the population health from electromagnetic hazards – challenges resulting from the implementation of the 5G network planned in Poland]. Med Pr. 2020 Jan 20;71(1):105-113. Zmyslony. <https://pubmed.ncbi.nlm.nih.gov/31793559/>

BioInitiative Report Recommendation – ‘No Observable Effect’ with factor of 10 added for safety = 0.0003-0.0006 $\mu\text{W}/\text{cm}^2$.
<http://www.bioinitiative.org/conclusions/>

History of Development of Radiofrequency Standards from 1953. THE CHALLENGE OF NON-IONIZING RADIATION: A PROPOSAL FOR LEGISLATION . Karen Massey. Duke Law Journal. 1978.
<https://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=2692&context=dlj>

EMF Info [here](#)

ICNIRP WHO Standards [here](#)

ICNIRP Perspective of Health Risks: Facts, Uncertainties, Public Perception and Need for Action [here](#)

ICNIRP Guidelines (1999) at 900 MHz are 450 microwatts/cm² = 41V/M [here](#)

Canada Safety Code 6 [here](#)

LONG-TERM EXPOSURE TO MICROWAVE RADIATION PROVOKES CANCER GROWTH: EVIDENCES FROM RADARS AND MOBILE COMMUNICATION SYSTEMS. Kyrylenko et al. National Academy of Sciences of Ukraine. 2013.
<https://exp-oncology.com.ua/article/1845/long-term-exposure-to-microwave-radiation-provokes-cancer-growth-evidences-from-radars-and-mobile-communication-systems>

Liechtenstein Reduces RF Exposure Limits. 2014. Peter Sierk. <http://www.emfrf.com/liechtenstein-reduces-rf-exposure-limits/>

Hypercable Conversion Chart PDF https://www.hypercable.fr/images/stories/Conversion_Chart_dbm_v_m.pdf

For a full list of EMR exposure guidelines go [here](#)

Austrian Medical Association (AMA) Exposure Limits

“In general, a wide variety of forms of EMF exposure (e.g. from cordless phones, wireless internet access, electrical installations and electrical devices in the building, mobile phone base stations, radio and TV transmitters, high-voltage lines or transformer stations) may be the root causes of health problems....Irrespective of the ICNIRP recommendations for acute effects, the following benchmarks apply to regular exposure of more than four hours per day...” AMA

The [EUROPEAN EMF GUIDELINES 2016](#) for the prevention, diagnosis and treatment of EMF-related health problems and illnesses is based on the Austrian Medical Association Guidelines and gives an “overview of the current knowledge regarding EMF-related health risks and provides recommendations for the diagnosis, treatment and accessibility measures of EHS to improve and restore individual health outcomes as well as for the development of strategies for prevention.” List of scientific references given. Here are their recommendations.

High-frequency electromagnetic radiation (as power flow density)

$0.1 \mu\text{W}/\text{cm}^2$ ($\geq 1000 \mu\text{W}/\text{m}^2$) ($\geq 1 \text{ mW}/\text{m}^2$)—Very far above normal

$0.001 \mu\text{W}/\text{cm}^2$ to $0.1 \mu\text{W}/\text{cm}^2$ ($10\text{-}1000 \mu\text{W}/\text{m}^2$) ($0.01\text{-}1 \text{ mW}/\text{m}^2$)- Far above normal

$0.000,1 \mu\text{W}/\text{cm}^2$ to $0.001 \mu\text{W}/\text{cm}^2$ ($1\text{-}10 \mu\text{W}/\text{m}^2$) ($0.001\text{-}0.01 \text{ mW}/\text{m}^2$)- Slightly above normal

Less than $0.000,1 \mu\text{W}/\text{cm}^2$ ($\leq 1 \mu\text{W}/\text{m}^2$) ($\leq 0.001 \text{ mW}/\text{m}^2$) – Within normal limits

“The benchmarks listed are intended to be applied to individual types of radiation, e.g. GSM, UMTS, WiMAX, TETRA, radio, TV, DECT or WLAN, and refer to peak levels [not averaged levels]. The benchmarks do not apply to radar, which must be evaluated separately. Highly critical types of radiation, such as periodic signals (mobile telephony, DECT, WLAN, digital broadcasting...), should be critically evaluated, especially if levels are far above normal, while less critical types, such as non-pulsed or non-periodic signals (USW, shortwave, medium and long wave, analogue broadcasting), may be considered more leniently.” AMA- Here are the [EUROPEAN EMF Guidelines 2016 EHS – PDF](#) to print or download.

Low-frequency Alternating Electric Fields

$\geq 10 \text{ V}/\text{m}$ Very far above normal

$1.5\text{-}10 \text{ V}/\text{m}$ -Far above normal

$0.3\text{-}1.5 \text{ V}/\text{m}$ - Slightly above normal

$\leq 0.3 \text{ V}/\text{m}$ – Within normal limits

*The benchmarks (potential-free measurement) are intended to be applied to the range up to and around 50 Hz; higher frequencies and distinct harmonics should be more critically evaluated.

SAR Radiofrequency Radiofrequency Radiation Limits

SAR or Specific Absorption Rate is, according to the FCC, a value that corresponds to the relative amount of RF energy absorbed in a biological tissue in watts per kilogram. This value is used as a government standard for lower frequencies of radiofrequency radiation exposures for portable and mobile wireless devices.

For the general population the FCC public exposure limit for the cellular telephones to the head is a SAR level of 1.6 watts per kilogram (1.6 W/kg) and averaged over 1 gram of tissue. The FCC limit for the hand is SAR of 4.0 W/kg and is measured at an average of 10g tissue. The FCC limit for general population/uncontrolled whole body exposure is 0.08 W/kg, as averaged over the whole body. Note "Exposure may be averaged over a time period not to exceed 30 minutes to determine compliance with general population/uncontrolled SAR limits"

Occupational limits for whole body exposure is 0.4W/kg and spatial peak SAR of 8W/kg averaged over 1 gm of tissue. Spatial peak SAR limits for hands, wrists, feet and ankles shall not exceed 20 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube).

Distances from Devices such as personal computers/laptops listed on page 15 and page 73 in FCC EOET Bulletin 65 . Occupational exposure limits listed on page 75.

Note: FCC- "The selection of the 20-cm value for differentiating between "portable" and "mobile" devices is based on the specification in the 1992 ANSI/IEEE standard that 20 cm should be the minimum separation distance where reliable field measurements to determine adherence to MPEs (maximum exposure limits) can be made."

Note: FCC page 43- "The localized SAR criteria used by the FCC, and specified in the ANSI/IEEE 1992 standard, only apply at operating frequencies between 100 kHz and 6 GHz." Above these frequencies power densities are used.

Cornell Law School Information on SAR:

47 CFR § 1.1310 – Radiofrequency radiation exposure limits listed [here](#).

What are the 2G, 3G, 4G and 5G frequencies?

1G – Analog- Advanced Mobile Phone Service (AMPS) was commercially introduced in the 1980's and operated with voice only at 800 MHz with a continuous wave signal.

2G – Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA), are variants of 2G systems, introduced in 1990's providing text messaging, multimedia messaging and internet access. These are pulsed signals and used in the first digital cell phones. Frequencies are a combination of 850 and 1900 or 900 and 1800 MHz.

3G – Universal Mobile Telecommunications Service (UMTS)– Introduced in 1998 with broadband features providing data transfer, mobile internet and video calling. There are dozens of frequency bands available in the 800–900 MHz range and the 1700–2100 MHz range depending on the carrier.

4G – Long Term Evolution (LTE) –Was released in 2008 with higher frequency broadband supporting faster web access, gaming, video conferencing, and HD Mobile TV. These frequencies are in the 700 MHz, 1700/2100 MHz and the 2500–2690 MHz range.

5G- Device-to-Device Communication, Proposed for expansion of the Internet of Things (IoT). Uses wavelengths from 30 to 100 GHz and possibly up to 300 GHz.

- 5G: 600 MHz = cm microwaves of 50cm ≈20 inches (“MHz” = Megahertz)
- 4G/5G: 700 MHz = cm microwaves of ~43cm ≈ 17 inches (“cm” = centimeter)
- 3G/4G: 800 MHz = cm microwaves of 37.5cm ≈ 15 inches
- 3G/4G: 900 MHz = cm microwaves of ~33.3cm ≈ 13 inches
- 3G/4G: 1800 MHz = cm microwaves of ~16.7cm ≈6.6 inches
- 3G/4G: 2100 MHz = cm microwaves of ~14.3cm ≈ 5.6 inches
- Wi-Fi: 2450 MHz = cm microwaves of ~12cm ≈5 inches
- 5G: 3100 MHz to 3550 MHz = ~9.7 to ~8.5cm ≈ 3.8 to 3.3 inches
- 5G: 3550 MHz to 3700 MHz = ~8.5cm to ~8.1cm ≈3.3 to 3.2 inches
- 5G: 3700 MHz to 4200 MHz = ~8.1cm to ~7cm ≈3.2 to 2.8 inches
- 5G: 4200 to 4900 MHz = ~7cm to ~6cm ≈2.8 to 2.4 inches
- Wi-Fi: 5800 MHz = ~5cm microwaves of ~2 inches (“mm” = millimeter)
- 5G: 24,250 to 24,450 MHz = mm microwaves of ~12mm ≈0.5 inch
- 5G: 25,050 to 25,250 MHz = mm microwaves of ~12mm ≈0.5 inch
- 5G: 25,250 to 27,500 MHz = mm microwaves of ~11mm ≈0.4 inch
- 5G: 27,500 to 29,500 MHz = mm microwaves of ~10mm ≈0.4 inch
- 5G: 31,800 to 33,400 MHz = mm microwaves of ~9mm ≈ 0.4 inch
- 5G: 37,000 to 40,000 MHz = mm microwaves of ~8mm ≈ 0.3 inch
- 5G: 42,000 to 42,500 MHz = mm microwaves of ~7mm ≈ 0.3 inch
- 5G: 64,000 to 71,000 MHz = mm microwaves of ~5mm ≈ 0.2 inch
- 5G: 71,000 to 76,000 MHz = mm microwaves of ~4mm ≈ 0.2 inch
- 5G: 81,000 to 86,000 MHz = mm microwaves of ~3.6mm ≈0.1 inch

Exposure Limits Have Never Considered Long Term Exposure or Non-Thermal Bio-Effects

Here is a 1999 letter (posted on EHTrust.org), [1999-radiofrequency-interagency-workgroup](#), from US Health and Human Services Radiofrequency Interagency Working Group to the Industry IEEE. It states, “There is a need to discuss and differentiate the criteria for guidelines for acute and chronic exposure conditions. The past approach of basing the exposure limits on acute effects data with an extrapolation to unlimited chronic exposure durations is problematic. There is an extensive data base on acute effects with animal data, human data (e.g. MRI information), and modeling to address thermal insult and associated adverse effects for acute exposure (e.g., less than one day). For lower level (“non-thermal”), chronic exposures, the effects of concern may be very different from those for acute exposure (e.g., epigenetic effects, tumor development, neurologic symptoms). It is possible that the IEEE RF radiation guidelines development process may conclude that the data for these chronic effects exist but are inconsistent, and therefore not useable for guideline development. If the chronic exposure data are not helpful in determining a recommended exposure level, then a separate rationale for extrapolating the results of acute exposure data may be needed. In either case (chronic effects data that are useful or not useful), a clear rationale needs to be developed to support the exposure guideline for chronic as well as acute exposure.”

Martin Pall, PhD. Discusses Development of ICNIRP Guidelines Based on Heat

5G: Great risk for EU, U.S. and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them. (2018) Martin L. Pall, PhD. Discusses SCENIHR and ICNIRP (International Commission on Non Ionising Radiation Protection – ICNIRP, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) Guidelines for RFR and robust scientific literature on adverse health effects which are both considered and not considered in their deliberations. <https://einarflydal.files.wordpress.com/2018/04/pall-to-eu-on-5g-harm-march-2018.pdf>

Environmental Health Trust also has a list of Key Policy Issues related to Exposure Guidelines here.



[Environmental Health Trust: 5G Research and Exposures](#)

Exposure Limits for Radio frequency Energy: Three Models

Ken Foster, University of Pennsylvania, Philadelphia

This [article](#) points out that different long term exposure limits in different countries are due to their different models of reasoning.

- Heat: The U.S. uses science based studies but only those that examine heat based adverse effects. They do not take into account studies on non-thermal adverse effects.
- Non-Thermal Effects: Russia and China use science based studies on non-thermal effects.
- Precautionary: Switzerland, Italy and many other countries use precautionary language for their long term exposure limits

“Thus, Russian (and Eastern European) limits clearly reflect the conviction that long-term (hours or more) exposures at levels far below Western limits result in adverse health effects. Indeed, the Russian and Eastern European medical literature contains many reports of health effects from low-level exposure to RF energy. These include, for example, nonspecific problems (such as headaches, fatigability, irritability, sleep disorders, and dizziness) in workers in radio factories, who are exposed to RF energy at undetermined levels^{11 12}. The Chinese literature contains similar reports.¹³ The Russian literature contains references to a “microwave disease” characterized by “asthenic, asthenovegetatic, and hypothalamic syndromes”¹⁴ The disease is not recognized in Western medicine, and its diagnostic criteria would undoubtedly strike many Western physicians as vague and nonfalsifiable. Even some Eastern European physicians have complained about the nonspecificity of these criteria as well.^{15 16}”

http://www.who.int/peh-emf/meetings/day2Varna_Foster.pdf

Russian Radiation Research and Protective Standards for EMR

Russian National Committee of Non-Ionizing Radiation Protection – 2008 report: “Mobile Communications and Children’s health. This sobering report discusses the need for exposure guidelines that protect children and the general population from chronic levels of radio frequency radiation. As noted the Russian limits are 100 times more restrictive than the U.S. , China, Canada and many other countries. [Russian National Committee of Non-Ionizing Radiation Protection – 2008 report. “Mobile Communication and Children`s Health”. Russia](#)

ELECTROMAGNETIC FIELDS FROM MOBILE PHONES: HEALTH EFFECT. RESOLUTION OF RUSSIAN NATIONAL COMMITTEE ON NON- IONIZING RADIATION PROTECTION. April 2011, Moscow. [Russian Committee on non-Ionizing radiatio 2011 report Children and Teens](#)

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Russian National Committee on Non-Ionizing Radiation Protection and EMF RF standards. New conditions of EMF RF exposure and guarantee of the health to population. Prof. Yu. Grigoriev, Russian National Committee on Non-Ionizing Radiation Protection Federal Medical Biophysical Centre, FMBA, Moscow, Russia. https://www.radiationresearch.org/wp-content/uploads/2018/06/021235_grigoriev.pdf

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or at

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See Also

- PST Cell Tower Exposure Levels. [Cell Tower Exposures and Health Effects](#)
- PST Cancer and Radiofrequency Radiation. [Cancer and RF Radiation](#)
- PST Electrosensitivity Science. [Electrosensitivity Science](#)
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radiation with a mean of 7,768 $\mu\text{W}/\text{m}^2$. All measurements exceeded the target level of 30-60 $\mu\text{W}/\text{m}^2$ based on non-thermal (no heating) effects, according to the BioInitiative Report.”

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Occupational Exposures

The [Center for Construction Research and Training](#) in Maryland works to reduce or eliminate safety and health hazards that construction workers face on the job. They have compiled an abundance of useful information on the hazards for RF exposures as well as identifying RF exposures with different antenna. This is a great resource for information on cell antennae and FCC requirements.

Their Radiofrequency (RF) Radiation Awareness Guide for the Construction Industry is especially useful.

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