



Comparing Base Station Exposure Levels

Electromagnetic Field (EMF) exposure levels from mobile base stations have been measured by operators and national regulators on a regular basis over the years. The results of these measurements have also been assessed in a number of studies. For instance Rowley and Joyner [2012]¹ reported the global weighted average environmental level for mobile communication base station technologies based on measurements across 23 countries, while Joyner et al. [2014]² also assessed levels over a 7 year period from Africa, and Rowley and Joyner [2016]³ analyzed an Italian database of 50.6 million measurement samples. These studies found that typical exposure levels were less than 1 mW/m² or between 0.01% and 0.022% of the relevant limits⁴ recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

There have been other studies that have also investigated base station exposure levels using more novel measurement approaches⁵, and these have also found levels to be well below ICNIRP recommendations.

With the increasing deployment of 5G around the world, there has been renewed interest in the overall and specific EMF exposure levels from base stations as well as what the wide utilisation of the more efficient beamforming technology exposures from 5G.

Selmaoui et al [2021]⁶ investigated the exposure of 5G networks in South Korea, finding that the contribution of 5G to the overall EMF exposure was only a 'small amount' (in this case less than 15% of the total exposure from all communication frequencies) - a finding that was also consistent with a study undertaken in Japan by Onishi et al. [2021]⁷, results published by the United Kingdom's Ofcom⁸ and by the Australian Communications and Media Authority (ACMA).⁹

And while beamforming is not unique to 5G, it's utilization within 5G has given rise to questions about what this means in terms of EMF exposure levels. The ACMA report found that the measured maximum exposure due to beamformed transmission from 5G base stations was only 2.5% of the ICNIRP-based standard in Australia. In a study by Aerts et al. [2021]¹⁰ utilizing an exposure assessment protocol that involved directing the 5G transmission beam towards the measurement equipment, they found that maximum extrapolated exposure levels were only 0.5-0.6% of the ICNIRP recommendations.

These recent studies, like those undertaken earlier, support the conclusion that irrespective of country, year or mobile technology, base station exposure levels at ground level remain only a small fraction of ICNIRP recommendations.

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¹ Rowley and Joyner, Comparative international analysis of radiofrequency exposure surveys of mobile communication radio base stations, *Journal of Exposure Science and Environmental Epidemiology* (2012) 1 – 12.

² Joyner, Van Wyk and Rowley National Surveys of Radiofrequency Field Strengths from Radio Base Stations in Africa, *Radiation Protection Dosimetry* (2013) 1–12.

³ Rowley JT, Joyner KH, Observations from national Italian fixed radiofrequency monitoring network, *Bioelectromagnetics*. 2016 Feb;37(2):136-9

⁴ At 900 MHz, 1 mW/m² represents 0.022% of the ICNIRP recommendations while at 2000 MHz and above it represents 0.01%.

⁵ See for example Huang Y *et al.*, Comparison of Average Global Exposure of Population Induced by a Macro 3G Network in Different Geographical Areas in France and Serbia, *Bioelectromagnetics* 37:382-390, 2016.

⁶ Selmaoui, B. *et al.*, Exposure of South Korean population to 5G mobile phone networks (3.4–3.8 GHz). *Bioelectromagnetics* 2021, 42, 407–414.

⁷ Onishi T *et al.*, Radiofrequency Exposure Levels from Mobile Phone Base Stations in Outdoor Environments and an Underground Shopping Mall in Japan, *Int. J. Environ. Res. Public Health* 2021, 18(15), 8068

⁸ Ofcom, Electromagnetic Field (EMF) Measurements near 5G Mobile Phone Base Stations, UK. 2020.

Available online: https://www.ofcom.org.uk/data/assets/pdf_file/0015/190005/emf-test-summary.pdf

⁹ Australian Communications and Media Authority, Electromagnetic energy (EME) near 5G mobile base stations, August 2021. Available online: <https://www.acma.gov.au/publications/2021-08/guide/electromagnetic-energy-eme-near-5g-mobile-base-stations>

¹⁰ Aerts, S. *et al.* In Situ Assessment of 5G NR Massive MIMO Base Station Exposure in a Commercial Network in Bern, Switzerland. *Appl. Sci.* 2021, 11, 3592.