Science and Politics of Base Station Electromagnetic Field Risks

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Abstract — **The current science-based approach to ensuring public safety from RF-EMF base stations is described, and a potential misframing of the debate as a purely scientific issue, which in turn led to inappropriate risk communication exercises, is pointed to. Plausibly, this polarised and charged the situation by disenfranchising other potentially legitimate siting concerns. While the primary health recommendation remains unchanged, namely, to follow the guidelines set by the science-based ICNIRP and IEEE expert groups, and to limit the ICNIRP 2020 and IEEE 95.12019 power density exposure level for general-public: between 400 – 2000 MHz f_{MHz}/200 (W/m^2) and 10 (W/m^2) above 2000 MHz, other legitimate concerns should not be disregarded.**

Index Terms — **base stations, EMF policy, human exposure, ICNIRP Guidelines, IEEE 95.1, risk assessment, risk management.**

I. Introduction

Wireless communication systems use electromagnetic waves in the Radio Frequency (RF) ranges of the spectrum, which are of a much lower frequency compared to ionizing radiation, such as X-rays or gamma-rays. As such, RF waves do not have enough energy to either break molecular bonds or even cause ionization of atoms in the human body. The heating capabilities of high-level RF-EMF (electromagnetic field) exposure (e.g., from microwave ovens) are well known. The question is whether there are some other enduring health effects at levels of exposure below the International Commission on Non-Ionising Radiation Protection limit (ICNIRP, 2020) [1]. While some studies have indicated the possibilities of non-thermal effects in living organisms, these have never been substantiated. The World Health Organisation (WHO) Q&A on 5G mobile networks and health says that 'provided that the overall exposure remains below international guidelines, no consequences for public health are anticipated' [2].

There is no scientific reason to use different exposure limits in different countries, suggesting that there is a tension between policymaking and pressure from public concern in this field. In the context of 5G infrastructure rollout and ensuring the safety of existing infrastructure and continuity of services, the recent increase in incidents against cellular sites (Source: Rowley, J.T. and Knox, N., GSMA (personal communication), 31 July 2021) poses a significant risk to deployment of next generation networks and to the operability of existing networks.

Based on a webinar held on 10 May 2021, the WHO states that 5G mobile networks do not spread COVID-19. Viruses cannot travel on radio waves/mobile networks. COVID-19 is spreading in many countries that do not have 5G mobile networks. COVID-19 is spread through respiratory droplets when an infected person coughs, sneezes or speaks. People can also be infected by touching a contaminated surface and then their eyes, mouth or nose.

This paper approaches this matter detailing the 5G engineering in section 2; there is a strong scientific consensus over exposure limits; the section specifies the RF-EMF updated exposure levels from 5G. Sections 3 and 4 review the policies on RF exposure limits of risks to the public.

II. 5G Engineering

A. 5G Frequencies

Future mobile communications will deploy 5G and beyond 5G. The operating frequencies define the RF human hazards and the EMF exposure limits. Following the 2020 edition of the ITU Radio Regulations (RR), the following frequency bands are identified in the ITU RR, to deploy International Mobile Communications (IMT): 450–470 MHz, 470–698 MHz, 694/698–960 MHz, 1,427–1,518 MHz, 1,710–2,025 MHz, 2,110–2,200 MHz, 2,300–2,400 MHz, 2,500–2,690 MHz, 3,300–3,400 MHz, 3,400–3,600 MHz, 3,600–3,700 MHz, 4,800–4,990 MHz, 24.25–27.5 GHz *, 37–43.5 GHz*, 45.5–47 GHz*, 47.2–48.2 GHz* and 66–71 GHz*. * revised at World Radio Conference 2019.

B. EMF Updated Exposure Levels from 5G

The ICNIRP RF-EMF Guidelines are backed by WHO and constitute the current scientific consensus. WHO advises that if regulatory authorities react to public pressure by introducing precautionary limits in addition to the already existing science-based limits, they should be aware that this undermines the credibility of the science and exposure limits. WHO acknowledges both the ICNIRP Guidelines and the IEEE standard on its website, but promotes the adoption of ICNIRP Guidelines.

Figure 1 depicts the differences between ICNIRP (2020) power-density exposure levels for occupational personnel and the general-public, averaged over 30 minutes [3] (revised Chapter 9 on EMF exposure, 25 April 2021, Figure 9.6). The power-density ratio of 5 in ICNIRP (2020) Table 5 (e.g., at 30 – 400MHz, power-density (Watts/m^2) ratio 10/2) results in an electric field-strength (V/m) ratio $61.0/27.7 = 2.2 \approx \sqrt{5}$.

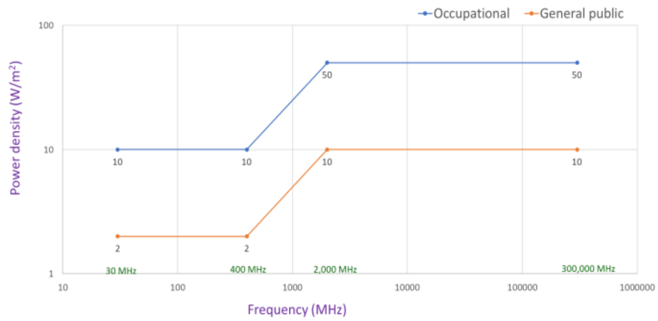

Fig. 1. Comparison of power-density for occupational and general-public exposures in the range 30 MHz – 300 GHz, averaged over 30 minutes and the whole body derived from [1] Table 5.

The ICNIRP [1] and IEEE [4] limits are largely harmonized, and the power-density limits for whole-body exposure to continuous fields are identical above 30 MHz.

Joshi et al. (2020) collected data from commercial 5G networks in Australia and South Korea and found that median device transmit power levels were 1% of the maximum and comparable to 4G devices [5].

III. Policies

A. International RF-EMF Exposure Limits

The numeric standards for EMF exposure limits are the formal steps taken by governments to limit both the occurrence and consequences of risky exposures. The following text was adopted in 2021 by ITU-D, ITU-T and by these ITU-R Working Parties (WPs) 5A, 5B and 6A: "Administrations are encouraged to follow the ICNIRP Guidelines or IEEE Standard, or limits set by their own experts. The best practice for administrations that choose to use international RF-EMF exposure limits is to limit the exposure levels to the thresholds specified in ICNIRP (2020) Guidelines". In February 2021, Australia became one of the first countries to implement the ICNIRP (2020) Guidelines in a national standard. Uganda also adopted these Guidelines. On May 2021 OFCOM UK based their compliance criteria/limits on ICNIRP 2020.

B. The Null Hypothesis

It is scientifically impossible to prove absolute safety (the null hypothesis) from any physical agent, as it is impossible to prove the negative, the void (zero group; empty set), i.e., that something does not exist [6] p. 79, [7] p. 24 and [3] section 9.2.1. In addition, "with regard to non-thermal interactions, it is in principle impossible to disprove their possible existence but the plausibility of the various non-thermal mechanisms that have been proposed is very low" [8] p.257. Therefore, an analysis of the balance between cost and potential hazards is essential to inform policymakers.

C. Socio-economic Risks

Hesitancy over RF-EMF progress raises economic issues for society. The delay in installing base stations causes harm to operators and delays the service provision. Studies show that more restrictive limits risk expanding the investment required in the order of billions [2] p. 33, and block the potential to use spectrum and address growing traffic requirements. Additional societal concerns include devaluation of property (as a result of installing base-stations near the estate), impact on the environment and spread of misinformation.

IV. Managing Public Risk

The management of risk by application of thresholds of tolerable risk is by now standard practice in many fields [9], particularly those involving carcinogens but also non-carcinogens such as certain air pollutants and other environmental contaminants [10]. It might therefore be hoped or even anticipated that for 'pollutants' with internationally agreed risk threshold criteria that winning agreement over the acceptability of some technology should be a straightforward scientific task of measurement and comparison with the agreed thresholds. Evidently, however, this is not the case with base station RF-EMF emissions which, despite invariably posing a minimal health risk according to the designated criteria, generate public anxiety and even militancy.

The problem of public acceptance of risk has been widely researched by natural scientists [11], psychologists [12], economists [13], sociologists [14] and others, and international agencies and governments have responded to this by producing guidance. For example, in the UK the Treasury Department produced a preliminary guide for policy makers in 2005, the aim of which was to achieve greater consistency and transparency in decision making while also addressing public interests and concerns [15]. Examination of this guidance reveals that the approach is anchored firmly within a framework of rational decision making and thus makes use of available evidence of harm, evidence-based values of preventing fatalities, and cost-benefit analysis in order to achieve greater consistency in decision making, including preventing or curbing risk management activity where the benefits are not justified by the costs.

All of the latter is consistent with the approach to the management of RF-EMF risk as so far described in this paper. However, The Treasury goes further in that they introduce a tool for assessing public concerns that may exist about risks of fatality and harm, an activity which is to be carried out in parallel with expert risk assessment. The parameters upon which the concern assessment tool relies are familiarity with and novelty of the hazard source; public understanding of cause and effect; equity issues (whether risk and benefits are evenly distributed or not); magnitude of perceived consequence; who controls the risk; and public trust in those who manage the risk. The guidance then suggests possible policy responses for each indicator should it provide evidence of significant public concern, but states that the information on concerns should be used to inform but not constrain decisions on the management of risk. The type of response envisaged in the face of public concerns which lack scientific justification is mainly in the form of information provision and education. Highly restrictive or expensive precautionary interventions are to be reviewed periodically [15].

The above approach signals clearly the need for two-way communication between decision makers and the public and this is a feature of all modern risk management strategies. For example, the International Risk Governance Council (IRGC) has long stressed the centrality of stakeholder engagement in decision making (Fig. 2 from [16]), as has the European Institute for Science, Media and Democracy in its 'Principles for the management of risk' [17]. The IRGC's framework also emphasises the need for a pre-assessment stage which involves relevant actors and stakeholder groups in the process so as to capture the various perspectives on the risk, its associated opportunities, and potential strategies for addressing it.

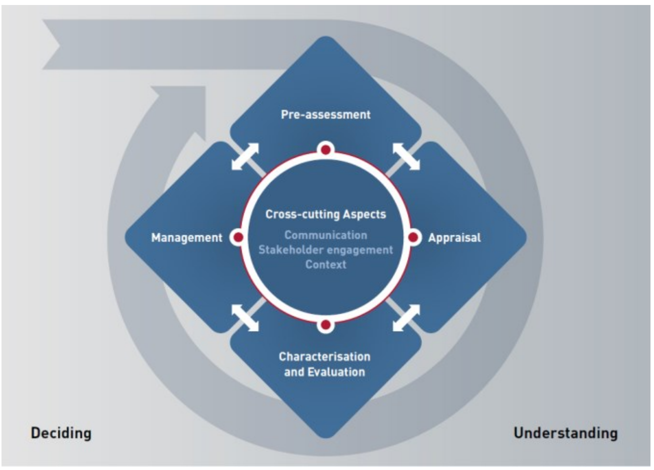

Fig. 2. The IRGC Risk Governance Framework IRGC

It may be that the absence of an adequate pre-assessment or framing stage lies at the root of the dispute over RF-EMF base stations. Recent research [18] and [19] summarised in [20], suggests that while it is true that health risk is often cited by the public as the reason for their concern, and for some it is, the majority are more perturbed by other issues such as visual amenity, equity and lack of consultation. One author [19] traces the conundrum to a misframing of the debate solely around health risk by a sector of the academic community whose interests were anchored in public perceptions of risk.

V. Summary

The siting of EMF base stations continues to generate public concern despite the fact that the associated radiation levels are generally far below well-established international standards. This generates a tendency to seek refuge in further application of the precautionary principle, but in the circumstances this is unlikely to provide a solution. It is further suggested here that much of the public concern may in fact be driven more by risk framing and procedural issues than by anxiety over health consequences. In that case solutions are more a matter of local politics than of science and evidence.

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