

Proposed FCC changes to Measuring and Evaluating Human Exposure to Radiofrequency Electromagnetic Fields and Wireless Power Transfer Devices are Flawed: need for biologically-based standards

(ET Docket No. 19–226; FCC 19–126; FRS 16618)

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Executive Summary

- The NPRM of the FCC in its Docket No. ET 19-226, “Human Exposure to Radiofrequency (RF) Electromagnetic Fields.” seeks to extend the current 24-year old recommended methods for testing radiofrequency radiation exposures for the general public and occupational arenas in force below 3 GHz to the frequency band from 3 GHz to 3,000 GHz (3 THz).
- It is our professional opinion that the agency should not move forward with the above proposal and needs to develop safety standards that protect against long-term health and environmental effects. Further, the agency should provide revised standards for testing and monitoring that reflect submitted peer-reviewed evidence that protection is required against nonthermal effects from current levels of non-ionizing radiation. ET 19-226 closes dockets opened since 2013, fails to take seriously the hundreds of peer-reviewed publications and other expert comments submitted as part of this docket, uncritically adopts the minority scientific guidelines developed by ICNIRP for internal fields in the frequency band below 3 GHz and extends them to those up to 3,000 GHz. In adopting ICNIRP positions of a group of 13 scientists many of which have close ties to industry, the agency also fails to take into account the fact that the majority including several hundred experts in the fields of bioelectromagnetics and related matters strongly dissent from the conclusions of ICNIRP, which remains a self-appointed self-governing minority group that has no independent oversight or accounting for its funding.
- We recommend a halt to the roll-out of the fifth generation, 5G, for telecommunication and for the expansion of wireless networks until hazards for human health and the environment of these new frequencies and the densification of networks have been fully investigated by scientists independent from industry. 5G paired with densification of 4G antennas will substantially increase environmental exposure to radiofrequency electromagnetic fields. We also recommend federally developed safety limits based on empirical scientific studies that have thoroughly investigated long term effects to humans, animals, insects, trees and the environment. Federal safety limits should be based on adequate data from animal and human research, not based on assumptions.
- The FCC lacks staff expertise to assess health implications of its proposed policies and has neglected its regulatory duty to take a “hard look” at the hundreds of comments and peer-reviewed publications submitted to the record since 2013. Furthermore, it is noted that the FDA, in advising the FCC, has dismissed the results of research that they themselves commissioned from the NTP when those findings negated their insistence that only thermal effects are relevant in exposure studies.
- FCC plans for satellite-based 5G coverage will involve an unprecedented number of satellites, disrupt weather forecasting, astronomy and critical science programs. As such, these FCC plans are opposed by NASA, NOAA and the US Navy. As noted below the space-based transmissions from these satellites fall in the same frequency range as the critical atmospheric water emission line (23.8 GHz) and would effectively ‘blind’ radiometric readings of airborne moisture,

undermining the capacity for accurate weather forecasting. Pointedly the FCC also lacks expertise or knowledge to properly assess the lasting global impacts of this action.

- Despite extensive peer-reviewed scientific evidence submitted to the docket by EHT on more than 60 occasions that document nonthermal impacts of RF, the FCC persists in adopting the view that thermal damage is the sole effect to be prevented from exposures to Radio frequency radiation. Accordingly, it sets the exposure levels to a SAR level 1.6 W/kg averaged over a 1 g volume of the entire head (which is treated as a homogenous entity) and a power density of 10 W/m² and treats the ear (pinna) like the hand, wrist or foot, where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) [averaged over 30 minutes] This statement of the docket is fundamentally flawed, even in the narrow definition of heating effects, as it ignores well known EM wave/tissue coupling effects as outlined herein.
- The FCC has failed in its obligation to maintain an accessible and searchable database of previous submissions to this docket and thus has abrogated its duty to accord serious consideration of such submissions.
- Contrary to the FCC position, non-thermal effects that are biologically important can occur from currently permitted and lower levels of RF and include disruption of cellular signaling and membrane integrity, the rise of reactive oxygen and nitrogen species (RONS) in the cell interiors and in blood, indirect damage to DNA, impairment of human reproduction and increased risk of cancer, infertility and neurological disease, altered neurotransmitter functions, permeability of the blood-brain barrier, morphology, electrophysiology, cellular metabolism, calcium efflux, and gene and protein expression.
- We and hundreds of other expert scientists do not agree with the FCC assumption that because transmissions at higher frequencies of 5G cellular networks would be absorbed superficially by the skin, such frequencies pose no danger to the public. First, in the foreseeable future for 5G to operate, these networks will have to include 3G and 4G frequencies, judged to cause an array of biological impacts by French, Israeli, Indian governments and other expert groups, including [Oceania Radiofrequency Scientific Advisory Association](#) (ORSAA, EHT, the Bioinitiative Report, among others. Second, the interaction between the higher frequencies of 5G and the skin has not been demonstrated to be benign. Instead the currently available research suggests biological and physiologically relevant effects.
- Submitted peer-reviewed publications document that exposures that take place in the top layers of the skin can have major immunologic and other systemic effects. The FCC ignores numerous submitted peer-reviewed publications from us and other experts detailing the complex biological role of the skin, including the fact that it is the largest organ of the body, that it carries out important immunological roles and is vital for the production of vitamin D.
- Furthermore the FCC ignores the fact that hotspots can form as a result of more efficient modalities of absorption in the skin, such as Standing Wave Coupling, due to the layered nature of the tissues and the short wavelength of the radiation, as is documented in peer-reviewed publications submitted to the docket.

- In addition, the effect of time division signals--time pulses---has been shown by numerous authors in peer-reviewed publication and submitted comments to be detrimental and lead to peaks of heightened skin temperatures, to the point of pain. The FCC ignores this fact, despite the publications in the scientific record, and claims that average values (that eliminate these peaks) are sufficient.
- The FCC intends no change to the Specific Anthropomorphic Mannequin (SAM) method for modeling compliance to RF exposures that employs the large homogenous head and body of an adult male. This, despite the indisputable fact that, by design, SAM does not gauge exposures within the specific tissues of the brain, skull, reproductive organs and bodies of infants, toddlers, and elementary school children that are among the fastest growing users of new wireless devices. At least Finite-Difference Time-Domain (FDTD) algorithm-based method should be utilised in modelling compliance to RF exposures.
- The FCC has ignored peer-reviewed publications regarding the possible impact of 5G on insect life, especially bees. As bees and other pollinators are critical to the production of food, this issue requires critical attention as the increase in wireless frequencies and use of higher frequencies will impact agriculture.
- In its refusal to update testing regimes, models and standards, the FCC ignores over 30,000 peer-reviewed scientific articles that form the solid foundation for questioning its decisions as illustrated by the EMF Scientists Appeal, ORSAA, the French ANSES assessments, the German national radiation assessments, among others.
- There are major national differences in monitoring and surveillance of exposures that reflect policy differences more so than technical ones. Thus, the Israeli Ministry of Environmental Protection regularly monitors on-line all cell towers and antennas and has canceled 20 towers in 2019 for exceeding their guidelines. Several countries have federal agencies that regularly monitor radiofrequency levels and provide this information to the public. U.S. (with more than 150,000 towers and up to a million planned in the next two years), Canada, Australia, and other nations have no regular federal monitoring, nor means of ensuring compliance with their standards for towers.
- Exposure limits in Russia, China, Switzerland and Italy are 100 times lower than those proposed by the FCC. Russia and China have "science based" limits.
- No secondary insurance companies provide coverage for liability from health or environmental damages from tower operation, with Swiss Re in 2019 terming 5G "off the leash" as a risk comparable to asbestos. Proposed expansions of wireless power transfer will rely on standards that are at least a decade old and need regulation in terms of acceptable body internal fields. Despite advances in technology and the need to take into account far-field wireless transfer as distances between the device and its charging station grow, the FCC intends to adopt the 2010 standard of the ICNIRP. The authors and many other well-published experts in the field strongly advise that there be an independent scientific review of this and other proposed FCC policies.
- Other nations are adopting positions that consider the public good before the communications industry. Thus, France has recalled dozens of cellphones found to emit unsafe levels of RF, Israel

has cancelled cell towers found to exceed acceptable levels, India has set levels for tower radiation that are one tenth those of ICNIRP, many Italian cities have called to halt 5G, and national governments from Switzerland to Belgium and Greece are questioning the rush to 5G, especially in light of the refusal of secondary insurance firms to provide coverage for any health or environmental damages tied with electromagnetic fields generally, including 5G.

- As experts in the field, we recommend that the FCC seek the advice of an independent multidisciplinary panel of an organization such as ORSAA, ANSES, the Royal College of Physicians of the UK, or the U.S. National Academies of Sciences, Engineering and Medicine to carry out an independent study of the health and environmental implications of 5G and its current exposure levels. Until such an expert panel can produce a biologically-based exposure standard, we recommend that safe exposure levels be adopted using the As Low As Reasonably Achievable (ALARA) principle (currently employed in radiology) that employs advances in hardware and software to achieve the lowest exposures. Connections using ethernet and cable should be preferred (rather than wireless) in buildings and homes to drastically reduce the need for wireless.
- Further, as scientific evidence continues to grow linking RF exposures to cancer and other serious health impacts, the communications industry will be faced with a mounting burden of litigation and liability. As the regulatory authority that failed to provide protection from such exposures, the FCC will find itself culpable.

Introduction

On the 4th April 2020, the Federal Communication Commission (FCC) issued a Notice of Proposed Rulemaking (NPRM) in its Docket No. ET 19-226, “Human Exposure to Radiofrequency Electromagnetic Fields.” [1]. The NPRM seeks public comment on several proposals to change how best to measure and evaluate human exposure to radiofrequency radiation (RF) under safety standards set forth in FCC regulations. The NPRM did not propose to make any changes to the safety standards themselves although the safety standards have not been substantially altered since their implementation in 1997.

In the introduction to its notice FCC-19-126A1 [2] the FCC states:

“Modern communications technologies are an ever-increasingly critical part of our everyday lives and play a vital role in the execution of our businesses and daily affairs. The number and types of radiofrequency (RF) devices have proliferated, and the ways we interact with them are continuously changing. As a result, our environment is populated with RF sources, at times located in close proximity to humans. The National Environmental Policy Act of 1969 (NEPA) requires the Commission to evaluate the effects of our actions on the quality of the human environment, including human exposure to RF energy emitted by Commission-regulated transmitters and facilities. The Commission has accordingly promulgated rules that set limits for RF exposure and, through the years, has created a framework to ensure compliance with these limits.”

As a general statement we note that the powers granted to the FCC in the race for the implementation of 5G cellular services are widespread, almost without precedent and include the power to approve satellite positioning and transmission [3], [4]. We note that the agency lacks expertise in public health, meteorology, and astronomy. Yet, its recent proposals have ignored a growing body of scientific and engineering concerns that the proposed use of 5G will drastically and permanently alter the capacity to predict weather [5], [6], monitor impacts on public health, or locations of satellites [7]. As representatives of the scientific community we find the FCC’s dismissal of the concerns of august bodies such as NASA, NOAA and the US Navy [7] to be worrying and baffling [8]. It is indicative of a corporate culture that has lost sight of its original purpose to regulate in the name of the public good. It is illustrative that out of over 150,000 cell towers in the US today [9] the Enforcement bureau of the FCC has issued only a handful of fines for violations of SAR limits in the last 10 years of enforcement [10]. As a comparison the State of Israel, with only 7,000 towers, maintains continuous online monitoring of tower transmission powers [11] and in 2019 shut down 20 for transmission power violations. It is difficult to accept the opening statement, quoted above, as accurately reflecting the role of the FCC.

Our submission provides detailed comments on the FCC’s proposal to apply 24-year old standards for evaluating exposures to radiofrequency radiation (RF) currently employed for frequencies up to 3 GHz to frequencies that are up to 1000 times higher-- from 6 GHz up to 3000 GHz. It is notable that while stipulating conditions and methods for averaging both the time and area employed in evaluating RF exposure, the FCC is not proposing any safety or environmental testing of those higher frequencies, nor has any been carried out on behalf of the federal government. We also address proposed FCC methods for evaluating Wireless Power Transfer Devices (WPT), defined as “a category of Industrial, Scientific, and Medical (ISM) equipment which generates and emits RF energy for local use by inductive,

capacitive, or radiative coupling, for transfer of electromagnetic energy between a power transfer unit (TU) and receiving unit(s) (RU) of a WPT system.”

While the technical issues raised in this FCC docket are complex and challenging, this does not mean that they cannot be understood. Moreover, we appreciate that approaches being established at this time are not likely to change easily in the future, especially because they reflect and dictate parameters that will be relied on for technology for decades to come. Accordingly, our statement to the FCC will critically comment on: (1) the FCC desire to extend outdated exposure limits and test standards that currently apply to 3 GHz up to 3000 GHz, without considering the growing body of peer-reviewed scientific evidence submitted to the docket that demonstrate a range of important non-thermal effects that can take place at or below current levels of exposure; (2) the proposed standardization of WPT including what distance is considered local and methods for evaluating the totality of scientific and engineering evidence relevant to assessing impacts on public health and the environment; and (3) the need to create, evaluate and implement biologically-based standards for combined frequency evaluations to replace outdated systems that presume that thermal impacts are the only ones to be avoided over short periods of time for cumulative waves and to incorporate anatomically-based modeling and averaging times and areas based on the concept of achieving exposures that are As Low As Reasonably Achievable (ALARA).

Public concerns about the impact of non-ionizing radiation exposure have been on the increase in recent years [12]–[16], despite repeated attempts to reassure that there is no notable health hazard [17], [18]. In general, the FCC has adopted the position of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) that the only impact on the human body from cell phone or other wireless radiation to be avoided is that of thermal effects [19]. In fact, the ICNIRP constitutes an unelected, self-appointed international group that is not subject to any governmental or other oversight. As part of its mandate the ICNIRP is supposed to carry out an ongoing assessment of the scientific literature pertaining to exposure standards [20]. Given the body of current research demonstrating worrying trends in adverse health effects, one must question if the ICNIRP is carrying out this task. As this submission will document, there are serious grounds [21] for challenging the authority currently conferred on ICNIRP by the FCC, Health Canada, and other such entities, even though there have been calls for this body to disband [22]. Moreover, as our comment will also document, a number of high-tech nations including France and India (See Section below National Responses to Current Safety Standards) and other expert groups, including more than 360 experts in the highly specialized field of bioelectromagnetics, have updated their own approaches to wireless radiation and accordingly adopted positions that also differ markedly from those of ICNIRP and the FCC. These expert groups have reviewed the scientific literature on the topic and concluded that there are major chronic health and environmental impacts from exposures to wireless radiation that are non-thermal in nature and that the ICNIRP standards are not sufficiently protective of children and others. It should be noted that in issuing its call for comments, the FCC has not indicated that it has undertaken a systematic review of relevant evidence, nor identified what specific body of evidence or scientific criteria on which it will rely to formulate its decision in this docket. Moreover, the proposed continuation of the outdated RF policies and standards rests entirely on avoiding impacts from short-term exposures and ignores the reality that millions are regularly being exposed to numerous wireless transmitting devices throughout their lifetimes.

As this comment will make clear, a growing number of distinguished experts are calling for a major revision of current standards and guidelines. To name but two, Professors Frank Barnes and Ben Greenbaum [23] have recently declared:

“Long-term exposures are not addressed in the current guidelines. Nor do the proposals in the NPRM address issues arising as a consequence of the increasingly long-term exposures to which much of the world’s billions of phone and other wireless radiating device users are exposed over their lifetimes”.

Amongst other titles and honours, Professor Barnes has a long and distinguished record in bioelectromagnetics, serving as Chair of the Bioelectromagnetic Society, an elected member of the National Academies of Sciences and Engineering, editor in chief of *Bioelectromagnetics*, the most cited specialized journal in the field, Executive Editor of the *Annual Reviews of Telecommunications* and many other positions. Professor Greenbaum has served as the editor in chief of Bioelectromagnetics and has been a consultant to the WHO International EMF Project in Geneva. They have jointly edited the 4th edition of the *Handbook of Biological Effects of Electromagnetic Fields*, published by CRC Press. In short their opinion is not one to be dismissed and is shared by many other experts in the field, as is indicated below and in other submissions to this docket from Victor Leach and others from the Oceania Radiofrequency Scientific Advisory Association.

According to the industry and private sector supported extensive database of relevant literature, provided by the EMF-Portal [24], there is currently an inventory of 31,195 publications and 6,724 summaries of individual scientific studies on the effects of electromagnetic fields. A recent research review on the health risks of Radio Frequency Radiation (RFR), involving independent verification based on 5,400 studies in the MedLine database, concludes that “the literature shows there is much valid reason for concern about potential adverse health effects from both 4G and 5G technology” and that extant research “should be viewed as extremely conservative, substantially underestimating the adverse impacts of this new technology” [25].

Further, this body of evidence has already led to changes in the regulatory stances of national agencies from several other high-tech countries that distinctly differ from those proposed by the FCC. Notably, the French national agency for Food, Environmental and occupational health & Safety (ANSES) has examined the current permitted exposure to cell phone radiation and found that 9 out of 10 phones tested exceeded their guidelines when tested directly next to the body, rather than at a distance that would be created if a plastic holster were to be used to carry phones [26]. Specifically, in reviewing all relevant evidence, ANSES acknowledges growing experimental and epidemiological evidence about non-thermal biological effects [27]. Indeed, there are significant non-thermal biological effects from the exposure of the population to low-level cellphone radiation, even at frequencies that are not able to ionize molecules. Furthermore, effects can also take place in non-mammalian organisms, such as insects and birds which are not addressed in the FCC docket.

Worryingly for industry the burden of litigation claiming tort from adverse health effects stemming from the use of cell o]phones and wireless is growing [28]

In the following pages we will examine the validity of several of the basic assumptions and assertions that guide the FCC policy statements and show them to reflect an incomplete, limited and biased reading of current science and to be out of step with the mainstream scientific findings. Their reading is fundamentally inaccurate as they rest on flawed interpretations of engineering and other technical evidence. They have ignored policy recommendations from numerous industry and other experts

regarding the need to update standards and testing procedures, especially to protect children and other sensitive groups. This is inconsistent with the obligations of a federal regulatory agency to take into account the totality of the weight of all relevant scientific evidence in making policy determinations. Moreover, as we will further establish, over the past decade, EHT and other expert groups have filed more than 80 different submissions including specific peer-reviewed publications in support of the request for revising current standards (see Appendix 3 for comparison of ICNIRP reviewed materials in contrast with those in the ORSAA database) .

The FCC did not take a “hard look” that is “searching and careful” of the extensive materials submitted to this and related dockets.

Serious database management flaws have rendered the submissions to the FCC inaccessible. In not providing a written record of consideration of submissions provided from 2013 to 2019, the FCC has failed to provide any indication of having taken a “hard look” at the submitted materials that is “searching and careful.” [29] Other submissions to ET Docket No. 19–226; FCC 19–126; FRS 16618 will make clear that, in this regard the FCC has acted in an “arbitrary and capricious” manner indicating a callous disregard for submitted materials. This has been done by rendering the publicly submitted materials inaccessible for public review and consideration and by failing to maintain its own manageable system that relies on accessible computer tools for retrieval and review for the docket. Further, the FCC was unable to review “the full administrative record that was before the Secretary [Commissioners] at the time he made his decision.”

According to the Court in *Overton Park* [29], any federal agency subject to the Administrative Procedures Act (APA) should provide an account of decision-making that constitutes “the full administrative record that was before the Secretary at the time he made his decision.” While acknowledging that “the APA does not require the agency to create a formal record in informal adjudications,” agencies are obliged to “create some form of a record so that courts can review their actions, and that record must be comprehensive.” In their decision in *Overton Park* the courts have effectively required that the agency provide a written account of their comprehensive review of submitted materials [30] The FCC must “create some form of a record so that courts can review their actions, and that record must be comprehensive.” [31] No such record exists in this docket, despite more than 900 different submissions being provided. Nor is the resulting database of submitted documents accessible using standard search and evaluation tools consistent with additional requirements stipulated by the APA.

The FCC claims that only thermal effects need be considered

Fundamental to the FCC permissible exposure levels is the premise that the only relevant potential adverse impact of low intensity RF signals at any frequency is to cause a measurable change in heating of the human body. Although they are also highly relevant, adverse nonthermal impacts on non-human biota are not considered in this docket at all. As stated in the docket:

“7. Although the radio spectrum is managed up to 3,000 GHz (3 THz), the Commission’s exposure limits are currently specified only up to 100 GHz. The Commission is unaware of any reason the limits should be different above 100 GHz. As frequency increases up to 3,000 GHz (3 THz), body penetration is reduced and ultimately approaches zero. Accordingly, there is no reason to expect that thermal effects will effectively change at the increasingly higher frequencies. Accordingly, the Commission proposes to

extend the same constant exposure limits that presently apply from 6 GHz to 100 GHz up to an upper frequency of 3,000 GHz (3 THz), which is considered to be the upper bound of existing radiofrequency bands.”

This statement fundamentally errs in three major respects. First of all it asserts, without proof, that the only effect to be avoided is that of heating. Second, it ignores the pivotal fact that in any modern wireless communication system - including the future 5G networks operating at frequencies above 3 GHz, will operate relying on multiple antennas that send and receive multiple pulse trains rather than continuous modulated waves. These pulses can be far more consequential for biological systems than continuous wave transmissions at any frequency. Finally, it assumes that biological effects are directly proportional to level of absorption, ignoring growing evidence on the immunological functions of the skin, described below.

Harmful non-thermal effects have been demonstrated at current levels of exposure

The agency position that heating is the only effect from RF that poses a risk to human health ignores a solid and growing body of research demonstrating non-thermal biological effects of RF electromagnetic field (EMF) exposure in both experimental animals and humans. Both adverse and beneficial biological effects of RF have been demonstrated throughout species. These impacts can take place at the level of cells and sub-cellular structures, including mitochondrial processes critical to cellular energy and metabolism. On the microscopic cellular level harmful effects on both the structures and functions of cells have been demonstrated to arise from mobile phone radiation; these include effects on protein expression, transcription and stability mediated by the MAPK (mitogen-activated protein kinase) cascades [32], enzyme activity [33], ovarian follicle development [34] and increased reactive oxygen species in stem cells [35]. These studies are representative of a large body of work - more than 3000 studies according to EMF Portal [24] and the [ORSAA database](#) of studies demonstrating non-thermal effects at the cellular level [36], [37]. Another noted pathway to cellular damage has been the effect of mobile EMF exposure on cell metabolism and membranes termed Voltage-Gated Calcium Channels (VGCC) [38]. VGCCs are a class of membrane proteins responsible for the transport of calcium and other ions into and out of the cellular interior. One of the roles played by these ions is the control of reactive oxygen species (ROS) [39]. ROS can lead to the production of free radicals that have the capacity to damage DNA and to destroy essential cellular components. Further, ROS have been identified as important precursors or early biological markers for a number of chronic neurological and other diseases as well as indicators of harmful effects on reproduction [40]–[43].

In addition to increasing these harmful cellular processes, current levels of RF also affect health at the level of tissues and organs relevant to both neurological and male reproductive health. Experimental studies reveal that animals prenatally exposed to nonthermal levels of pulsed cellphone radiation produce offspring with significant damage to their hippocampus, including limited development of pyramidal cells [44].

FCC ignores substantial peer-reviewed scientific evidence demonstrating harmful non-thermal effects at current levels of RF exposure

On the tissue level of the organism (human being), EMF exposure has been linked to degradation of the antioxidant defence system [45]. A common argument against the relevance of this body of work is that it is mainly *in vitro* and therefore not applicable to the “real world” situation of mobile phone use. However, recent studies of people living in proximity to mobile base stations have found evidence for ROS in their blood, which is recognized as a biochemical indicator of stress that has been associated with increased risks of cancer and other chronic diseases [46]. Another important 2015 review of existing studies on radio frequency radiation (RFR) effects was published by the National Academy of Sciences in the Ukraine, Indiana University, and the University of Campinas in Brazil [41]. Based on 93 out of 100 peer-reviewed studies, that paper concluded that low-intensity RFR is an oxidative agent for living cells with a high pathological potential. The oxidative stress induced by RFR exposure explains a range of RFR health impacts, both cancer and non-cancer illnesses. In addition to chronicling illnesses, this study outlines 6 different biological mechanisms that may explain these RFR effects in the body. To quote this source: “In conclusion, our analysis demonstrates that low-intensity radio frequency radiation (RFR) is an expressive oxidative agent for living cells with a high pathogenic potential and that the oxidative stress induced by RFR exposure should be recognized as one of the primary mechanisms of the biological activity of this kind of radiation.” [22]

Studies have also found that nonthermal cellphone radiation and laptop radiation can damage human sperm, reducing sperm quantity and quality, impair mitochondrial DNA of sperm, and appear to play a role in testicular dysgenesis and erectile dysfunction. We should note, as have other commentators, that male infertility clinics in Australia, the United States and India regularly advise men having difficulty impregnating their partners to remove all wireless devices from their bodies. This advice is consistent with studies showing that current levels of cell phone radiation can damage mitochondrial DNA of sperm,, increase reactive oxygen species (ROS), and reduce sperm quantity and quality [26]–[28].

As many have observed, it is especially remarkable that the FCC has rejected [47] the findings of the U.S. government’s largest experimental study ever conducted of cellphone radiation—that of the National Toxicology Program (NTP) [48]–[52]. Using protocols honed over more than four decades, the NTP study relied on protocols for exposure developed by industrial designers and advisors of the Swiss IT’IS Foundation, and approved by the Interagency Work Group on RF. Thus, the NTP design followed well-established protocols used to evaluate more than 400 other compounds.

Moreover, unlike all other compounds evaluated by the NTP, their study of cellphone radiation underwent an unprecedented 3-day peer-review [53] at the behest of the FDA and NIH Director who were pressured to carry this out. Contrary to the expectations, that review strengthened the findings of the NTP scientists and found ‘clear evidence’ of cancer in male rats, some evidence of other cancers, and strong evidence of DNA damage in both rats and mice in multiple organs.

In the peer-reviewed journal *Environmental Research*, Ronald Melnick PhD, the former Senior Toxicologist who designed the NTP study, provided a detailed commentary on the utility of the National Toxicology Program study on cell phone radio frequency exposure [54], debunking the widely circulated

criticisms of the NTP study. (PDF from FCC) Among his observations were the facts that the NTP study reported significantly increased incidences and/or trends for gliomas and glial cell hyperplasias in the brain and schwannomas and Schwann cell hyperplasias in the heart of exposed male rats. Further he noted significantly increased DNA damage (strand breaks) in the brains of exposed rats and mice, reduced pup birth weights when pregnant dams were exposed to GSM- or CDMA-modulated RFR and the induction of cardiomyopathy of the right ventricle in male and female rats. These results clearly demonstrate that cellphone radiation at levels not known to induce any measurable change in temperature, can be damaging.

We agree with Melnick and others that the NTP findings are especially important because the International Agency for Research on Cancer (IARC) in 2011 classified RFR as a "possible human carcinogen" based largely on increased risks of gliomas and acoustic neuromas (which are Schwann cell tumors on the acoustic nerve) among long term users of cell phones. The fact that similar tumors have now also been detected in both rodents and humans in cell types affected by RF further strengthens the association of this exposure with cancer. In his commentary [54], Melnick addresses several unfounded criticisms about the design and results of the NTP study that have been promoted to minimize the utility of the experimental data on RFR for assessing human health risks. Regarding the alleged major difference in survival between control and exposed animals, he noted that this difference did not in any way negate the positive findings of cancer and DNA damage in exposed animals. Moreover, the expert peer-review panel also concluded the NTP studies were well designed, and that the results demonstrated that both GSM- and CDMA-modulated RFR were carcinogenic to the heart (schwannomas) and brain (gliomas) of male rats.

In rejecting the findings of the NTP, the FCC relies on a brief conclusory sentence from the Food and Drug Administration (FDA) questioning the relevance of the government study that previous officials of the FDA had in fact ordered to be carried out [47]. No detailed reasoning for this extraordinary rejection of government research by the original requesting agency has ever been offered. Moreover, this rejection is inconsistent with the views of many national expert bodies as outlined below.

Conflicting Scientific Opinions and Analyses Manufacture Doubt

As is evident from the extraordinary dismissal of the NTP findings by the FDA-- the government agency that initially requested the study--there are major ongoing disputes between experts in the field. Unfortunately, the FCC in its reliance solely on the FDA and ICNIRP is excluding detailed and substantiated materials that have been generated by hundreds of experts over the past several decades. As the ORSAA group recently noted in a publication, there are ongoing conflicts of interest where agencies designated to evaluate health and environmental impacts of the technology (including FDA, and Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)) are also charged with promoting the same technology:

"RF technology is a booming multi-trillion dollar industry globally, and changing current prescribed safety levels to more stringent standards would bring about unfavorable financial consequences and affect industrial and military functions. In some countries, such as Australia, the regulator, which has a health protection responsibility, also sells RF spectrum licenses, which represents a clear conflict of interest. The very same agencies with responsibility for providing safety advice to the public are also considered by some to have been captured by the industry " [39].

One illustration of this capture for ARPANSA is the fact that, prior to COVID-19, that agency offered meters to the public for monitoring exposures to radon, ionizing radiation, and power lines, but did not offer any meters for measuring exposures to non-ionizing radiation from mobile phones, smart meters or other wireless radiating devices. Moreover, ORSAA documents the difficulties scientists face in publishing results that question some of the assumptions on which ICNIRP and the FCC depend, not least of which is their mistaken view that nonthermal effects either do not occur, or where there is undeniable evidence that such effects have happened as with the NTP, then the view is that these findings are not of any biological importance.

The conclusion of the recent ORSAA publication bears quoting here in full as it encapsulates the dilemma that is faced by those seeking to obtain a complete assessment of relevant science:

“People from countries following the Federal Communications Commission (FCC) recommendations or ICNIRP guidelines need to ask why their regulators hold such opposed views from the same body of scientific research. Low-dose ionizing radiation dose limits are in the same category as man-made RF-EMF, yet the International Commission on Radiological Protection (ICRP) takes a precautionary approach when setting limits, whereas this paradigm is completely absent in the ICNIRP's philosophy on radiation protection.”

Industry scientists are often accorded considerable weight in evaluating scientific evidence and constitute welcomed members of the relevant “extended peer community.” Much of the uncertainty characteristic of the understanding of the health and environmental risks of wireless radiation can be understood to be manufactured, in a parallel sense to that detailed by Naomi Oreskes for the tobacco industry [55]. For instance, the national ombudsman for the media in Ireland [56], upheld a complaint filed by Professor Tom Butler regarding a widely circulated media report that appeared in the Irish Times claiming that those concerned with health risks of 5G “can be traced to a single scientist and a single chart.”

That independent review concluded:

“That The Irish Times breached Principle 1 (Truth and Accuracy) of the Code of Practice of the Press Council of Ireland.

Professor Butler made a formal complaint to the Office of the Press Ombudsman claiming that Principle 1 (Truth and Accuracy) and Principle 2 (Distinguishing Fact and Comment) of the Code of Practice had been breached. Professor Butler challenged what he understood to be the subtext of the article which was, he said, that there were “no real links between wireless technology and health”. In particular, he disputed the accuracy of the sub-heading to the article, claiming that there was “significant scientific concern that dates back to the 1950s, at the very least”. He referenced many scientific papers and research findings which questioned the safety of microwave radiation, stating that “there is a significant body of scientific evidence on hazardous non-thermal levels of microwave radiation”. He questioned the statement of the author of the article that “mainstream scientists continue to see no evidence of harm from cell phone radio waves” which he described as “demonstrably false”.

The Press Ombudsman’s task is to decide if the Code of Practice of the Press Council has been breached. Principle 1 requires the press to strive at all times for truth and accuracy. In the article the author made assertions about the effects of wireless technology which Professor Butler claimed were inaccurate. His complaint, which included substantial supporting documentation and international research, contained

sufficiently persuasive evidence to allow a decision that the article did not meet requirements in regard to Principle 1. It is a frequently repeated truism that everyone is entitled to his own opinion but not his own facts. An opinion piece in a newspaper has the same obligation to facts as any other part of a newspaper. I am upholding this complaint on the basis that the article, in not taking more account of scientific research that raised concerns about the impact on human health of radio waves, breached the accuracy requirements found in Principle 1.”

We note that, were an ombudsman to review ICNIRP opinions, they might reach a similar conclusion regarding the failure to take into account the full range of scientific research in reaching its conclusions about human health.

Others, notably Harvard’s Center for Ethics, have questioned the revolving door of leadership at the FCC, where telecom industry chiefs regularly come from and return to their industry, after serving as commissioners at the FCC. Effectively, the agency has become the champion of the industry, unconcerned with potential health or environmental implications of that technology. ICNIRP’s international guidelines only recognize thermal effects, and pay no recognition to the non-thermal effects of non-ionizing EMF. However, a large body of scientific evidence suggests that bio-effects and health impacts can and do occur at low exposure levels, which can be thousands of times below public safety limits. Thus, as our comment on this docket makes clear, ICNIRP’s presumption that exposure to non-thermal levels is safe is fundamentally flawed.

Useful policy recommendations and challenges for research arising from rapid technological changes are outlined by Miller et al. [57]. In addition to addressing total cumulative exposure across the spectrum from multiple sources and for sensitive populations such as children, due to the exponential changes in technology and its uses, there is:

“Advances in RFR-related technologies have been and continue to be rapid. Changes in carrier frequencies and the growing complexity of modulation technologies can quickly render “yesterdays” technologies obsolete.”

Internal Fields E_i and Wireless Power Transfer Potential Hazards

Although the greater portion of our comments on this docket is devoted to human exposure at the higher frequencies, some words must be devoted to the subjects of Internal fields and Wireless power transfer (Section E. of the NPRM).

Internal Fields

Point 5 of the docket states:

“5. While each of the standards appears to provide appropriate E_i guidelines, the ICNIRP 2010 guidelines are the most widely accepted from an international perspective. The Commission proposes to adopt limits on E_i similar to the ICNIRP 2010 guidelines into its rules for frequencies between 3 kHz to 10 MHz.”

While we applaud the decision to state internal fields as part of device compliance, it is unacceptable for a federal government agency to rely on a 10-year-old standard devised by a self-appointed group of 11 experts (ICNIRP) without a dedicated literature search or funded study to assess the validity of these older guidelines. As others have noted, the technologies, users and applications have changed radically

during this time. Again many other expert groups have reached quite different conclusions regarding appropriate policies.

We insist that such a study be undertaken before a standard is set relying on decades-old approaches for these new technologies. Further such a study should take into account investigations carried out by ORSAA (www.orsaa.org) , as well as researchers at IT'IS (<https://itis.swiss/virtual-population/>) that have developed anatomically based models of exposure. Among the major issues such a study should address are questions regarding the increased susceptibility of the young developing brain, poorly myelinated nervous systems, and fast-growing bodies to changing internal fields that have been raised repeatedly by other submissions to the FCC by the American Academy of Pediatrics, and clinical experts such as David Carpenter, Torril Jeter, Robert Morris, neurologist, Maya Shetreet-Klein and psychiatrists, Martha Herbert and Victoria L. Dunckley [29], and many others from international groups noted below.

Wireless Power Transfer

Item 20 of the of the NPRM states the following:

“20. Locally operated wireless power transfer systems. Part 18 allows the use of potentially unlimited power if a device operates within a designated Industrial, Scientific and Medical (ISM) frequency band, so long as the device operates “locally.” Because the Commission’s rules do not define what would constitute “local” usage, measurement and compliance challenges arise in assessing wireless power transfer devices that provide charging of receiving units located at a distance from the wireless power transfer transmitting unit. The Commission seeks comment on whether the term “local” should be defined in terms of distance between the transmitting and receiving units. If the Commission defines “local” based on this distance, what is the maximum distance between the transmitting and receiving units that should be considered as “local” operation?”

Currently the most efficient form of WPT is by inductive coupling [59], via the magnetic component of the field. The obvious applications of WPT like cell phone charging [59] or remote charging of an electric car [60] represent two extremes in terms of power that are topical. Although the FCC recognizes the need to define what exactly the term ‘local’ means, their concerns are couched solely in the terms of device operations and compliance, while avoiding interference with other devices, and ignores concerns about health impacts. The document completely fails to investigate any possible health implications of proposed WPT that could occur over larger distances, and instead focuses only on how to define what distance between transmitting and receiving units should be considered “local.” This lack of consideration is especially worrying given the outdated definition of allowable internal fields and the growing applications for WPT in such realms as the powering of prosthetics [56] or other medical devices [61] , as well as those employing Virtual Reality [62] and other consumer applications. Given the lack of technical expertise within the FCC to consider these concerns, it is inappropriate to base the entire consideration of safety on outdated and under- researched values for internal fields.

At its core, far field WPT operations involve communication between a transmitter and a receiver on the same bands as WiFi. Once contact is established between a device and charging station, the station sends out focused RF signals that are then absorbed and converted into DC power by an embedded microchip [63]. These chips can be built into phones, computers, hairdryers, washing machines, dishwashers, or any standalone energy-using device in the household. Given their anticipated expansion

into many spheres of commerce, WPT stations will increase indoor exposures to wireless radiation through free-flowing power. The FCC has recently granted its first certification for over-the-air, power-at-a-distance wireless charging [64], [65].

While our document focuses on technical and scientific deficiencies of the proposed rule, we must note that with respect to WPT markets are rapidly expanding as these words are being written, with no consideration of the absence of health and safety information. Industry analysts report that the wireless charging market including Starbucks and McDonalds and a growing number of retailers exceeded 11 billion in 2019 and is expected to grow at 14.5% CAGR between 2020 and 2026 driven largely by a rise in global sales of wearable devices and high-end smartphones [66]. While health and environmental impacts of WPT are currently unknown, as the remainder of this document will make clear, they are not unknowable. Indeed evidence already amassed on the health and environmental risks of 3G and 4G that is discussed below, indicates that there are serious health concerns, especially for children, pregnant women and men who wish to father healthy children.

WPT and 5G have in common that they both involve bringing exposures much closer to dense human contact than at any time in history. The environment around WPT is filled with more free flowing power than standard WiFi or cordless phones emit. Indeed, a report from an international tech online magazine provided this telling statement from an anonymous executive of a major hardware company:

“I don’t think I would want to be in a room with free moving power signals.”

The exponential growth in wireless power transfer and charging constitutes an unparalleled increase in the amount of EMF radiation in our everyday world taking place without any prior evaluation of potential health and environmental impacts. The online technology evaluating website, Engadget [65] reported that dishwashers are being designed that can charge a cell phone wirelessly at a distance of 15 feet, noting that sending wireless signals that are different for that purpose will result in much wasted radiation distributed in the environment.

“Wireless charging is a little bit more convenient than plugging your device in, but was picking up a microUSB lead ever that much of a chore in the first place?...Then there’s the question of if it wouldn’t be damaging to health in the same way that people have raised concerns about living next to electrical substations?” [67]

We strongly recommend that a thorough independent health survey of wireless transfer be undertaken, especially for applications involving prosthetics and other body contact applications that will entail lifelong exposures.

SAR Definition and Measurement and reliance on the Standardized Anthropomorphic Mannequin (SAM)

History of Exposure Testing, Guidelines, and Standard-Setting (adapted from Gandhi et al., 2012 [68] previously submitted to FCC by EHT)

In September 1982 the American National Standards Institute (ANSI) published the first dosimetry exposure standard to electromagnetic fields between 300 kHz to 100 GHz. This document proposed 4 W/kg as the limit of absorption under which irreversible damage may occur from RF heating of flesh. A 10 fold safety limit was then arbitrarily imposed for human whole body exposure of 0.4 W/kg averaged over 6 min, and a 20-fold greater spatial peak SAR exposure over any 1 gram of tissue of 8 W/kg averaged over 6 min. As ANSI did not feel competent to judge biological and medical implications of exposure they passed the baton to the Institute of Electrical and Electronic Engineers (IEEE), a body not noted for its medical expertise. This standard was adopted and revised by the IEEE in 1991 [69], to allow whole body average SAR exposure to 0.08 W/kg averaged over 30 min and the spatial peak SAR for any 1 gram of tissue to 1.6 W/kg averaged over 30 min for the general population, with workers permitted to have the same exposures in one-fifth the time, i.e., 6 minutes. With little or no change this standard has remained to this day. It was officially adopted by the FCC in 1996. The guidelines for how to measure the compliance to this standard was standardized in 1998 by the international commission on Non-Ionizing Radiation Protection (ICNIRP) in 1998 [70] and finally approved by the FCC in 2001. It is surprising that public health research has never featured in the adoption of the principal tool for human exposure safety until the National Toxicology Program study of 2017.

The FCC exposure limits were, and remain, identical to the 1991 IEEE standard. The FCC SAR adopted values were: (1) For occupational exposures, “0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet, and ankles where the spatial peak SAR 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) [averaged over 6 minutes].” (2) For the general population exposures, “0.08 W/kg as averaged over the whole body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) [averaged over 30 minutes].”

Finally in 2001 the FCC established a standardized cell phone SAR certification process was available (the SAM cell phone certification process). However, the FCC continued to offer the alternative computer simulation certification process [68] .

The FCC definition of SAR and its measurement remain unchanged based on assumption that there are no effects in addition to thermal impacts and that the adult head and body phantom of the Standard Anthropomorphic Mannequin (SAM) are protective of children of all ages to adulthood. We should note that SAM is based on the 98th percentile of military recruits in 1988, weighing about 220 pounds with a 12-pound head. While the FCC safety standards apply to all users’ body sizes (from small children

to large adults), the actual testing model is based upon a 6'2", 220 lbs. large adult male. According to a 2011 study [68], SAM represents only the largest 3% of cell phone users.

The continuation of point 7 of the docket states as follows:

"7.Accordingly, there is no reason to expect that thermal effects will effectively change at the increasingly higher frequencies. Accordingly, the Commission proposes to extend the same constant exposure limits that presently apply from 6 GHz to 100 GHz up to an upper frequency of 3,000 GHz (3 THz),...."

This statement of the docket is fundamentally flawed, even in the narrow definition of heating effects, as it ignores two well known EM wave/tissue coupling effects. These are Standing Wave coupling and the inconvenient inhomogeneity of the real human body as compared to the SAM [71]–[74]. We will treat each separately below. Furthermore it ignores a biological reality by assuming that superficial skin exposure to the EM spectrum can be of no biological impact. An example of such is detailed in the section "Other Comments".

While these models may have been useful in the early stages of developing standards, they do not reflect current understanding of neurophysiology and development. Effectively the FCC rejects requests submitted to the docket from multiple parties including the American Academy of Pediatrics (AAP), EHT, Dr. David Carpenter, former Dean of Public Health, University at Albany of the State University of New York, and Director of Public Health Laboratory for the State of New York, Dr. Joel Moskowitz of Berkeley, and others that have documented in submissions to the FCC the multiple ways that children are more susceptible to RF [75]. We call special attention to a September 2019 letter sent to Members of Congress calling for revised standards to protect children, including the Honorables: Anna Eschoo, Edward Markey, Elizabeth Warren, Elijah Cummings, Lamar Alexander, signed by Dr. Jerome Paulson, former Chair of the American Academy of Pediatrics Executive Council on environmental health, pediatrician at Children's National Medical Center in Washington, D.C., and Professor in the Department of Pediatrics at The George Washington University School of Medicine and Health Sciences.

Standing wave coupling reveals inadequacy of SAM/SAR concept

In paragraph 35, the FCC declares that it will exempt several forms of RF from any testing because of the assumed lack of biological impact:

"As proposed in the 2013 RF Further Notice, a single RF source will be exempt from routine RF exposure evaluation under any one of three circumstances: 1) the RF source transmits at no more than 1 mW average power; 2) the RF source normally operates between 0.5 cm and 40 cm separation from the body, in the frequency range between 300 MHz and 6 GHz, and transmits at no more than the average power threshold result of the formula we adopt based on localized specific absorption rate (SAR) limits; or 3) for all other transmitters, (a) the RF source transmits at no more than the average power threshold result of the set of formulas we adopt based on the maximum permissible exposure (MPE) limits, and (b) the intended operation is normally separated at a distance from any part of the radiating structure of at least $\lambda/2\pi$, where λ is the free-space operating wavelength. These specific exemption criteria are a generally-applicable set of formulas, based on power, distance, and frequency, for all services using fixed, mobile, and portable transmitters."

This exemption ignores several facts about frequencies above 6 GHz. At these frequencies, wavelengths can approach the same dimension as critical tissue structures and the conditions for standing waves begin, likely resulting in unacceptable increases in absorption and therefore tissue temperature. Standing waves are created when part of a wave is reflected by the boundary between two different tissue layers (for instance the dermis and underlying fat tissues) constructively interfering with impinging wave form. The condition for this to happen is only that the length of the radiation approaches that of the layer thickness.

The underlying assumption of the SAR standard is that the wavelength of the signal is longer than the spatial dimensions of the volume of interest. In this case the situation is quasi static and heating is by absorption of the signal and this is a function of the signal intensity only. But with higher frequency signals, above 6 GHz, this condition is violated as the wavelengths begin to approach the same size as common biological materials. This can easily be seen in anatomically-based finite-difference time-domain (FDTD) electromagnetic simulations using 3-dimensional microCT scans of several important pollinating insects including the honeybee (*Apis Mellifera*) [76]. The FDTD technique (commonly used in heterogeneous human body models) is implemented in the commercial simulation software Sim4life (ZMT, Zurich, Switzerland) that evaluates absorption of RF-EMFs inside the human body as well as that of the honeybee and other insects as a function of frequency. These French researchers devised several different methods for measuring the propagation of EMFs inside and around the obtained 3D insect phantoms noting that absorption necessarily depends on their dielectric properties: the relative permittivity and conductivity.

They reported that:

“All insects showed a dependence of the absorbed power on the frequency. All insects showed a general increase in absorbed RF power at and above 6 GHz, in comparison to the absorbed RF power below 6 GHz. Our simulations showed that a shift of 10% of the incident power density to frequencies above 6 GHz would lead to an increase in absorbed power between 3–370%”

Further, they cautioned that these conditions were likely to result in severe impairment of insect behavior including their capacity to pollinate or produce honey.

The wave length at 6 GHz is $\lambda = 5$ cm in air and at 3000 GHz it is $\lambda = 0.1$ mm. Under all circumstances, the effective wavelength in biological structures is caused by wavelength contraction resulting from passage through material that is more dense than air and is given by λ/\sqrt{n} , where n is the index of refraction of the tissue. Different tissue structures with different indices of refraction and dielectric constants have been identified reflecting their different densities and water contents (fat/muscle of skin/fat) that present distinct planes of reflection for the impinging signal. Effectively the higher the water content of any object, the greater absorption will take place. Consider that the brains of children contain much more fluid than that of an adult. Further, their skull is less dense and can absorb up to 10 times more RF than an adult. We comment further on this subject below.

Accordingly, as wavelengths approach the dimensions of these structures, portions of the wave are reflected back and forth inside the structure and begin to interfere with each other. If the conditions are correct, standing waves in flesh or tissue begin to appear as electromagnetic waves impinge on one another. This enhanced coupling leads to heightened SAR values and the potential creation of hotspots that can occur within different tissues contained within the head and body. **As a result, the crude**

homogeneous phantoms favoured by current compliance testing relying on the SAM, sanctioned and even dictated by the FCC, cannot provide a realistic approximation of human exposures to these higher frequencies because they do not reflect complex differentiated tissue within the human skull. Numerous commentators to the FCC, including EHT on many different occasions, have documented the fact that FDTD models offer much more accurate estimation of absorption because they rely on heterogeneous models throughout the age and sex range, including one of the pregnant young woman.

This is not the first time that the FCC has been made aware of the inadequacy of the SAR definition for such wavelengths/dimensions. We point out articles by Christ et al. [77], [78], Klemm and Troester [79] and Betzalel et al. [80], [81], amongst others showing clear evidence that 5G frequencies can be absorbed deeply and have biological impacts. To quote from the Thesis of Dr. G. Melia [82];

“Table 1 shows the frequencies at which the penetration depth of each material is 1 cm in the 5-10 GHz range. Over this range, we may expect EM absorption by the human body to be complicated, with possibly no strong relationship to any one biometric parameter (especially once non-normal and non-planar incidence are introduced), due to the effects of reflections within the body’s outer layers. We should add that the eye remains exquisitely vulnerable to RF as the volume is quite small and it lacks any natural cooling mechanism.”

Table 1: Frequencies that can penetrate 1 cm into three biological tissues [83]

Dry Skin	5.2 GHz
Infiltrated Fat	9.5 GHz
Muscle	4.7 GHz

Simply put, the layered structure of tissues, especially skin, is going to lead to strong coupling and therefore absorption of RF radiation, far higher than the simplistic models employed by the FCC. Moreover, the eyes will be especially prone to damage. Finally, as others have confirmed, systemic immunological and other impacts can occur even with minimal absorption.

The current docket does not take such wavelength effects into consideration, rendering their own definition of safety insufficient and their preferred measurement technique inadequate.

The inhomogeneous brain and body and homogeneous SAM

Without exception, the dielectric constant of the air--indicating the ease with which any signal can penetrate the air-- is uniformly much lower than that of any living tissue which contains fluid or fat. Thus, the dielectric constant of the air is generally assumed to be 1. The dielectric constant of the brain of a child is estimated to approximate 60, while that of an adult may be 30. Because the child brain contains more fluid and fat it will absorb much more radiation than will an adult, as indicated by modeling carried out by Fernandez et al. [84] and Morris et al. [85]. We should add that ICNIRP and the FCC are disingenuous when noting no differences in exposure to the whole head of an adult and child, when brain exposures are understood to be much more relevant and in need of protection.

Even more problematic is the concept enshrined by SAM that it is appropriate to consider the body phantom as a homogenized, uniform liquid and ignore the differences in electromagnetic properties between skin, bone, fat and flesh, [43], as well as basic anatomic distinctions between men and women, including the exquisite vulnerability of the testes, pregnant women, infants, toddlers and young children. Detailed studies have documented the folly in doing so [73], [74]. The table below illustrates how important properties - conductivity, density and dielectric permittivity - vary wildly for different tissue types.

Table 2 The parameters for different tissue types in the human head, taken from Ref [86]: Permittivity ϵ_T , Conductivity σ (S/m), Density ρ (kg/m³), Specific heat capacity C (J/kgC), Thermal conductivity K (W/mC), Metabolic production (W/m³), Blood flow associated term B (W/m³C)

Tissue	ϵ_T	σ	ρ	C	K	A	B
Blood	59.37	2.044	1058	3840	0.49	0	0
Blood Vessel	43.34	1.066	1040	3553	0.46	1600	9000
Bone (Cancellous)	19.34	0.588	1920	2150	0.30	2510	14120
Bone (Cortical)	11.78	0.275	1990	1650	0.30	0	0
Bone (Marrow)	5.37	0.069	1040	2700	0.22	5020	28230
Brain (Cerebellum)	46.11	1.709	1038	3687	0.57	10040	56490
Brain (Gray Matter)	50.08	1.391	1038	3687	0.57	10040	56490
Brain (White Matter)	37.01	0.915	1038	3600	0.50	2820	15890
Skin	38.87	1.845	1125	3610	0.42	2190	12310

The resulting simulation model of the human head (Figure 1) illustrates the heterogeneous nature of tissues within the human head that cannot be reflected in SAM. It therefore makes little sense to persist in using a simplified SAM to gauge the safety of mobile devices. Furthermore, the simulation results (Figure 2) demonstrate large temperature differentials in the cranium or skull due to EM absorption from a mobile phone, with temperature jumps of over a degree in the skin and cranium bone with either the 6 or 30 minute averaged time for exposure.

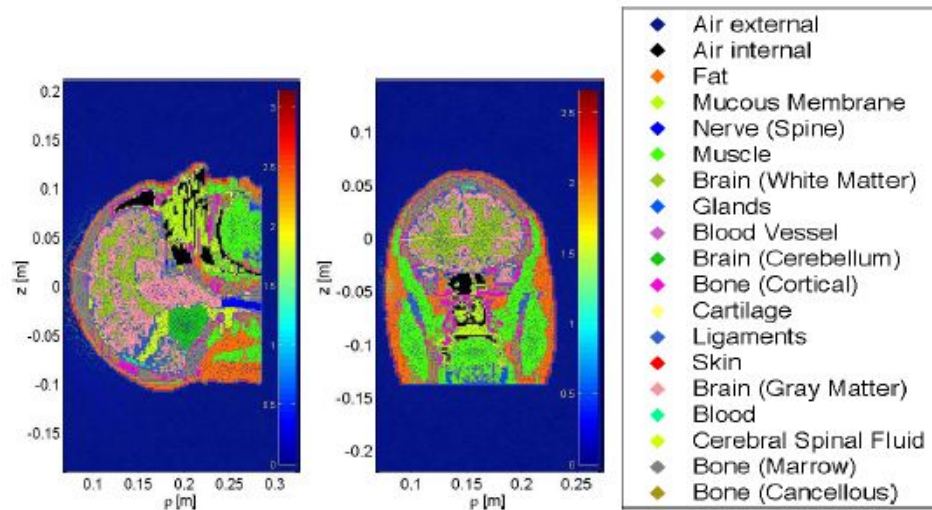


Figure 1 - the distribution of different tissue types in the head by table 2.2. taken from ref. [86]

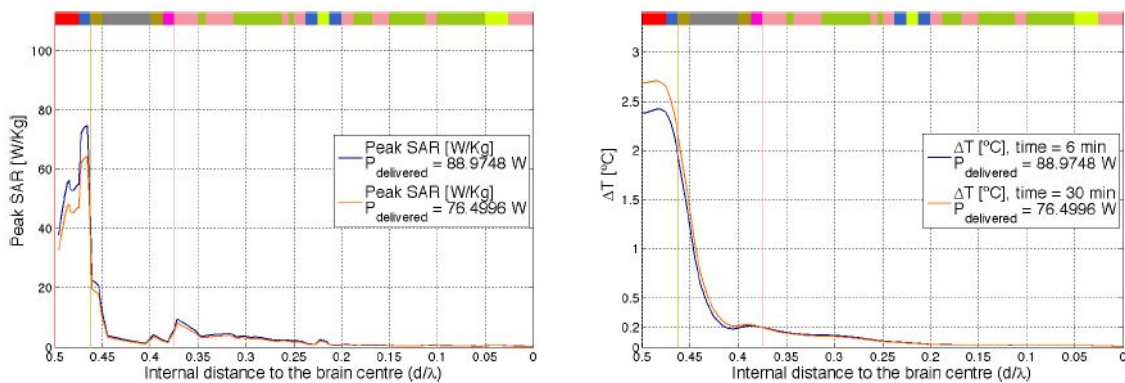


Figure 2 SAR and temperature increase for the cranial setting at 6 and 30 minute exposures. taken from ref. [86]

Further the IEEE and ICNIRP safety guidelines employ a plastic “pinna” (ear) of from 6 to 15 mm in thickness next to the head of SAM for SAR testing of cellular telephones. This contributes to an underestimation of radiation exposures that take place inside the brain that have been amplified and confirmed in testing by ANSES [33] and by independent testing carried out by FCC-certified laboratories for the *Chicago Tribune* [87]. These tests consistently confirm that when phones are evaluated directly next to the body, rather than with a holster allowing up to an inch distance away, the body absorbs up to 11 times more radiation than current outdated thermally-based limits allow. Similar results can be expected for the brain. Reports from Phonegate Alert (<https://www.phonegatealert.org/actualite>) further detail important limitations of current test systems and underlie repeated calls to revise these systems accordingly. Thus, Gandhi reported that:

“Both from measurements and computer modeling that the specific absorption rate (SAR) reduces by 10%–15% for every millimeter separation of the cell phone on account of rapidly diminishing EM fields in

the near-field region of the cell phone antenna. This rapid reduction of SAR depending on the antenna and its location on the handset has been shown, both computationally and experimentally, regardless of the phantom model such as a flat phantom suggested for SAR compliance testing of devices in contact with the body, for a sphere phantom, and for head-shaped models used for SAR compliance testing of cell phones. Unfortunately, our observations in the past were based on SARs of only three cell phones. Expecting that the SARs for cell phones may exceed the safety limits for body contact, cell phone manufacturers have started to recommend that the devices can be used at 5–25 mm from the body even though it is difficult to see how to maintain this distance correctly under mobile conditions. The National Agency ANFR of France recently released the cell phone SAR test data for 450 cell phones that measure 10-g SARs reducing by 10%–30% for each millimeter distal placement from the planar body phantom. Their data corroborate our findings that *most cell phones will exceed the safety guidelines when held against the body by factors of 1.6–3.7 times for the European/ICNIRP standard or by factors as high as 11 if 1-g SAR values were to be measured as required by the U.S. FCC.*” [italics added][26]

Vulnerability of Children to other medical interventions establishes the need to take special actions to reduce children’s exposures to RF

The docket errs in its assumption that tests developed for mature large adults adequately protect children that contain more fluids, less dense bone, and incomplete myelination, all of which make them more vulnerable to exposures to RF. The docket states:

“We further decline to revisit our RF exposure policy as it pertains to children. Under IEEE Std 1528-2003—the standard for determining the compliance of devices such as cell phones—the measurement test setup that is used was designed to test for effects on children as well as adults.”

The IEEE Standard that is referenced above only includes RF between 4 MHz and 10 GHz and importantly does not address the fact that at whenever stage of life they may be exposed, from infancy and toddlerhood, throughout adolescence, children are not merely small adults. Their bodies contain more fluid. Their bones, especially their skull, are less dense. Computer simulations of absorption of continuous wave signals at a single frequency at a time into the head of SAM cannot and do not reliably estimate absorption from simultaneously operating multiple frequencies (typical of a smart phone today) into the different components of the child brain, as previously submitted peer-reviewed publications have made clear. As a result even if RF exposures were identical--and we and others have shown that they are not--the biological impacts can be expected to differ as a result of the differing immune and nervous systems of children.

This IEEE standard relies on the simplified model of the head--essentially an homogenous fluid-holding sphere and body--a pool of uniform liquid, with the intent to provide solely “for the reproducible and conservative measurement of the peak spatial-average SAR (psSAR) ... by radio-frequency (RF) transmitting devices, with a defined measurement uncertainty.” [88]

Proposed Peak SAR values and Maximum Allowed Power Density will Result in Unacceptable and Intolerable Thermal Impacts

The Commission proposes for frequencies above 6 GHz a maximum power density of 4 mW/cm² for the general public.

“9. The proposed general population localized power density value of 4 mW/cm² matches the exposure limit specified at 6 GHz in the IEEE Std C95.1–1991 standard referenced in the Commission’s rules. Based on planar models, this standard suggests that a power density of 4 mW/cm² just above 6 GHz is consistent with the Commission’s 1-gram SAR limit of 1.6 W/kg at 6 GHz. Also, the thermal perception threshold at frequencies approaching 100 GHz for large areas of exposure is indicated at about 4 mW/cm².”

Thermal perception is defined as a temperature rise in flesh of less than 0.1 °C. Given the inadequacies of the SAM-based SAR standard which allows an unreasonably large thickness for the ear (“pinna”) and fails to take into account different electrical properties of brain tissue, more realistic simulation studies [89] based on anatomically-modeled 1 mm cubic Voxel models of the head demonstrate that with the current standards one can expect temperature rises 5 to 10 times this level, i.e. well into and well beyond the realm of thermal perception. This proposed level of exposure would result in unacceptably high and intolerable conditions by allowing prolonged exposures to levels that are relied on for medical devices that are typically used for relatively circumscribed and time-limited periods. (see below)

SAR values do not adequately depict the biologically disruptive nature of pulsed signals that can lead to permanent tissue damage

The SAR standard refers specifically to averaged values over periods of 6 or 30 minutes estimated for a single frequency at a time and is more suitable to a continuous wave signal (CW) than the pulsed signal trains from multiple operating frequencies of today’s modern communication. The belief, and it can be described as a belief as opposed to an established scientific fact, is that there is an equivalence between an averaged power of a rapidly changing pulse train of signals and a CW signal.

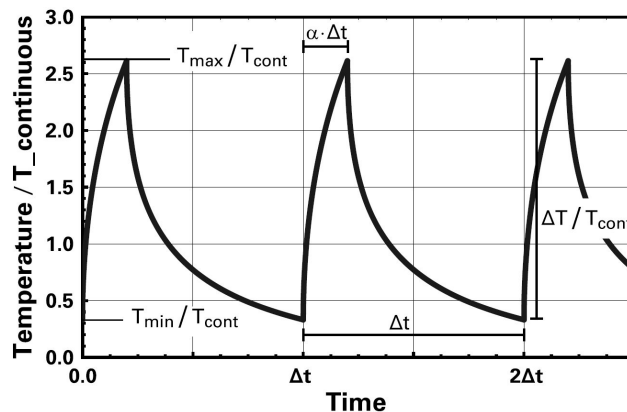


Figure 3 - Taken from [90] Transient temperature oscillations resulting from a pulse train, computed for $\Delta t = t_1$ and $\alpha = 20\%$ at an intensity resulting in a temperature increase of 1 K at continuous exposure. T_{min} : minimum temperature; T_{max} : maximum temperature; T_{cont} : temperature at continuous exposure.

By analogy this reasoning would suggest that if a steak is placed on a grill and half the steak is in the pan where it thoroughly cooks, while the other half remains raw and uncooked outside the pan, then the steak can be considered to be cooked on average. Theoretical studies by two of the pre-eminent modelers in the field, Neufeld and Kuster [90] of IT'IS, show significant temperature oscillations from a pulse train in the skin of more than 1 °C for pulses centered around 5 GHz and have led these authors to warn about the need to lower standards for permissible exposures accordingly:

“THE FIFTH generation of wireless communication technology (5G) promises to facilitate transmission at data rates up to a factor of 100 times higher than 4G. For that purpose, higher frequencies (including millimeter-wave bands), broadband modulation schemes, and thus **faster signals with steeper rise and fall times will be employed**, potentially in combination with pulsed operation for time domain multiple access.

5G is designed as a ubiquitous communication system spanning applications such as high-bandwidth mobile data and telephony, real-time machine-to-machine communication (e.g., autonomous mobility), and the Internet of Things (IoT). *Exposure to radio-frequency electromagnetic microwave radiation (RF-EMR) from wireless devices to large radar installations and medical equipment can result in increases in body core temperature or cause localized temperature rises, with the potential for adverse health effects.”* [italics added]

As these influential authors advised:

“The results also show that the peak-to-average ratio of 1,000 tolerated by the International Council on Non-Ionizing Radiation Protection guidelines may lead to permanent tissue damage after even short exposures, highlighting the importance of revisiting existing exposure guidelines.”

We feel that the FCC would do well to heed this advice.

Kuster and Neufeld relied on a FDA validated model of tissue damage, the CEM43, with an experimental data based damage threshold for human skin of 10 hours. They employed respective safety factors of 10 and 50 in examining thermal and tissue damage models for homogenous skin and modeled temperature changes that can be expected to occur under currently allowed conditions of exposure to RF that can be expected to take place with the implementation of 5G, along with 3G and 4G. They found that for a very low peak-to-average ratio of 100 ($\alpha \geq 0.01$), humans can be expected to tolerate only 30 seconds of exposure before experiencing unpleasant sensations of heat. The main factor underlying the biological impacts of pulsed signals is the disparity between the time width of the EM pulse and the time constant for heat dissipation in the skin, approximately 1000 greater than the pulse width. What this means is that while tissue may be able to absorb the energy of the EM pulse efficiently, it is a lot less efficient at getting rid of the same energy as heat. Therefore the tissue cannot reach a state whereby the energy deposited by an EM wave is dissipated. The resulting buildup of heat translates to a significant temperature change. In the jargon of science, it is a result of a thermal linear response of an electromagnetic impulse. (This situation is akin to a child sitting on a swing that is gently moving and being slowly pushed to and fro. If that same child is stationary on the swing and suddenly receives repeated short and sharp slaps on the back, the swing will barely move, but the energy of the blows will be felt by the child!!)

These results about thermal coupling within tissue have been revised upwards recently [48], [49] and have indicated the need to change ICNIRP guidelines to protect public health.

This rather basic fact of impact and response, understood in physics, is entirely missed by the FCC docket. Indeed, there is no consideration of the erratic pulsation nature of modern communications and the profound biological impact such signaling can have. This significant omission is evident when studying the FCC standards for determining the peak spatial-average SAR [38]–[40]. Effectively the agency ignores the fact that peak pulses, repeatedly taking place over nanoseconds through cellular phone calls, or when apps are constantly updating and downloading, can be far more biologically important than values averaged over a period of 6 or 30 minutes. In fact, where RF averaging is carried out over half an hour this effectively smoothes out any impacts of the thousands of short, episodic peaks that do occur.

Thus, there is strong scientific evidence in literature showing that in experiments where pulsed signal is used these signals induce biological effects that are different from those produced through continuous wave signals. Below is an example from a neutral research database, which indicates the important effect of pulsing and the additional importance of using real mobile device -exposure in laboratory experiments [93]–[95]. Effectively greater biological responses occur when studies are able to employ real-world exposures.

Simulated Mobile Phone Signals in Experiments Do Not Reliably Approximate Biological Impacts of Real-world Mobile Phone Signals

Table 2.2 Number of bio-effect Mobile phone studies with Signal Type and Wave- form [37]

Research Categories	Real Mobile Phone used in Experiments			Simulated Mobile Phone Signals used in Experiments					
Wave form	Pulsed			Pulsed			Continuous		
Outcome	#Effect	#No Effect	#Uncertain Effect	#Effect	#No Effect	#Uncertain Effect	#Effect	#No Effect	#Uncertain Effect
<i>in vivo</i>	120	18	11	69	49	8	6	4	0
<i>in vitro</i>	28	8	1	60	63	7	10	17	2

Averaging areas for higher frequencies do not Reflect Real-world Properties

When defining appropriate averaging areas, FCC should look at how relatively low power density (average) and SAR levels of RF can cause oxidative stress--as well-established and validated marker of degenerative diseases. In their review of 100 studies, Yakymenko et al. [42] nicely illustrate how these low levels of RF can affect cells (in vitro) and animals (in vivo). Below is a summary of in vitro studies which indicate that both pulsed and continuous wave RF can have impacts, although it appears that the former generally are more impactful[23]

Table 2 - Publications reporting positive findings on oxidative stress form RFR in-vitro [39]

Reference	Biological system exposed	RFR exposure	Statistically significant effects reported*
(Agarwal et al., 2009)	Human spermatozoa	Cell phone RFR, in talk mode, for 1 h	Increase in reactive oxygen species (ROS) level, decrease in sperm motility and viability.
(Campisi et al., 2010)	Rat astroglial cells	900 MHz (continuous or modulated), electric field 10 V/m, for 5; 10; 20 min	Increase in ROS levels and DNA fragmentation after exposure to modulated RFR for 20 min.
(De Iuliis et al., 2009) (Friedman et al., 2007)	Human spermatozoa HeLa membranes	1.8 GHz, SAR = 0.4–27.5 W/kg 875 MHz, 200 μ W/cm ² , for 5 and 10 min	Increased amounts of ROS. Increased NADH oxidase activity.
(Hou et al., 2014)	Mouse embryonic fibroblasts (NIH/3T3)	1800-MHz GSM-talk mode RFR, SAR = 2 W/kg, intermittent exposure (5 min on/10 min off) for 0.5–8 h	Increased intracellular ROS levels.
(Kahya et al., 2014)	Cancer cell cultures	900 MHz RFR, SAR = 0.36 W/kg, for 1 h	Induced apoptosis effects through oxidative stress, selenium counteracted the effects of RFR exposure.
(Lantow et al., 2006a)	Human blood cells	Continuous wave or GSM signal, SAR = 2 W/kg, for 30 or 45 min of continuous or 5 min ON, 5 min OFF	After continuous or intermittent GSM signal a different ROS production was detected in human monocytes compared to sham.
(Lantow et al., 2006b)	Human Mono Mac 6 and K562 cells	Continuous wave, GSM speaking only, GSM hearing only, GSM talk, SARs of 0.5, 1.0, 1.5 and 2.0 W/kg.	The GSM-DTX signal at 2 W/kg produced difference in free radical production compared to sham.
(Liu et al., 2013b)	GC-2 cells	1800 MHz, SAR = 1; 2 W/kg, 5 min ON, 10 min OFF for 24 h	In the 2 W/kg exposed cultures, the level of ROS was increased.
(Lu et al., 2012)	Human blood mononuclear cells	900 MHz, SAR = 0.4 W/kg, for 1–8 h	The increased level of apoptosis induced through the mitochondrial pathway and mediated by activating ROS and caspase-3.

When looking at these studies, it is easy to notice that in several, oxidative stress is reported to appear after a few hours exposure and exposure levels are often below existing FCC guidelines. Pulsed signals appear especially biologically active in both human and animal cell cultures, with oxidative stress leading to inflammation and disease, as Yaymenko et al. [42] illustrate above.

The Skin as the largest organ

Medical uses and side-effects of nonthermal levels of EMF spectrum as part of phototherapy for newborn jaundice demonstrates that superficial skin absorption has systemic biological effects

The docket assumes that superficial skin exposure can be of no biological impact. This flies in the face of long standing medical practice that employs part of the EMF spectrum to treat a variety of serious diseases relying solely on phototherapy--the application of light to the skin surface. The docket states at paragraph 126:

“however, we do not feel it is appropriate to relax our limits at higher frequencies for exposure from consumer communication devices, considering the already minimal skin depth at 100 GHz. Accordingly, we propose to extend our existing limits to 3,000 GHz (3 THz) to stay ahead of the possibility of technologies being introduced that are only nascent or unknown today.”

This FCC statement misunderstands basic biology and the fact that skin exposures can affect multiple organs. Thus, the longstanding treatment of the bodies of newborn jaundice with nontherma levels of blue-light (400 nanometers) is based on the well-known capacity of skin to

send exposed blood cells through the liver which hydroxylates vitamin D to form 25-(OH) vitamin D (25-OHD) and to the kidneys to form the active metabolite 1,25(OH)₂ vitamin D. This well established form of phototherapy is based on the fact that blue light is absorbed superficially by the skin and the capillaries of the baby, enabling these internal organs to change the bilirubin in the blood. Typically this employs a 430 to 490nm light emitting diode (LED) bulb in an overhead lamp (at a distance no greater than 8 cm).

During phototherapy, the newborn must be completely covered to avoid permanent damage to the retina. In fact, because health care professionals working with these babies report nausea, disturbances of their own vision, and other side effects from their own exposures to this part of the EMF spectrum, they take precautions to minimize exposures. While the mechanisms for eye damage are still being elucidated, they include severe damage to the retina [96], [97] termed light-induced damage. Three distinct mechanisms have been identified: photomechanical, photothermal, and photochemical. Photomechanical damage occurs from the sudden increase in energy captured by the RPE, which may lead to permanent photoreceptor damage of rods and cones. This type of damage depends entirely on the amount of energy absorbed and not on the spectral composition. In contrast, photothermal damage arises when the retina and the RPE are exposed to pulsed, brief intense (100 ms to 10 s) light that induce a significant increase in the temperature of these tissues [96], [97].

The more common type of retinal/RPE damage is photochemical, that takes place with either short, intense exposures or with longer chronic exposures, either one of which results in permanent damage to vision from non-thermal exposure. These phenomena are still being investigated and are believed to involve the increased production of reactive oxygen species (ROS) which lead to oxidative damage. Moreover, when lipofuscin [98]--the brown yellow pigment that accumulates with age in the eye and elsewhere-- absorbs blue light, the material becomes phototoxic, which can lead to further damage to vision [99].

The Vulnerability of Children

A five-year-old's brain, healthy or otherwise, is encased in a thinner skull and contains more fluid than an adult brain. The American Academy of Pediatrics cautions that children need more real face-time than screen time—more laps than apps—and the group has written to the FCC supporting the need to revamp standards to recognize the growing use of these devices by infants and toddlers. Most disconcerting are findings from Nesrin Seyhan, the NATO-supported founding chairman of the Biophysics Department at Gazi University in Ankara, Turkey, whose controlled studies show that prenatally exposed rats and rabbits have fewer brain cells—and those that survive sustain more damage to their brains, livers, reproductive systems and eyes. Recent reports from Yale University's chief of obstetrics and gynecology, Hugh Taylor, found that prenatal exposure significantly increased hyperactive behavior in offspring and altered brain chemistry. Other research carried out by renowned National Institute of Drug Abuse Director Nora Volkow, MD, PhD, finds that just 50 minutes of exposure to cell phone radiation in adult males directly alters the production of glucose— the brain's main fuel [100]. Experimental work completed by American, Australian, Greek, and Turkish teams working with experts

in male reproductive health has reported that cell phone-radiation-exposed human sperm die three times faster, swim significantly more poorly, become more deformed, and develop significantly more damage to sperm DNA [101]–[105]. Peer-reviewed publications on all these findings have been previously submitted to the FCC, with several of the researchers named here meeting directly with FCC representatives and with the Interagency Work Group on RF from 2013-18.

Human Skin as the largest Organ of the body is ignored

The FCC proposal fails to understand that the first 2 mm of the skin consists of the integumentary system that include multiple layers of cells and tissues with important immunological, neurological and other functions and that slight immediate penetration can produce profound systemic impacts. Thus, the FCC states at paragraph 126:

“We are unaware of any reason the limits should be different above 100 GHz than across the already existing wide frequency range. As the difference in body penetration further diminishes towards zero, there is no apparent reason to expect that thermal effects will effectively change in the increasingly higher frequencies. Accordingly, we propose to extend the same constant exposure limits that presently apply from 6 GHz to 100 GHz up to an upper frequency of 3,000 GHz (3 THz), which is considered to be the upper bound of existing radio frequency bands. Starting at 300 GHz or a wavelength of 1,000 micrometers (μm), standards have been developed for lasers primarily for application in industrial settings. In an effort by standards bodies to match the laser standards, RF limits have been increased at millimeter wave frequencies; however, we do not feel it is appropriate to relax our limits at higher frequencies for exposure from consumer communication devices, considering the already minimal skin depth at 100 GHz. Accordingly, we propose to extend our existing limits to 3,000 GHz (3 THz) to stay ahead of the possibility of technologies being introduced that are only nascent or unknown today.”

The docket assumes that the skin chiefly functions as a barrier or envelope and remains biologically inert. It has been pointed out that in the frequency range supported by this docket most of the signal will not penetrate the body, but will be absorbed in the skin (point 7 of this docket) [17]. However, while absorption may be superficial, it is not inconsequential. Thus, it is increasingly recognized that the skin is not simply a barrier between a messy interior and harsh exterior, but is itself a major organ of the body. Recent results have suggested that the skin plays a significant and pivotal role in the immune system of the body. Furthermore, it is understood that in the frequency region of interest the modality of electromagnetic coupling of signals to skin is complex and efficient, because of the layered nature of skin and structures like the sweat duct [80], [81], [106], [107]. **While millimeter waves may not be absorbed beyond 2 mm into the skin, that distance is sufficient to induce biological impacts given the complex array of immune and other functions that take place within the epidermis as indicated in Figure 2 [65].**

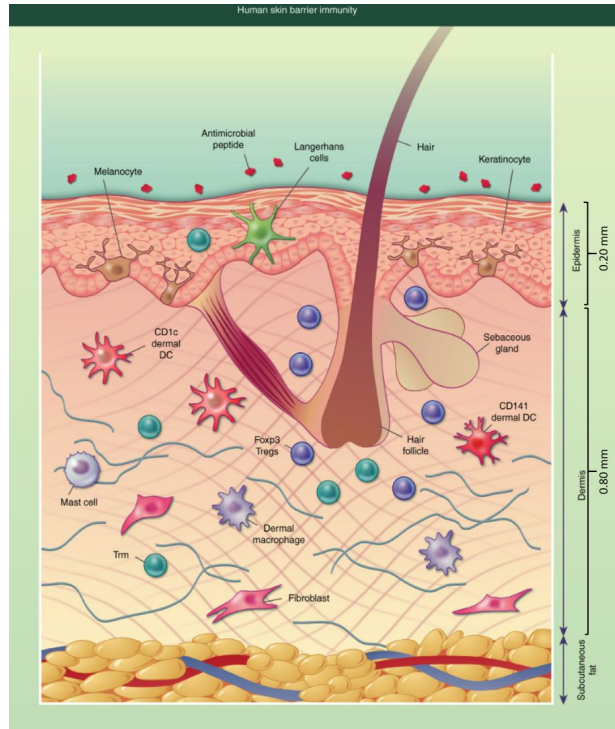


Figure 2. Diagrammatic representation of human skin barrier immunity. The surface of the skin is covered in antimicrobial peptides and lipids, some of which originate from the sebaceous gland located near the hair follicle. The epidermis consists of keratinocytes forming stratified corneum, with melanocytes interspersed. Langerhans cells and T resident memory cells (Trm) can also be found in the epidermis. It is approximately 0.2 mm thick. The dermis (approximately 0.8 mm thick) has a more diverse collection of cells including structural cells such as fibroblasts, and immune cells such as dermal dendritic cells (DCs) and macrophages, CD4+ and CD8+ Trm, mast cells and Foxp3+ T regulatory cells (Tregs), which are often located near the hair follicle. The final layer of the skin is the subcutaneous fat, which is primarily composed of adipocytes.

We note that several recent investigators have detailed the mechanisms through which skin exposures can have systemic effects on the immune system and its tertiary components. For instance:

Kabashima et al. state “Upon inflammation, various immune cells pass through, reside in or are recruited to the skin to orchestrate diverse cutaneous immune responses. To achieve this, immune cells interact with each other and even communicate with non-immune cells, including peripheral nerves and the microbiota. Immunologically important anatomical sites, such as skin appendages (for example, hair follicles and sweat glands) or postcapillary venules, act as special portal sites for immune cells and for establishing tertiary lymphoid structures, including inducible skin-associated lymphoid tissue.” [108] For more than 3 decades [109], scientists have appreciated that although the skin lacks direct access to the blood or lymphatic circulation, it contains a number of immune-competent cells and can be considered a part of the immune system, governing responses to infections or other potentially threatening agents. These cells include: Langerhans cells, the macrophage-like antigen-presenting cells of the epidermis; keratinocytes, epithelial cells with immune properties; dendritic epidermal T lymphocytes, resident cells that may serve as a primitive T-cell immune surveillance system; epidermotropic lymphocytes, migrants from vessels in the dermis; and melanocytes, epidermal pigment cells with immune properties.

Moreover, it is puzzling to see that the current FCC proposal does not recognize the special vulnerability of the eye to RF, especially the frequencies that will be used in 5G. The skin over the eye is in fact permeable by millimeter waves because it is the thinnest on the body (half a millimeter). In contrast, skin is thickest on the palms of the hands and soles of the feet (1.5 millimeters).

Given the evidence described above, the long term effects of heightened absorption in the skin of 5G and other RF signals cannot be ignored by the FCC. Rates of growth of melanocytes or other precancerous lesions of the skin could certainly be accelerated through exposures to 5G or other RF frequencies, which could also have important immunological effects. Moreover it is understood that in addition to thermoregulation, the skin affects a cascade of responses that are subject to numerous changes with age, as indicated in this figure below.

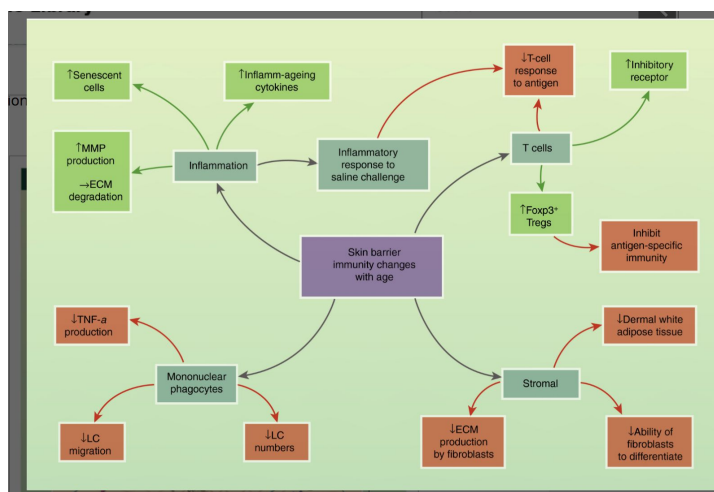


Figure 3 - Skin barrier immunity changes with age. Schematic showing the effect of age on skin-resident populations. Negative/inhibitory effects are shown in red and positive/enhancing effects are shown in green. ECM, extracellular matrix; LC, Langerhans cell; MMP, matrix metalloproteinases; Treg, T regulatory cells

Millimeter wave medical devices have an effect on internal organs, not just skin

Medical applications of millimeter waves (MMW) utilize a frequency range 42 -100 GHz. This technology (millimeter wave therapy) has been developed within the last 50 years and several reviews [110], [111] show that short exposures of skin in certain specific spots with MMW creates a strong beneficial effect in internal organs (like lung and heart). However, if these spots on skin are irradiated longer periods of time the effect turns harmful [112]. Manufacturers of these medical devices even warn about using MMW treatments longer than 2 hours per day. From this perspective, running a 5G cell tower 24/7 at similar frequency range as medical MMW devices can be deemed a health hazard insofar as it deviates from MMW medical device manufacturers' safety instructions. Therefore, chronic exposure of MMW frequencies should be tested in chronic exposure set-up using above mentioned frequencies before allowing 5G cell towers, micro cells, end-gadgets and IoT-devices to operate 24/7 in MMW-range.

Association of sunlight with Serum Vitamin D levels also indicates that skin exposure affects overall health

It is well known that those living in sunnier climates tend to have higher levels of serum Vitamin D [113]. In fact, Scandinavian countries fortify their foods with Vitamin D in an effort to combat problems created by their lack of sunlight in the winter. The skin plays a major role in the process of Vitamin D production which takes place through the liver and kidneys as a result of superficial exposure to ultraviolet radiation B that affects systemic production of serum levels. A growing number of diseases are linked with Vitamin D deficiency, including breast cancer, multiple sclerosis, overall mortality, cardiovascular disease, depression and even schizophrenia. Seasonal affective disorder (SAD) has long been recognized to respond to exposures to artificial sunlight that affect major neurotransmitters involved in depression.

Many National Responses to Current Safety Standards are more stringent than ICNIRP

The FCC proposal does not address the fact that other nations have also proposed more stringent approaches to RF especially regarding children [109]. These include:

- **Russia** - The Russian Ministry of Health and the Russian National Committee for Protection Against Non-ionizing Radiation which have just released new recommendations for children now moving to online learning at home on computers. They recommend limiting overall screen time and using wired rather than Wi-Fi. They also warn against using smartphones for educational purposes.
- The exposure limits in Russia, China, Switzerland and Italy are 100 times lower than those proposed by the FCC [17].
- **France** - ANSES has continued to carry out studies of phones in the real world under real world exposures that simulate phones stored in the pocket or on the body. France has banned Wi-Fi in kindergarten and restricts Wi-Fi in school by having the wireless off as the default setting. Teachers have wired (not wireless) computers for internet access. The country launched public health initiatives on how to reduce cell phone radiation exposure years ago.
- **Israel** - They have banned Wi-Fi in nursery schools, restricted Wi-Fi in elementary schools, banned cell phones in classrooms and have a national agency educating citizens on how to reduce cell phone radiation. In 2016, the mayor of Haifa called for wired networks in lieu of wireless in schools.
- **Cyprus** - They have also removed Wi-Fi from elementary classrooms and have a strong public awareness campaign educating parents, teenagers and pregnant women.
- **Belgium** - Banned cell phones manufactured for young children.
- **Italy** - Mayors of several Northern cities as well as some of the Districts of Rome have long called for wired networks to replace Wi-Fi networks in schools in cities such as Borgofranco d'Ivrea, Italy.

- **French Polynesia** - they have also removed Wi-Fi from nursery schools and like Cyprus, launched a major public health campaign.

Other Comments regarding lack of specificity of what 5G constitutes

We take exception to the FCC refusal to provide for routine monitoring of emissions from cellphone towers, including their maximum allowed effective radiated power, minimal vertical and horizontal distance permitted. We note that other nations have adopted such monitoring and, when merited, taken steps to remove or reduce exposures

At paragraph 108, the agency declares:

“RF Check suggests that the Commission recognize that licensees alone cannot ensure compliance and that a comprehensive, uniform solution that involves all parties is necessary. RF Check proposes the creation of a database in which transmitting antennas are registered and their exposure areas calculated, with the antenna and exposure areas visually depicted. This database would be accessed and viewed by a worker at any worksite via smartphone.”

We agree with RF Check that there should be a publicly accessible database with regularly monitored RF levels showing both peak and average SAR, with the former reflecting shortest averaging times.

Evidence is clear that repeated exposures to changing modulated peaks in exposure to weak RF can have major impacts on health. Absent access to real-time monitoring, it will not be possible to evaluate public health and environmental impacts. The assumption that such exposure has no effect has led to a policy where there are no measurements widely available to study whether or not such an effect is occurring.

We note with interest that Israel [11] among other nations has a policy of regular monitoring of cell tower emissions that can be accessed online. The public can access the position of every cell tower in Israel with an interactive map that shows the area of coverage and where signals will be strongest. Of course, it is important with such a system to include power wattage that can be monitored as well. We believe it is critical to institute averaging periods that correspond to potential biological impacts. Thus, peak measurements are more important than for instance a 24 hr average, with the latter being meaningless. It will be important to report peak values as well as other measures.

Importantly, 5G is itself a phenomenon that has not been standardized as to nomenclature or frequencies, referring generally to frequencies above 5 GHz and that can range up to 100 GHz. For the new 5G networks to function completely, any new antennas will have to incorporate 4G and 3G signals along with millimeter wave frequencies [114]. While these earlier technologies currently power most devices operating in the world today, they also have been found to be carcinogenic and to damage DNA, according to the NTP [52] and the Ramazzini Institute [115], among others. Because millimeter wave frequencies cannot travel as far nor can they penetrate buildings or trees, antennas will have to be placed close to human habitation. Effectively these 5G enabled antennas will bring 3G and 4G signals previously reserved for tall towers and more remote locations into closer human contact. This has led more than 370 scientists [116] to call for a moratorium on 5G until safety studies can be carried out and biologically based standards can be developed to promote reasonable approaches to public health and safety. A similar call by the scientific community in Australia is calling for the same [117].

The U.S. Navy and NOAA object to 5G interference with astronomy and meteorology from 20,000+ approved new satellites

As we pointed out in our introduction, serious objections have been filed with the FCC concerning the space-based potential for 5G frequencies, as planned and encouraged, that will disrupt weather forecast and the earth observation satellites. According to directors at National Aeronautics and Space Agency (NASA), National Oceanic and Atmospheric Administration (NOAA), and the U.S. Navy, the FCC policies to assist 5G in flourishing in space could jeopardize the collection of vital information for weather prediction and astronomy, including the tracking of satellites [118], [119]. Commercial companies such as Space X and Amazon intend to launch up to 20,000 more satellites for a space-based 5G system working in the 24 GHz range.

Currently there are about 5,000 satellites in circulation, about half of which are 'junk', according to several resources [120]. Transmission of information from satellites, weather balloons, ocean buoys, weather radars and other technologies is conveyed by these satellites currently. Thus, if the extra 20,000 5G satellites that are envisioned by Space X and Amazon were actually launched, the transmission of information from such meteorological apparatus will suffer from considerable interference that would impact the accuracy of the forecast in relation to the observations, as measured by the "forecast skill". In fact, such launching should never occur without a proper assessment of the impact it might have in the "forecast skill", as noticed by Dr. Jordan Gerth in a letter published by The Washington Post, dated Feb. 28, [114].

Another, important aspect in this deployment is the fact that modern weather analysis relies on the profiling of atmospheric moisture, either by space-based satellites or by ground based polarization radiometers (for example those supplied by Radiometer Physics GmbH. [121]) as these have been replacing weather balloons. These devices operate, typically, in a frequency range from the ~23 GHz to ~90 GHz, and they are essentially passive instruments that use the electromagnetic emission of certain elements at characteristic frequency range in the atmosphere to infer the mentioned atmospheric profiles. In particular, the water vapour line present in the absorption spectrum of the atmosphere at 23.8 GHz will suffer considerable interference of the noise created by the proposed FCC deployment. Thus, it would render atmospheric profiling very difficult, if not impossible. Considering that those profiles are indispensable for the production of meteorological forecasts, it is expected that, once again, this satellite deployment would impact the "forecast skill".

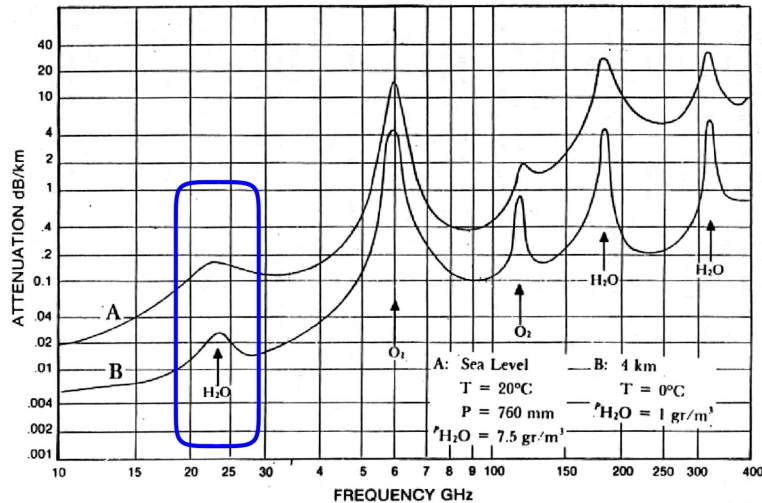


Figure 4 - The Atmospheric extinction coefficient (black line) as a function of frequency. line marked A is measured at sea level and the line B is measured at 4 km. The critical water vapour line is marked at 23.8 GHz by blue rectangle. Sampling of the critical water vapour line at 23.8 GHz would be seriously disrupted by the deployment of LEO 5G satellites using the 24 GHz band for transmission .(taken from the FCC [122])

Here we should note that the FCC has overstepped its competence in rejecting these concerns from these science-based agencies and giving priority to economic development of 5G systems over serious issues raised regarding how the planned satellites would impair the capacity to carry out reliable meteorological forecasts as well as astronomical observations critical to space missions. Please, consider that meteorological forecasts are crucial for activities that go on from primary sectors such as agriculture and fishing, renewable energy to navigation, aviation and security. In proposing policies that would damage weather prediction and astronomical observation, the FCC has not taken into account the possible consequences to food and energy chain, energy supply, etc., that could result in major disruptions in the economy worldwide.

The question then boils down to: “Are these satellites so important to our society that we could risk deployment without a proper assessment of the impact in the “forecast skill” and all its consequences?”

A final remark on this point is that using high-frequencies, especially near the frequency lines shown in Figure 4 to communicate with such a dense network of satellites, would mean that a substantial amount of the signal may be absorbed by the atmospheric water. This fact alone would render this deployment unacceptable and would have two effects that required the FCC attentions: 1) communication will be dramatically inefficient (an educated guess would give a figure of around 90 % of the signal lost); 2) the power absorbed by the atmosphere will tend to slightly increase its temperature, and as the atmosphere is a complex dynamic system, there is no way to understand what impact that heating may have on climate.

The FCC is referred to the mentioned article to complement these comments: The Washington Post published a letter, dated Feb. 28, [119] from the Commerce Secretary Wilbur Ross and NASA Administrator Jim Bridenstine urging the FCC to remove a policy paper that, to quote the letter, “would have a significant negative impact on the transmission of critical Earth science data — an American

taxpayer investment spanning decades and billions of dollars with data supporting public safety, natural disaster and weather forecasting."

The letter said the FCC posted the proposal when "there was no consensus in the interagency on this topic."

It requested the FCC take down the proposal "immediately" ahead of a scheduled meeting convened by NASA "to continue the long-standing interagency reconciliation process on this important topic."

On 8th March [123], the FCC replied to the letter and summarily rejected the request. It claimed that it had already "engaged extensively" with Commerce, NOAA and NASA, and that matters had been settled by the State Department, the appointed "arbiter." This is an astonishing usurpation of scientific competence and authority by an agency that has no expertise in either weather prediction or astronomy. It is tempting to ask if you would want an FCC official to be commanding Space Force or SpaceX rockets. Moreover, having the State Department rule over the matter seems ill-advised. While the gist of our comments deal with serious health and environmental concerns, issues of meteorology and astronomy merit the most serious concern, especially given the potential for irreversible damage to systems that have taken decades and billions of dollars to build.

Suggested Steps

The FCC has failed to take full cognizance of peer-reviewed published scientific evidence submitted to it regarding several other relevant dockets (see Appendix 1) and has also failed to duly consider that other national governments and expert groups have developed protective policies and standards based on the view that pulsed signals are much more biologically active than continuous signals and on the understanding that children and pregnant women require greater protection than others. Biologically based approaches should be developed that seek to achieve exposures that are as low as technically feasible, similar to those adopted for water contaminants at levels deemed As Low as Reasonably Achievable (ALARA).

Originally developed for radiation safety in the 1980s, ALARA [107] has since been advanced by EHT, ORSAA and others as a way to encourage technology to employ hardware and software to achieve the lowest radiation levels necessary for operation.

The outdated and inadequate SAR and SAM standards should be discarded immediately in favour of measures of radiative ambient power density. The measure for how high these should be governed by the ALARA principle described below.

We also note that for years anatomically-based, highly-detailed whole-body models of humans throughout the age range including models of specific major organs, termed the Virtual Family (VF), have been employed to assess potential medical and surgical devices. Carried out in collaboration between the U.S. Food and Drug Administration (FDA), the Foundation for Research on Information Technologies in Society (IT'IS Foundation, Zürich, Switzerland), Schmid & Partner Engineering AG (SPEAG, Zurich, Switzerland), the Hospital of the Friedrich-Alexander-University, Erlangen, Germany, and Siemens Medical Solutions, Erlangen, Germany, the VF project was developed from MRI models of healthy volunteers. Swiss researchers have refined this further with ZMT Zurich MedTech AG (ZMT, Zurich, Switzerland) and the IT'IS Foundation have sponsored the release of VF 2.0 and 3.0 models.

The FDA website depicts the VF models as follows [124] : “VF models are used for electromagnetic, thermal, acoustic, and computational fluid dynamics (CFD) simulations. Examples of applications of electromagnetic and thermal simulations are the assessment of the safety of active and passive medical implants in an MRI environment and the evaluation of the safety and efficacy of ablation devices. Electromagnetic and thermal simulations have been performed on the entire set of VF models and additional models of children to calculate the whole-body averaged and local specific absorption rate (SAR) during exposure to 1.5 and 3T whole-body MRI coils. These electromagnetic and thermal simulations have also allowed the evaluation of the safety of multi-channel transmit radio frequency whole-body MRI coils. An example of application of electromagnetic and CFD simulations is the assessment of the applicability of the magneto-hemodynamic effect as a biomarker for cardiac output⁶. Acoustic simulations have been performed to assess the impact of the human anatomy on the focus location, shape, and intensity of ultrasound waves during focused ultrasound treatment⁷. As of the end of 2014, the VF was used in more than 120 medical device submissions to FDA and was cited more than 180 times in peer-reviewed literature.”

We ask the agency to ponder this: *If VF models are used for electromagnetic, thermal, acoustic, and computational fluid dynamics (CFD) simulations, why cannot these same models be used to evaluate biological absorption and impacts of RF from cell phones and other wireless devices and set standards to reduce that exposure to the lowest feasible levels?*

EHT, along with other public health experts, have consistently called for biologically based standards that would rest on ALARA. This approach would approve those technologies that show clear evidence of limiting exposures through innovations in hardware (such as antenna design) as well as innovations in operating systems (such as default frequency of updating and downloading, and automatically going to sleep mode when in various states of relative inactivity or as sensed by accelerometers--that automatically sense when a device is next to a human body).

Although there is a dearth of research into what are truly acceptable levels of ambient power density for the frequencies of interest below which there appears to be little or no biological impact, the authors note important research by Zothansiam et al. [46] . This research documents and relates DNA damage and antioxidant status in populations living in the immediate vicinity (less than 80 m) of cell phone towers compared to those, a control population, living far from the same towers (more than 300 m). **This study, professionally and thoroughly done, shows that for ambient power densities of 0.014 - 0.065 mW/m², measured for the control population, the traces of such biological damage are greatly reduced, compared to the exposed population. As a start for an ALARA standard one could consider this power density range for not just ambient exposure, but as an acceptable level of device exposure.**

Further, we wholeheartedly agree with the AAP and other experts in pediatric neurology [125] from many nations that young children should not routinely be exposed to these devices or expected to use them for educational purposes.

As pointed out in a recent review on the physiological effect of millimeter waves on human skin [126], there have only been 99 studies covering the proposed frequency band for 5G. In short there is an urgent need for independent research.

In that regard, the FCC should undertake a major public educational campaign with the industry to make information about current protocols including distances from the body that phones and tablets are tested broadly known. Further, efforts should be launched to promote wired access in schools and

homes and to encourage young parents to always download information from wireless devices and put devices on airplane mode before handing them to children. Prompted by the lawsuit from the University of California Berkeley, Environmental Law Clinic and Dr. Joel Moskowitz of UC Berkeley, the State of California attempted to provide a broad educational program to promote awareness of the reasons why and methods how to reduce exposures to wireless radiation. First proposed in 2009, based on guidance developed by the University of Pittsburgh Cancer Institute Center for Environmental Oncology, the program included a major educational program to staff and their families. After some 27 revisions, the final program released by California's Health Department was substantially watered down but does include guidance about why and how to reduce wireless radiation, especially for children, pregnant women and those with pre-existing conditions [127].

We hope that the States will also partner with industry to expand efforts to promote better public, employer and worker understanding of the need to reduce exposures to wireless radiation. We note that, for more than two decades, no major secondary insurer will provide coverage for any health or environmental damages from cell phones or other wireless radiation. In several European nations, harmed individuals have succeeded in obtaining major financial damages from their former employers for having required them to use phones as part of their work [28], [128]. As such lawsuits mount, they may also add to the pressure for reform. **As the weight of litigation mounts, the question will be asked: why has regulation ignored the warnings of science ?**

Conclusion

The FCC proposed changes in rules regarding human exposure to RF/EMF fail to acknowledge the state of the art of the published peer-reviewed science, developments of more stringent standards by other nations, and relies on outdated assumptions and methods for testing phones and other wireless devices. Further the proposal ignores more than 60 peer-reviewed submissions from EHT-associated scientists and several hundreds from others from a number of experts that have long worked in the field, including A. Blake Levitt, the scientists of the ORSAA, Phonegate Alerte, The *Bioinitiative Report*, Environmental Grassroots and many others. Since 2013, the agency itself has had less than 1 full time equivalent staff member assigned to the duty of reviewing this and related dockets. Further, the agency has never conducted a systematic inventory of the materials submitted since from 2013-to the end of 2019 when indication of this action was first given, has not tasked consultants with carrying out a thorough review of the submitted material and currently has an unworkable database of all the records submitted thus far, despite its obligation to maintain a transparent indication of relevant efforts undertaken regarding this proposal.

Moreover, the agency is out of touch with the substantial body of scientists and other government experts that concur that there is serious evidence of nonthermal effects in animals and humans, including the capacity of current levels of radiation from cellphone and other wireless radiation to cause multiple forms of cancer, damage DNA, impair reproduction, interfere with sleep and memory, disturb production of melatonin, affect cardiac function, affect the nervous system, and a number of other serious neurological and developmental impacts.

We recommend a halt to the roll-out of the fifth generation, 5G, for telecommunication and for the expansion of wireless networks until hazards for human health and the environment of these new frequencies and the densification of networks have been fully investigated by scientists independent from industry. 5G paired with densification of 4G antennas will substantially increase environmental

exposure to radiofrequency electromagnetic fields. We also recommend federally developed safety limits based on empirical scientific studies that have thoroughly investigated long term effects to humans, animals, insects, trees and the environment. Federal safety limits should be based on adequate data from animal and human research, not based on assumptions.

In 2014, the Safra Center for Ethics of Harvard Law School issued a report that may explain why the FCC has been so lax in its review of this serious matter affecting every man, woman and child in this nation and around the world. The report by Norman Alster for the Center concluded that the FCC is a captured agency, noting that its leaders have regularly been recruited from and returned to the industry that it regulates with little capacity for independent review and evaluation. Indeed the technical demands of the issues with which the FCC must regularly grapple mean that few are trained or equipped to comprehend the complexities of the numerous issues with which the agency is charged. The systematic shrinking of federal funds for research on this topic, fueled in large part by lobbying from one of the most profitable industries in the world--the telecom industry-- also speaks legions about why the government has consistently failed to ask important questions regarding the biological and environmental reverberations of this growing technology and provide the means to find their answers. As an old proverb runs--if you don't want to know, don't ask.

We urge the FCC to ask the hard questions that it cannot answer at this time. What are the impacts on public health and the environment of the unprecedented expansion of this industry? What will be the ERP from 5G enabled antennas that will include 3G and 4G operating antennas that can be installed within yards of residences around the nation? What are the consequences for future workforce development of producing young children that can and are encouraged to swipe before they talk or walk? What are the social and emotional consequences of encouraging children to rely on computers, rather than learn how to work as teams to solve problems? What are the repercussions of encouraging digital devices to serve as intermediaries between young parents and their children? Fundamentally, do we have evidence of the safety of wireless radiation?

We are chiefly concerned about public health and the environment. We concur with the AAP that young children are at highest risk from medical and behavioral problems. We also raise a warning flag, appreciating that if 5G does further impair honeybees and 2,000 other pollinators, then agriculture itself is at risk. Others have documented that trees and agriculture are directly vulnerable to this radiation .

The burden of proof the agency is demanding of us appears to be inherently unreasonable. We are asked to prove that the ear should not be treated like the hand or foot. We are asked to show why children should not be considered simply small adults? Effectively, the only proof of harm that would be deemed sufficient in this record would be that created by those who have directly incurred damage to their own health, literally become the bodies of evidence through their documented suffering as a result of EMF exposures.

We urge that the agency revise its approach to evaluating cellphones and other wireless devices to take into account the body of peer-reviewed scientific evidence in EMF-Portal [23]and ORSAA [34] At this point, evidence has accumulated of serious health impacts in children, in men of reproductive age, as well as a growing body of experimental studies showing clear evidence that cellphone and other wireless radiation can damage memory, learning, behavior, and the capacity of men to father healthy families if they chose to do so. Therefore, the rules for evaluating human exposure should be changed

to a biologically-based standard that will be developed in consultation with other national health and communication experts. Until that is accomplished, we advise adoption of the concept of ALARA, in parallel with the positions taken by a number of other expert groups.

Appendix I: List of EHT submissions to prior relevant dockets

All Links hereby incorporated by reference.

Date Received	Proceeding ID	FCC Upload Filing URL	Name of EHT affiliated Filer(s)	Total Page Count
9/13/19	13-39,13-84,03-137	10913927726988	Environmental Health Trust	29
9/13/19	13-39,13-84,03-137	1091340619273	Environmental Health Trust	51
9/13/19	13-39,13-84,03-137	10913296696567	Environmental Health Trust	34
9/13/19	13-39,13-84,03-137	109131837001830	Environmental Health Trust	33
9/13/19	13-39,13-84,03-137	1091314126731	Environmental Health Trust	21
9/13/19	13-39,13-84,03-137	10913128473042	Environmental Health Trust	26
9/13/19	13-39,13-84,03-137	10913119016386	Environmental Health Trust	25
9/13/19	13-39,13-84,03-137	109130755017293	Environmental Health Trust	27
6/17/19	19-71	1061728670863	Environmental Health Trust	35

6/17/19	19-71	10617092931536	Environmental Health Trust	13
6/3/19	19-71,19-36	10603967407328	Environmental Health Trust	35
4/29/19	13-84,03-137	10429038011618	Environmental Health Trust	6
4/29/19	13-84,03-137	10429016089243	Environmental Health Trust	44
12/10/18	13-84,03-137	1210030663890	Environmental Health Trust	47
10/1/18	13-84,03-137	1001332406626	Environmental Health Trust	55
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5/31/18	17-79	10531586230040	Environmental Health Trust	115
9/6/17	13-84,03-137	1090617265110	Environmental Health Trust	1
9/6/17	13-84,03-137	10906049223245	Environmental Health Trust	17
9/6/17	13-84,03-137	10906001218058	Environmental Health Trust	57
7/11/17	17-79,15-180,17-84,13-84,03-137	10711815002508	Environmental Health Trust	191
6/29/17	17-79,15-180,13-84,03-137	106292067109730	Environmental Health Trust	14
6/7/17	17-79,13-84,15-180	10607967426295	Environmental Health Trust	46

6/7/17	17-79,15-180,13-84	106070048305926	Environmental Health Trust	134
2/20/17	16-421	102200773116598	Environmental Health Trust	787
7/18/16	13-84,03-137	10718080685516	Environmental Health Trust	59
7/11/16	14-177,15-256,10-112,97-95,13-84	10709642227609	Environmental Health Trust	1397
7/7/16	13-84,03-137	10707225417557	Environmental Health Trust	897
7/7/16	13-84,03-137	1070786836035	Environmental Health Trust	597
7/7/16	13-84,03-137	1070795887708	Environmental Health Trust	997
7/7/16	13-84,03-137	10707304111787	Environmental Health Trust	152
7/7/16	13-84,03-137	10707243848074	Environmental Health Trust	523
6/13/16	03-137	60002004449	Environmental Health Trust	7
6/13/16	13-84	60002004448	Environmental Health Trust	7
2/7/13	13-84	6017339199	Toni Stein on behalf of Environmental Health Trust PART 1	4
2/7/13	13-84	6017339198	Toni Stein on behalf of Environmental Health Trust PART 1	11

2/7/13	13-84	6017339197	Toni Stein on behalf of Environmental Health Trust PART 1	11
2/7/13	13-84	6017339196	Toni Stein on behalf of Environmental Health Trust PART 1	37
2/7/13	13-84	6017339194	Toni Stein on behalf of Environmental Health Trust PART 1	4
2/7/13	03-137	6017162987	Toni Stein on behalf of Environmental Health Trust PART 1	4
2/7/13	03-137	6017162984	Toni Stein on behalf of Environmental Health Trust PART 1	11
2/7/13	12-357	6017162980	Toni Stein on behalf of Environmental Health Trust PART 1	11
2/7/13	03-137	6017162979	Toni Stein on behalf of Environmental Health Trust PART 1	11
2/7/13	03-137	6017162978	Toni Stein on behalf of Environmental Health Trust PART 1	37
2/7/13	12-357	6017162977	Toni Stein on behalf of Environmental Health Trust PART 1	37
2/7/13	03-137	6017162954	Toni Stein on behalf of Environmental Health Trust PART 1	4
2/7/13	12-357	6017162953	Toni Stein on behalf of Environmental Health Trust PART 1	4

2/7/13	12-357	6017162982	Toni Stein on behalf of Environmental Health Trust PART 1	-
2/7/13	13-84	6017339193	Toni Stein on behalf of Environmental Health Trust	17
2/7/13	03-137	6017162862	Toni Stein on behalf of Environmental Health Trust	17
2/7/13	12-357	6017162861	Toni Stein on behalf of Environmental Health Trust	17
2/7/13	13-84	6017339179	Toni Stein on behalf of Environmental Health Trust	8
2/7/13	13-84	6017339176	Toni Stein on behalf of Environmental Health Trust	23
2/7/13	12-357	6017162736	Toni Stein on behalf of Environmental Health Trust	8
2/7/13	12-357	6017162732	Toni Stein on behalf of Environmental Health Trust	23
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9/16/13	13-84	6017467408	Devra Lee Davis PhD MPH	66
2/4/13	13-84	6017338973	Devra Davis	36

2/4/13	03-137	6017161777	Devra Davis	36
Date Received	Proceeding ID	Filing URL	Name of Filer(s)	Total Page Count
9/16/13	13-84	6017467408	Devra Lee Davis PhD MPH	66
Date Received	Proceeding ID	Filing URL	Name of Filer(s)	Total Page Count
11/25/16	16-39	1125315211630	L. Lloyd Morgan	-
11/18/13	13-84	6017477112	L. Lloyd Morgan	87
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6/1/20	19-226	10531821017710	Theodora Scarato	43
6/1/20	19-226	10531002724083	Theodora Scarato	110
4/17/18	13-84	10417871820142	Theodora Scarato	135
4/17/18	13-84	10417078206082	Theodora Scarato	34

12/20/16	16-399	122037800466	Theodora Scarato	1122
12/20/16	16-1	12201878924630	Theodora Scarato	-
9/3/13	13-84	6017465938	Theodora Scarato	12
9/3/13	13-84	6017465591	Theodora Scarato	12
2/5/13	13-84	6017339061	Theodora Scarato	1
2/5/13	12-357	6017162276	Theodora Scarato	1
2/5/13	03-137	6017162275	Theodora Scarato	1
Date Received	Proceeding ID	Filing URL	Name of Filer(s)	Total Page Count
5/14/20	19-226	1051420599254	Ronald L. Melnick	10
Date Received	Proceeding ID	Filing URL	Name of Filer(s)	Total Page Count
6/18/19	19-71	1061840066469	angela tsiang	8
6/18/19	19-71	10618142781486 5	Angela Tsiang	-

9/26/16	14-177,15-256,RM-11664,10-112,97-95,13-84	109262631324881	Angela Tsiang	-
7/14/16	10-112	1071463140829	Angela Tsiang	10
7/14/16	15-256	107140608225937	Angela Tsiang	10
7/14/16	97-95	1071422961888	Angela Tsiang	10
7/14/16	14-177,13-84	10714467523076	Angela Tsiang	10
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8/11/17	17-108	191082283432884	Jeromy Johnson	-
5/8/17	17-108	10508181876483	Jeromy Johnson	-
4/26/16	14-28	60001671669	Jeromy Johnson	-
3/5/13	13-84	6017339270	Jeromy Johnson	1
3/5/13	12-357	6017166856	Jeromy Johnson	1
3/5/13	03-137	6017166844	Jeromy Johnson	1
6/21/12	09-182	6017075356	Jeromy Johnson	-

6/21/12	09-182	6017075328	Jeromy Johnson	-
6/21/12	09-182	6017075312	Jeromy Johnson	-
6/21/12	09-182	6017075305	Jeromy Johnson	-
6/21/12	09-182	6017075267	Jeromy Johnson	-
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4/10/14	12-353	6017611578	The EMR Policy Institute	10
2/3/14	13-32	6017587308	The EMR Policy Institute	6
2/3/14	11-59	6017587307	The EMR Policy Institute	6
2/3/14	13-238	6017587306	The EMR Policy Institute	6
11/18/13	03-137	6017477201	The EMR Policy Institute	55
11/18/13	13-84	6017477200	The EMR Policy Institute	55
11/18/13	03-137	6017477095	The EMR Policy Institute	6
11/18/13	03-137	6017476994	The EMR Policy Institute	6

9/3/13	03-137	6017465392	The EMR Policy Institute	67
9/3/13	13-84	6017465391	The EMR Policy Institute	78
9/3/13	03-137	6017465390	The EMR Policy Institute	78
9/3/13	13-84	6017465388	The EMR Policy Institute	77
9/3/13	03-137	6017465387	The EMR Policy Institute	77
9/3/13	13-84	6017465393	The EMR Policy Institute	-
3/7/13	13-84	6017339323	The EMR Policy Institute	4
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3/7/13	12-357	6017167065	The EMR Policy Institute	4
3/7/13	03-137	6017167064	The EMR Policy Institute	4
3/7/13	03-137	6017167063	The EMR Policy Institute	54
3/7/13	12-357	6017167060	The EMR Policy Institute	19
3/7/13	03-137	6017167059	The EMR Policy Institute	19
3/7/13	13-84	6017339322	The EMR Policy Institute	-

2/5/13	12-357	6017162168	The EMR Policy Institute	17
2/5/13	03-137	6017162163	The EMR Policy Institute	17
2/5/13	13-84	6017339024	The EMR Policy Institute	-
5/23/11	03-109	6016786274	The EMR Policy Institute	17
5/23/11	96-45	6016786273	The EMR Policy Institute	17
5/23/11	01-92	6016786272	The EMR Policy Institute	17
5/23/11	05-337	6016786271	The EMR Policy Institute	17
5/23/11	07-135	6016786270	The EMR Policy Institute	17
5/23/11	09-51	6016786269	The EMR Policy Institute	17
5/23/11	10-90	6016786268	The EMR Policy Institute	17
5/23/11	11-13	6016786267	The EMR Policy Institute	17
4/18/11	11-13	6016376607	The EMR Policy Institute	71
4/18/11	03-109	6016376606	The EMR Policy Institute	71
4/18/11	96-45	6016376605	The EMR Policy Institute	71

4/18/11	01-92	6016376604	The EMR Policy Institute	71
4/18/11	05-337	6016376603	The EMR Policy Institute	71
4/18/11	07-135	6016376602	The EMR Policy Institute	71
4/18/11	10-90	6016376601	The EMR Policy Institute	71
4/18/11	09-51	6016376600	The EMR Policy Institute	71
4/18/11	11-13	6016376594	The EMR Policy Institute	23
4/18/11	03-109	6016376593	The EMR Policy Institute	23
4/18/11	96-45	6016376592	The EMR Policy Institute	23
4/18/11	01-92	6016376591	The EMR Policy Institute	23
4/18/11	05-337	6016376590	The EMR Policy Institute	23
4/18/11	07-135	6016376589	The EMR Policy Institute	23
4/18/11	10-90	6016376588	The EMR Policy Institute	23
4/18/11	09-51	6016376572	The EMR Policy Institute	23
4/18/11	11-13	6016376555	The EMR Policy Institute	172

4/18/11	03-109	6016376554	The EMR Policy Institute	172
4/18/11	96-45	6016376553	The EMR Policy Institute	172
4/18/11	01-92	6016376552	The EMR Policy Institute	172
4/18/11	05-337	6016376551	The EMR Policy Institute	172
4/18/11	07-135	6016376550	The EMR Policy Institute	172
4/18/11	10-90	6016376549	The EMR Policy Institute	172
4/18/11	09-51	6016376543	The EMR Policy Institute	172
4/18/11	11-13	6016376524	The EMR Policy Institute	143
4/18/11	03-109	6016376523	The EMR Policy Institute	143
4/18/11	96-45	6016376522	The EMR Policy Institute	143
4/18/11	01-92	6016376521	The EMR Policy Institute	143
4/18/11	05-337	6016376520	The EMR Policy Institute	143
4/18/11	07-135	6016376519	The EMR Policy Institute	143
4/18/11	10-90	6016376518	The EMR Policy Institute	143

4/18/11	09-51	6016376503	The EMR Policy Institute	143
4/18/11	11-13	6016376491	The EMR Policy Institute	48
4/18/11	03-109	6016376490	The EMR Policy Institute	48
4/18/11	96-45	6016376489	The EMR Policy Institute	48
4/18/11	01-92	6016376488	The EMR Policy Institute	48
4/18/11	05-337	6016376487	The EMR Policy Institute	48
4/18/11	07-135	6016376486	The EMR Policy Institute	48
4/18/11	10-90	6016376485	The EMR Policy Institute	48
4/18/11	09-51	6016376471	The EMR Policy Institute	48
4/18/11	11-13	6016376296	The EMR Policy Institute	6
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4/18/11	96-45	6016376294	The EMR Policy Institute	6
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4/18/11	05-337	6016376292	The EMR Policy Institute	6

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4/18/11	10-90	6016376290	The EMR Policy Institute	6
4/18/11	09-51	6016376277	The EMR Policy Institute	6
8/16/10	10-120	6015851423	The EMR Policy Institute	13
7/20/09	09-51	6015069759	The EMR Policy Institute	94
6/8/09	09-51	5515364508	The EMR Policy Institute	485
6/8/09	09-51	5515364452	The EMR Policy Institute	374
6/8/09	09-51	5515364342	The EMR Policy Institute	257
9/29/08	08-165	5515320020	The EMR Policy Institute	53
8/8/08	08-95	5515185669	The EMR Policy Institute	67
12/6/06	03-187	5513861747	The EMR Policy Institute	28
12/6/06	06-164	5513861740	The EMR Policy Institute	28
3/6/06	02-353	5513482612	EMR Policy Institute	2
3/6/06	04-356	5513482611	EMR Policy Institute	2

3/6/06	02-353	5513482420	EMR Policy Institute	2
3/6/06	04-356	5513482419	EMR Policy Institute	2
11/18/04	04-356	5512035363	The EMR Policy Institute	6
12/8/03	03-137	5510444038	The EMR Policy Institute	20
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2/12/13	13-84	6017339206	Antoinette Stein	12
2/12/13	12-357	6017163528	Antoinette Stein	12
2/12/13	03-137	6017163527	Antoinette Stein	12
2/7/13	13-84	6017339191	Antoinette Stein	139
2/7/13	13-84	6017339174	Antoinette Stein	8
2/7/13	12-357	6017162760	Antoinette Stein	139
2/7/13	12-357	6017162731	Antoinette Stein	8
2/7/13	03-137	6017162728	Antoinette Stein	8

Appendix 2: Worldwide governmental actions on cell phones and wireless radiation limits

Please see External Attachment of Appendix 2.

Appendix 3: Comparisons of materials reviewed by ICNIRP/FDA, ARPANSA, and ORSAA

The following extract is taken from the " [124]

Table 1. Comparison of available Epidemiological studies on wireless technology.

	FDA Report (Cancer only)	ARPANSA TRS-164 (Cancer only)	ORSAA (Cancer only)	ORSAA Other Health Studies
Demonstrates statistical association in user groups. Effect studies	22	12	37	50
Demonstrates statistical association in user groups. "No Effect" Studies	25	14	27	9
Demonstrates statistical association in user groups. "Uncertain Effect" Studies	11	8	14	9
Total	58	34	78	68

The conclusion is very clear. The selection of papers in the FDA report is inadequate and unrepresentative of the available literature.

This recent review by **Pareja-Peña F et al. 2020**, [126] of the 400 MHz – 3 GHz radiofrequency electromagnetic field influence on brain tumor induction is a much more balanced review.

***In-vivo* Animal Studies (Genotoxicity/Carcinogenicity and Tumorigenesis)**

I have reviewed the *in-vivo* animal studies cited in the FDA report and compared these with the ORSAA database records, as follows:

The FDA report reviewed 37 studies and the comparison with the ORSAA database is in **Table 2**. The period used to select studies was from 2008 to 2018 (01/01/2008 to 31/12/2018) as stated in the FDA report.

Table 2: *In-vivo* animal studies in FDA report versus ORSAA database.

Study type	FDA Report	ORSAA database
Effect	23	43
No Effect	4	5
Uncertain Effect	8	7
NESS (Dosimetry & Setup studies)	2	Didn't collate
Total	37	55

It is clear that the FDA report reviewed only about half of the available scientific papers.

Even with their poor quality review of 37 papers, the trend is clear: the *in-vivo* experimental animal studies show overwhelming genotoxicity resulting from RF exposures.

Once again, the non-cancer bioeffects are omitted in the FDA review. The bioeffects that need to be considered are listed below in their respective categories. Effects found in any of these categories have the potential for long-term chronic health implications. The glaring question is 'Why has the FDA ignored these subject areas?':

- Altered Electrophysiology
- Altered Enzyme Activity
- Altered Protein Levels
- Audiological Effects
- Autonomic Nervous System Effect
- Cardiovascular Effects
- Cell Membrane Effects

- Cellular Signaling Effect
- Central Nervous System Effects
- Circulatory System Effects
- Dermal Effects
- Gene Expression Changes
- Growth/Development Effects
- Learning Effects
- Mitochondrial Effects
- Neurodegeneration
- Neurological System Effects
- Neurotransmitter Effect
- Ocular Effects
- Pregnancy Effects
- Renal Effects
- Salivary Gland Effects
- Skeletal Effects
- Sleep Effects
- Thyroid Effects

CONCLUSION

While the FDA report purports to be a scientific assessment, it falls short in many respects. I conclude that this is just another political report trying to justify the rollout of further wireless technology. We are rolling out wireless 5G technologies without pre-market health testing and this is an unethical experiment on large population groups and the environment. This is not how a reputable risk management approach works. For example, when considering the health risks of ionising radiation at low doses (below 100 mSv), there are biological effects, but no proven health effects. In this case, the International Commission on Radiological Protection ICRP, apply risk management principles such As Low As Reasonably Achievable (ALARA). This principle means that we do the following:

- design equipment to minimise exposure to users;
- administratively advise users on the safe use of devices;
- use alternative methods of service delivery to limit exposure.

In Health and Safety management, the “Hierarchy of Controls” for dealing with risks are:

1. elimination
2. substitution

3. engineering controls
4. administrative controls
5. personal protective equipment.

These philosophies of protection are completely absent from the rollout of wireless technology. This is even more important because man-made EMF, unlike low dose ionising radiation, is not found in our environment. Life on earth has not biologically evolved with this man-made pulsed EMF. ICNIRP statements that a short-term (6 minute) thermal guideline protects everyone are reckless and negligent.

The current research on existing wireless technologies tells us clearly that we should be taking an approach that reduces exposure, not one which increases exposure. This recommendation includes environmental levels.

European Parliament Reports and Memorandum.

Report | Doc. 12608 | 06 May 2011

[The potential dangers of electromagnetic fields and their effect on the environment](#)

[B. Explanatory memorandum by Mr Huss, rapporteur](#)

Excerpts from the memorandum regarding ICNIRP

19. To back up their argument, the experts quoted the scientific assessments carried out by associations such as the International Committee on Non-Ionisation Radiation Protection (ICNIRP), a small private NGO near Munich, or by official organisations: the World

Health Organization, the European Commission and a number of national protection agencies. It appears that these European and national organisations or international bodies have based their thinking on the threshold values and recommendations advocated by the ICNIRP when that private association was set up near Munich at the beginning of the 1990s.

21. The representative of the European Environment Agency in Copenhagen, an official advisory body to the European Union, stressed the importance of the precautionary principle written into the European treaties and accordingly pointed to the need for effective preventive measures to protect human health and avoid painful health issues or scandals of the kind already experienced over asbestos, tobacco smoking, lead and PCBs (polychlorobiphenyls), to name but a few. He presented a convincing analysis of the scientific assessment methods currently used and the different levels of evidence to conclude, on the basis of the "Bioinitiative" scientific report and other more recent studies by the Ramazzini Institute in Bologna, that the indices or levels of proof were sufficient at this stage to prompt action by governments and international bodies.

29. The rapporteur underlines in this context that it is most curious, to say the least, that the applicable official threshold values for limiting the health impact of extremely low frequency electromagnetic fields

and high frequency waves were drawn up and proposed to international political institutions (WHO, European Commission, governments) by the ICNIRP, an NGO whose origin and structure are none too clear and which is furthermore suspected of having rather close links with the industries whose expansion is shaped by recommendations for maximum threshold values for the different frequencies of electromagnetic fields.

30. If most governments and safety agencies have merely contented themselves with replicating and adopting the safety recommendations advocated by the ICNIRP, this has essentially been for two reasons: in order not to impede the expansion of these new technologies with their promise of economic growth, technological progress and job creation;

and also because the political decision-makers unfortunately still have little involvement in matters of assessing technological risks for the environment and health.

44. A significant number of top scientists and researchers have banded together in a dedicated international body entitled ICEMS, "International Commission for Electromagnetic Safety", in order to carry out independent research and recommend that the precautionary principle be applied in the matter. In 2006 (Benevento Resolution) and 2008 (Venice Resolution), these scientists published instructive resolutions calling for the adoption of far tougher new safety standards and rules.

45. Scientific studies disclose athermic or biological effects of electromagnetic fields or waves on cells, the nervous system, genetics, etc., which essentially fall into three categories: biological effects influencing the metabolism, sleep, the electrocardiogram profile; effects observed in experimentation on animals or in cell cultures (in vitro); effects emerging from epidemiological studies on prolonged use of mobile telephones or on living near high voltage power lines or base stations of relay antennas.

[Serious Safety Concerns about 5G Wireless Deployment in Australia and New Zealand](#)

"Contrary to the ARPANSA claims, when we examined the limited number of studies that investigated effects of mm waves (carrier waves of 5G), we found concerning evidence. When we searched for airport screening/radar safety studies we could not find a single Australian/New Zealand investigation. Studies from elsewhere appear to have mostly found evidence of biological impact. For example, a study by researchers at Shiraz University, Iran²⁷ published in 2013, but later retracted without an expressed reason, reported a high prevalence of neuro-behavioural problems in the occupationally exposed people significantly associated with their time at work. Their test cohort of airport radar personnel exposed to mm waves (14-18 GHz) revealed neurological, behavioural and cognitive problems despite being young (33 ± 6.8 years). We contacted the authors and they informed us that their publication was retracted due to pressure from the government authorities (that researchers would face litigation unless they withdrew the publication). Their findings were similar to a number of studies that have found adverse health effects in people exposed to radar.^{28•30} Neurological problems (such as migraine, headache and dizziness) were found in exposed residential populations around military radar in a study in Cyprus with a dose response (worse closer to the radar towers).²⁸ However, the authors of this military-funded study attempted to attribute their findings to antenna visibility or aircraft noise without evidence to substantiate this claim and also ignoring a large body of evidence demonstrating that RF-EMR exposure can cause neurological symptoms. Moreover, researchers at University of Washington Medical Center

had previously reported an increased risk of testicular cancer in personnel exposed to hand-held police radar units.²⁹

Bandara P, McCredden J, May M, Weller S, Maisch D, Kelly R, Chandler T, Pockett S, Leach V and Wojcik D. [Serious Safety Concerns about 5G Wireless Deployment in Australia and New Zealand](#). Radiation Protection In Australasia 2020; 37(1):47-54.

Research papers with links submitted as reference on industry influence and conflict of interest.

- The International Journal of Oncology published [“World Health Organization, radiofrequency radiation and health – a hard nut to crack \(Review\)”](#) in 2017 detailing conflicts of interest with ICNIRP and the WHO EMF Project, both started with industry support.
- The American Journal of Industrial Medicine published [“Secret ties to industry and conflicting interests in cancer research”](#) in 2006 about industry funding of studies such as the Danish Cohort cell phone studies that are often put forward show no harm.
- Molecular and Clinical Oncology published [“Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation”](#) in 2020 published in details how ICNIRP is referred to as “a private German non-governmental organization. ICNIRP [that] relies on the evaluation only of thermal (heating) effects from RF radiation, thereby excluding a large body of published science demonstrating the detrimental effects caused by non-thermal radiation.”
- Environmental Health published [Childhood Brain Tumour Risk and Its Association With Wireless Phones: A Commentary](#) in 2011 about how a study called CEFALO on brain tumor risks for children using mobile phones” – authored by several ICNIRP scientists- did not provide assurances of safety as prompted by the study authors. In a [2019 letter](#) signed by several expert scientists the misrepresentation of the CEFALO study was deemed to “represent scientific misconduct.”
- Environmental Research published [Extremely low frequency electromagnetic fields and cancer: How source of funding affects results](#) in 2019 that found almost all government or independent studies find either a statistically significant association between magnetic field exposure and childhood leukemia, or an elevated risk “while almost all industry supported studies fail to find any significant or even suggestive association.”
- Neurological Sciences published [“Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes.”](#) in 2017 . The review of the literature and meta-analysis of case-control studies found evidence linking mobile phone use and risk of brain tumours especially in long-term users (greater than 10 years) with a significantly positive correlation- higher quality studies show a statistically significant association between mobile phone use and risk of brain tumour. “Even the source of funding was found to affect the quality of results produced by the studies.”

Please also be aware of these investigative reports on industry influence:

- [The Harvard Press Book “Captured Agency: How the Federal Communications Commission is Dominated by the Industries it Presumably Regulates”](#) by Norm Alster documents the financial ties between the US federal government’s Federal communications Commission (FCC) and how, as a result, the wireless industry has bought inordinate access to—and power over—a major US regulatory agency. [Read that here.](#)
- [“The Disinformation Campaign—And Massive Radiation Increase—Behind The 5G Rollout”](#) by Mark Hertsgaard And Mark Dowie in The Nation April 23, 2018
- [War on 5G: Amsterdam Investigation into Scientists Finds Telecom Influence by Jannes van Roermund and Paul Thacker, De Telegraaf \(Amsterdam\), Jun 2, 2020 \(English translation\)](#) on the American Council on Science and Health attacks against Prof. Moskowitz and more.
- 2020, [Is 5G Going to Kill Us](#), The New Republic by Christopher Ketcham “Modern public health calamities, from asbestos to auto safety to leaded gasoline and tobacco, often follow a predictable narrative. Industry dismisses the health risk, government regulators shrug and look away, and a beleaguered minority is left to sound the alarm”
[“Health and Cellphones: How Wireless Made Us Think Cell Phones Are Safe” Your Call, KALW 91.7FM San Francisco](#) explores “how big wireless companies used the same playbook as big oil and big tobacco to deceive the public” with guests Dr. Devra Davis and Mark Hertsgaard.
- Democracy Now: [How the Wireless Industry Convinced the Public Cellphones Are Safe & Cherry-Picked Research on Risks](#)

Investigate Europe’s Three Part Investigation on 5G

- [5G The Mass Experiment \(Part 1\)](#)
- [How Much is Safe? Finances Effect Research \(Part 2\)](#)
- [Real 5G issues overshadowed by Covid-19 conspiracy theories \(Part 3\)](#)

Appendix 4: Additional References for Children and Cell Phone Radiation.

American Academy of Pediatrics Official Letters

- [2013 AAP Letter to FCC Commissioner Mignon Clyburn and FDA Commissioner Margaret Hamburg calling for a review of RF guidelines](#)
- [2012 AAP Letter to US Representative Dennis Kucinich in Support of the Cell Phone Right to Know Act](#)
- [2012 AAP Letter to the FCC Chairman calling for the FCC to open up a review of RF guidelines](#)

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