FCC 13-39

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies	)	ET Docket No. 13-84
	)	
Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields	)	ET Docket No. 03-137
	)	

To: Office of the Secretary
Federal Communications Commission
Washington, DC 20554

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AFFIDAVIT(S) OF _B. Blake Levitt_and Henry C. Lai_

State of Connecticut, Litchfield County, USA

I, B. Blake Levitt, attest that my statements are true to the best of my knowledge.

I, Henry C. Lai, attest that my statements are true to the best of my knowledge.

Comments for FCC ET Docket No. 013-84 and ET Docket No. 03-137

1. My name is B. Blake Levitt. My address is 355 Lake Road, Warren. Connecticut 06777, USA.

2. I am a medical/science journalist, former *New York Times* contributor, and author of *Electromagnetic Fields, a Consumer's Guide to the Issues and How to Protect Ourselves* (Harcourt Brace, First Edition; iUniverse Back-In –Print Edition, 2007) which won a chapter Award of Excellence from the American Medical Writers Association; and Editor of *Cell Towers, Wireless Convenience? or Environmental Hazard? Proceedings of the "Cell Towers Forum," State of the Science, State of the Law* (Safe Goods/New Century Publishing, 2001). I am also the co-author, with Dr. Henry C. Lai, of *Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays,* published in Environmental Reviews/NRC Research Press, 2010 (Environ Rev: 18: 369-295 doi:10.1139/A10-018).[1] I have published widely on the health and environmental effects of low-level nonionizing radiation for over 20 years for both the lay and professional reader. I have also consulted nationally for municipalities struggling with safer cell tower and infrastructure siting after passage of The Telecommunications Act of 1996 (TCA) which restricted local and state rights regarding the ability to take radiofrequency radiation (RF) into consideration in telecommunications tower/antenna array siting. I am also on the Executive Committee of The Berkshire-Litchfield Environmental Council (BLEC), a 501 (3)(c) non-profit organization that focuses on environmental issues affecting the Northwest corner of Connecticut and the Berkshires region of Massachusetts. BLEC has sponsored

[1] Levitt, B.B., Lai, H. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays, Enviro. Rev. 369-395 (2010), doi:10.1139/A 10-018 http://www.nrcresearchpress.com/doi/pdf/10.1139/A10-018

several educational forums on safe infrastructure siting and has researched in depth the environmental effects of low-level ambient RF exposures to myriad species.

3. My name is Henry C. Lai. My address is 5557, 35th Ave., NE, Seattle, Washington 98105, USA

4. I am a Research Professor Emeritus of Bioengineering in the University of Washington, Seattle, WA, USA. I have carried out research on the biological effects of nonionizing electromagnetic fields for more than 30 years and published numerous papers on the topic. I am a co-editor of the journal Electromagnetic Biology and Medicine. I was one of the "subject matter experts" interviewed for the July 2012 report "Telecommunications: Exposure and Testing Requirements for Mobile Phones Should be Reassessed" by the Government Accountability Office (GAO).

5. Background:

On March 29, 2013, the FCC issued an Order, Notice of Proposed Rulemaking (NPRM) and a Notice of Inquiry (NOI) as a single document (13-39) in response to the July 2012 report from the Government Accountability Office GAO which recommended, among other things, that the Commission:[2]

• Reassess the current FCC radiofrequency radiation (RFR) exposure limits, including its effects on human health; the costs/benefits in keeping the current limits; to seek the opinions of relevant health/safety agencies; and to change the limits if determined necessary.

• Reassess whether the current mobile phone testing requirements, given new technologies and different use patterns, do in fact result in the identification of maximum RF energy exposures, especially when mobile phones are held against the body – the head in particular -- and to update testing requirements if determined necessary.

The NPRM proposes to standardize all criteria for frequency, power density, and antenna separation in order to determine whether a facility or device should be exempt from routine evaluation for harm to the human body. This would do away with the current categorical exclusions. The NPRM also discusses distinctions between general population and occupational RFR exposure and proposes new requirements for signs and barriers at transmitter sites.

[2] "Telecommunications: Exposure and Testing Requirements for Mobile Phones Should be Reassessed." http://www.gao.gov/assets/600/592901.pdf

The NOI addresses three areas: the propriety of existing standards and policies; possible options for precautionary exposure reduction; and possible improvements to the equipment authorization process and policies as they relate to RF exposure.

The first two points address whether thermal damage (tissue-overheating), which is the current focus of FCC standards, is the only RFR risk, or whether other human health damage can be caused by chronic exposures with cumulative effects over longer periods of time.

This is the first time in 17 years that the FCC has looked at the adequacy of its thermal-based RFR-exposure standards to protect human health. The FCC is admittedly not expert in the subject and defers to other agencies and professional organizations. Nevertheless, FCC is charged by law with adopting and enforcing RF exposure safeguards. The rationale and overall model is therefore critical for biological accuracy. Toward that end, FCC has called upon better-informed agencies such as the Environmental Protection Agency (EPA) for opinions on ambient exposures, and the Food and Drug Administration (FDA) for opinions on consumer products, as well as industry groups like the International Electrical and Electronics Engineers (IEEE) which has a financial stake in relaxed regulation, as well as the knowledgeable public for input on key areas of concern. Unfortunately, programs within EPA for this kind of research and policy-making have been almost completely defunded, leaving few there to render a considered opinion; and FDA's funding has also been reduced. This, in effect, leaves industry groups with the most clout.

The FCC expresses confidence in the current thermal-only basis, but acknowledges that with the rapid proliferation of wireless devices over the years, as well as the ubiquity of antennas needed for supportive infrastructure, and the new technological designs that allow much closer-to-the-body operation and medical implantation, that a new review is in order. The GAO report expressed similar confidence in the current methodology. This is in stark opposition to the most current data, and the direction that many other countries are taking regarding precautionary approaches.

Neither these authors, nor many expert members of the international research community, harbor the same confidence in such narrowly defined standards, which are premised upon understanding underlying biological mechanisms. Many now think that, given the peer-reviewed literature published since 1997 that setting an exposure threshold should based mainly on the knowledge at which level biological/health effects are observed, and not on the mechanism of the effects. Most of that research has come from outside of the U.S, including the recent classification of RF fields as a 2B (possible) carcinogen by the International Agency for Research on Cancer (IARC) at the World Health Organization

(WHO).[3] Indeed hundreds of studies have found biological/health effects at orders of magnitude below the current FCC thresholds. The changes regarding SAR allowances for the pinna (ear), as well as possible new setbacks from products and infrastructure, and potential new classifications that would supplant categorical exclusions, go nowhere near far enough in protecting public health and, in some areas, may serve to increase exposures to the general population.

6. FCC Comments from NPRM and NOI:

> ¶16. In this *Order*, we adopt rules explicitly permitting licensees and grantees to demonstrate that they comply with the Commission's RF exposure rules based on specific absorption rate (SAR) in lieu of maximum permissible exposure (MPE) for fixed and mobile transmitters. Providing an additional option for parties to demonstrate that they comply with the RF exposure limits could reduce those parties' expenses in some cases. Additionally, in the *Order*, we classify the outer ear as an extremity based on similarities to other parts of the body such as the hands and feet, which are already classified as extremities. This reclassification of the outer ear as an extremity is consistent with health agency comment and industry standards and should eliminate unnecessary compliance costs that could occur under alternative evaluation schemes.
>
> Accordingly, in the *Notice*, we requested comment on classifying the pinna (outer ear) as an extremity, to which less stringent exposure criteria would apply. While we received comments both for and against this classification, we amend section 1.1310 of our rules to subject the pinna to the same RF exposure limit currently applicable to hands, wrists, feet, and ankles.
>
> ¶44.
> *Background*. Our localized SAR limit for the general population is 1.6 W/kg as averaged over any one gram cube of tissue, except for extremities, explicitly defined in our existing rules as the hands, wrists, feet, and ankles, where the limit is 4 W/kg as averaged over any ten gram cube of tissue.78
> (For occupational exposure, the localized SAR limit is 8 W/kg as averaged over any one gram cube of tissue, except for within the extremities where it is limited to 20 W/kg as averaged over any ten gram cube of tissue.) In the *Notice*, 79 we referred to deliberations by the

[3] http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

> IEEE of a standard revision that would treat the pinna of the human ear also as an extremity for the purpose of SAR evaluation.80 We invited comment on whether we should consider adopting such a revision once approved by the IEEE .In the meantime, IEEE revisions characterizing the pinna as an extremity have been issued in IEEE Standards C95.1b-2004 and C95.1-2005. We note that classification of the pinna is only relevant to evaluation of localized SAR and not MPE. The MPE limits were derived under the assumption of whole body exposure, and control of localized SAR is implicit in their derivation.

> ¶45.
> *Comments*. Ericsson and Motorola both supported those revisions, and Motorola recommended that the Commission adopt it by reference in a separate rulemaking….   This revision has now been adopted by the IEEE as Amendment 2 to IEEE Std. C95.1 (IEEE Std. C95.1b-2004).
> The pinna is the external part of the ear that extends away from the skull, consisting primarily of cartilage.

7. Author Comments:

Our comments are mainly on the validity and adequacy of the current guidelines in the protection of the general public exposed to radiofrequency radiation (RFR). Reclassification of the pinna as an extremity is of secondary importance. However, we do not agree with such a reclassification.

There are two major situations of radiofrequency field exposure: 1) near-field exposure, in which the source is close to the body and only part of the body is exposed and the pattern of energy absorption is relatively stationary; and 2) far-field exposure in which the source is away at a distance greater than two wavelengths of the radiation, the whole body is exposed and the pattern of energy absorption is more variable as the object moves in the field. The main cause of near-field exposure is in the use of cell phones or other wireless communication devices when the radiation is concentrated to the head of the user. In the far-field situation, the main sources are RF-transmission towers in the vicinity, e.g., radio and TV towers, cell phone base stations, and wireless emitters and radars. The FCC regulates both near- and far-field exposures.

The current RF exposure guidelines need a major overhaul but under no circumstance should be made more lenient. The guidelines are based on limited and obsolete scientific data and illogical rationale. It can be misleading to discuss the exposure standards based on thermal v. non-thermal effects. It is very difficult to scientifically differentiate between RF-

induced thermal and non-thermal biological effects. An increase in tissue temperature does not necessarily imply that an effect being observed is thermal in nature only. Guidelines should be based mainly on the exposure levels (SAR or power density) at which biological effects have been consistently observed, not the mechanism of the effects.

While expanding the Commission's RF exposure rules to be based on specific absorption rate (SAR) is broadening toward a more biologically based standard rather than a doseimetry based model such as the maximum permissible exposure (MPE), SAR should not be used in lieu of MPE for fixed and mobile transmitters. Because of complex numerous variables, SAR is almost impossible to determine in the field and should not be used for ambient exposures.

Computational models for SAR calculation can be quit reliable, however. [4] Because of this, we recommend that FCC require manufacturers to provide state-of-the-art data on their phones, posted both on the FCC's website and made available to consumers at point-of-sale. Although SAR is the most biologically relevant, MPE has been used as a surrogate to determine SAR. The main emphasis for far-field exposures should remain on an MPE model, simply because it is easier to measure, control and mitigate when necessary. SAR is far too complex for a field model for infrastructure exposures and is therefore unreliable. It could actually make the standards less clear and enforceable as industry could easily hide behind specious SAR models and increase the power output of transmitters.

8. Specific Absorption Rate (SAR):

When a cell phone is held close to the head, the radiofrequency energy penetrates the head and is absorbed by body tissues. Depending on various physical factors, energy absorption is not uniform. High and low energy deposition areas are formed. The amount of energy absorption is measured by the specific absorption rate (SAR) which is the rate of energy absorbed by a unit mass of tissue, generally expressed in W/kg. Energy distribution can be calculated using computer simulation. Guidelines are set by limiting the peak SAR. In order to do that, the amount of tissue for peak SAR consideration has to be defined. In the present standards, the limiting SAR is defined by 1 or 10 gm of tissue, i.e., the SAR within 1 or 10 gm of brain/head tissue should not exceed a certain value. In the IEEE guideline, the peak SAR in the head is not to exceed 1.6 W/kg averaged over 10 g of tissue. The proposed FCC guideline of SAR of 1.6 W/kg over 1 gm of tissue is the near-field (partial body) exposure situation. This was derived from an erroneous rationale. The rationale was that the

[4] In fact, it was just such computerized SAR calculation that caused concern for the reliability of cell phone industry claims about power density and which lead to the reclassification of the pinna as an 'extremity.' Om Ghandi's and Neils Kuster's calculations showed that some cell phones exceeded the 4W/kg limit. That was why cell phone manufacturers came to recommend holding the phone a few inches away from the head. Without reclassification, some cell phone manufacturers would have had to pull their models from the market.

0.4 W/kg guideline was a whole body exposure situation (i.e., an animal's behavior was disrupted when it's whole body was exposed to 4 W/kg), and when part of the body is exposed, as in the case of cell phone use, that part of the body should be able to take more radiation. Thus, the guideline for partial body exposure was increased 4 times to 1.6 W/kg. There is no evidence that the partial body can tolerate more energy deposition than the whole body. The opposite may be true. Up to 300,000 brain cells (neurons and glial cells) can be contained within 1 cu mm of brain tissue. Genetic damage in one single cell, as caused by exposure to RFR from a cell phone, is enough to lead to cancer.

The current FCC guidelines for the SAR are based on narrow data from one set of experiments carried out in the 1980's[5] [6] which showed behavioral disruption in animals after exposure to RFR at a whole body SAR of 4 W/kg. These studies have not been independently replicated, yet are enshrined in the standards. Many other experiments since then have shown behavioral and other physiological effects in animals and humans at a SAR lower than 4 W/kg but no changes to the guidelines have been made.[7] This point ties directly into the reclassification of the pinna (ear) as an extremity, which would allow cell handset exposures to increase to 4W/kg from the current 1.6 W/kg averaged over one gram of tissue.

As examples, Table I below lists a group of low-intensity *in vitro* studies reported in the literature. 'Low intensity' is defined as a SAR less than 0.1 W/kg, which is 1/40 of the biologically effective SAR used in the setting of present RF guidelines. In addition, since cell phones are the major source of near-field exposure and modulations may have a significant role in eliciting biological effects, only studies using cell phone frequencies and modulations were considered. (It should be noted that signals used in these studies could only partially match the modulations of cell phone signals.) An additional criterion is that SARs are provided in these studies. There are 17 papers that satisfied these criteria listed in Table 1. The biological effects reported by these studies included: genetic effects, cell proliferation, membrane chemistry, protein damage, calcium metabolism, stress protein production, immunological changes, and DNA damage. The average SAR of these 17 studies is 0.029 W/kg (range 0.07 – 0.000021 W/kg). The duration of exposure ranged from 15 min to 72 hours.

Table 2 is a list of in vivo animal studies. There are 12 studies that fit the criteria. Animal species of these studies included mouse, rat and hamster. Endpoints studied included

[5] de Lorge, J., and Ezell, C.S. 1980. Observing-responses of rats exposed to 1.28- and 5.62-GHz microwaves. Bioelectromagnetics, 1(2): 183–198, 1980.

[6] de Lorge, J.O. 1984. Operant behavior and colonic temperature of Macaca mulatta exposed to radiofrequency fields at and above resonant frequencies. Bioelectromagnetics, 5(2): 233–246, 1984.

[7] Lai, H. Biological effects of radiofrequency radiation from wireless transmission towers. In *"Cell Towers: Wireless Convenience? OrEnvironmental Hazard?"* Levitt, B.B. (ed.), New Century Publishing, East Canaan, CT, 2001, pp. 65-74, 2001.

effects on: testosterone and insulin levels, DNA double strand breaks, reproductive system, metabolism, memory functions, blood-brain barrier, embryonic kidney development, immune system, and free radical formation. The average SAR of these 13 studies is 0.015 W/kg.

It is very obvious from the data presented in the tables that recent studies do not support the use of 4 W/kg SAR as the basis of exposure limits.

Table 1. In vitro studies (800-2000 MHz) (n = 17); Average = 0.029 W/kg (range 0.07 – 0.000021 W/kg, median 0.025 W/kg)

		SAR (W/kg)	Effect reported
Belyaev et al.(2005)	915 MHz, GSM, 24 & 48 hr	0.037	Genetic changes in human white blood cells
Belyaev et al.(2009)	915 MHz, 1947 MHz; GSM, UMTS 24 & 72 hr	0.037	DNA repair mechanism in human white blood cells
Capri et al.(2004)	900 MHz, GSM 1 hr/day, 3 days	0.07	Cell proliferation and membrane chemistry
De Pomerai et al. (2003)	1 GHz 24 & 48 hr	0.015	Protein damages
Dutta et al. (1984)	915 MHz, sinusoidal AM at 16 Hz	0.05	Increase in calcium efflux in human neuroblastoma cells
Ivaschuk et al. (1997)	836.55 MHz, TDMA 20 min	0.026	Transcript levels for c-jun were altered in nerve growth factor-treated PC12 rat pheochromocytoma cells
Kwee et al. (2001)	960 MHz, GSM 20 min	0.0021	Hsp-70 stress protein increased in transformed human epithelial amnion cells
Makova et al. (2005)	915 and 905 MHz, GSM 1 hr	0.037	chromatin conformation in human white blood cells affected
Marinelli et al. (2004)	900 MHz CW 2 - 48 hr	0.0035	Cell's self-defense responses triggered by DNA damage.
Pavicic et al. (2008)	864 and 935 MHz, CW, 1-3 hrs	0.08	Growth affected in Chinese hamster V79 cells.
Phillips et al. (1998)	813.5625 MHz	0.0024	DNA damage in human

	(iDEN); 836.55 MHz (TDMA) 2 hr and 21 hr		leukemia cells.
Sarimov et al. (04)	895-915 MHz GSM 30 min	0.0054	Human lymphocyte chromatin affected similar to stress response.
Schwarz et al. (2008)	1950 MHz UMTS 24 hr	0.05	Genes in human fibroblasts.
Stagg et al. (1997)	836.55 MHz TDMA duty cycle 33% 24 hr	0.0059	Glioma cells showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division.
Stankiewicz et al. (2006)	900 MHz GSM 217 Hz pulses-.577 ms width 15 min	0.024	Immune activities of human white blood cells affected.
Velizarov et al. (1999)	960 MHz GSM 217 Hz square-pulse, duty cycle 12% 30 min	0.000021	Decrease in proliferation of human epithelial amnion cells.
Wolke et al. (1996)	900, 1300, 1800 MHz, square-wave modulated at 217 Hz; Also 900 MHz with CW, 16 Hz, 50 Hz and 30 KHz modulations	0.001	Calcium concentration in heart muscle cells of guinea pig.

Table 2: Non-human in vivo studies with SAR N=14, mean = 0.015 W/kg (range: 0.004 – 0.02 W/kg), median = 0.014 W/kg

		SAR (W/kg)	Effects reported
Forgacs et al. (2006)	1800 MHz, GSM- 217 Hz pulses, 576 μs pulse width; 2 hr/day, 10 days	0.018	Increase in serum testosterone.
Kesari and Behari (2009)	50 GHz; 2hr/day, 45 days	0.0008	Double strand DNA breaks observed in brain cells

Kesari and Behari (2010)	50 GHz; 2 hr/day, 45 days	0.0008	Reproductive system of male rats
Kesari et al. (2010)	2450 MHz, 50-Hz modulation, 2 hr/day, 35 days	0.11	DNA double strand breaks in brain cells.
Kumar et al. (2010a)	10 GHz, 2h/day 45 days	0.014	Cellular changes and increase in reactive oxygen species in testes
Kumar et al. (2010b)	10 GHz, 2 h/day, 45 days 50 GHz, 2h/day, 45 days	0.014 0.0008	Genetic damages in blood cells
Lerchl et al. (2008)	383 MHz (TETRA), 900 and 1800 MHz (GSM) 24 hr/day, 60 days	0.08	Metabolic changes.
Navakatikian and Tomashevskaya (1994)	2450 MHz CW and 3000 MHz pulse-modulated 2 μs pulses at 400 Hz Single (0.5-12 hr) or repeated (15-60 days, 7-12 hr/day) exposure, CW-no effect	0.0027	Behavioral and endocrine changes, and decreases in blood concentrations of testosterone and insulin.
Nittby et al. (2007)	900 MHz GSM 2hr/wk, 55wk	0.0006	Reduced memory functions.
Perssson et al. (1997)	915 MHz-CW and pulse-modulated (217-Hz, 0.57 ms; 50-Hz, 6.6 ms) 2-960 min; CW more potent	0.0004	Increase in permeability of the blood-brain barrier.
Pyrpasopoulou et al. (2004)	9.4 GHz GSM (50 Hz pulses, 20 μs pulse length) 1-7 days postcoitum	0.0005	Exposure during early gestation affected kidney development.
Salford et al. (2003)	915 MHz GSM 2 hr	0.02	Nerve cell damage in brain.
Veyret et al. (1991)	9.4 GHz 1 μs pulses at 1000 pps, also with or without sinusoidal AM between 14 and 41 MHz, response only with AM modulation, direction	0.015	Functions of the immune system.

	of response depended on AM frequency		
Yurekli et al. (2006)	945 MHz GSM, 217 Hz pulse-modulation 7 hr/day, 8 days	0.0113	Free radical chemistry.

9. Pinna (Ear) as 'Extremity':

The current FCC standards are 1.6 W/kg as averaged over any one gram cube of tissue, except for extremities, specifically defined by FCC as the hands, wrists, feet, and ankles, where the limit is 4 W/kg as averaged over any ten gram cube of tissue. For occupational exposure, the localized SAR limit is 8 W/kg as averaged over any one gram cube of tissue, except for within the extremities where it is limited to 20 W/kg as averaged over any ten gram cube of tissue. (The FCC notes that classification of the pinna is only relevant to evaluation of localized SAR and not MPE. The MPE limits were derived under the assumption of whole body exposure, and control of localized SAR, is implicit in their derivation.)

We think the rationale for considering the external ear (pinna or auricle) as an extremity should be re-examined more carefully. The auricle is simply not an 'extremity.' Just a casual look at the Medline comes up with some alarming information. First, it is very obvious that the auricle is histologically different from the arms and legs. There are no bone, tendon, and skeletal muscle.

Let us first consider the possible thermal effect on the auricle while using a cell phone. The 'rationale document' states very well that the auricle can probably handle the heat load. But, it fails to consider individuals who cannot thermo-regulate very well. This is not uncommon. For example, the micro-circulation of the auricle is controlled by, among other neurotransmitter systems, the adrenergic and serotonergic systems [Li et al, 1998, 2000; White et al., 1985; see references below]. People who take alpha-2 agonists for hypertension, beta-agonists for asthma, and serotonin-agonists for psychiatric depression would be vulnerable to thermal damage to the auricle when using a cell phone. Should customers who use these therapeutic drugs have additional warnings when using cell phones?

In addition, Oftedal et al (2000) recently reported that "…sensations of warmth on the ear and behind/around the ear, burning sensations in the facial skin and headaches were most commonly reported by cell phone users."

Cancer of the auricle is not uncommon [e.g., Hayter et al., 1996; Moriyama et al., 2000; Silva et al., 2000; Worley et al., 1999], because the auricle does not consist mainly of

post-mitotic cells like the arms and legs. And that the question of whether RFR can cause genetic damage is far from settled.

Thirdly, the auricle, different from the arms and legs, is innervated by the vagus nerve. The vagus also innervates many other vital organs in the body, including, for example, the heart, GI-tract, and reproductive organs. Vagus reflexes are well known [Engel, 1979; Gupta et al., 1986]. Stimulating the auricle can affect these organs. Two important case reports include stoppage of the heart [Prasad et al., 1984] and epilepsy [Santanelli et al., 1985] triggered by stimulation of the auricle in humans.

Reclassification of the pinna as an extremity was a mistake. Such reclassification now allows the SAR to increase from 1.6 W/kg (averaged over 1 gm of tissue) to 4 W/kg (averaged over 10 gm of tissue) which will allow the emission power density of cell phone handsets to increase. Also, this reclassification does not take into consideration that many people – especially the young – now text rather than put a cell phone directly to the head. An increase to the higher SAR with the accompanying allowable increase in cell phone emissions, will create much stronger RFR exposures to the eyes since screens are small and now typically held close to the face for viewing purposes. The eye is a highly conductive aqueous saline organ – the exact opposite of cartilage. One study reported an increased risk of melanoma of the eye[8] with cell phone exposures but the same authors were not able to replicate their own work.[9] This area warrants close follow-up. The reclassification is inviting adverse effects to the ear, the brain, the eyes, and potentially other systems in the body.

There has been no clear rationale by FDA or FCC or IEEE for treating the ear as an extremity. Other than facilitating higher power output for potentially better operation of the handsets which is only in industry's favor, there is no real public advantage and possible public health endangerment. It is obvious why the IEEE, as an industry group with no medical training, would push for this reclassification but a complete mystery why the FDA went along with it.

10. Blanket Exemptions -- Cumulative Effects Not Considered, Smart Grid/Metering Case in Point:

FCC proposes to standardize compliance via adopting thresholds of power, distance and frequency for routine environmental evaluation. Below the threshold of one milliwatt (1

[8] Stang A, Anastassiou G, Ahrens W, Bromen K, Bornfeld N, Jöckel KH. The possible role of radiofrequency radiation in the development of uveal melanoma. Epidemiology. 12(1):7-12, 2001.

[9] Stang A, Schmidt-Pokrzywniak A, Lash TL, Lommatzsch PK, Taubert G, Bornfeld N, Jöckel KH. Mobile phone use and risk of uveal melanoma: results of the risk factors for uveal melanoma case-control study. J Natl Cancer Inst. 101(2):120-123, 2009.

mW) of power or less, services or devices would be exempt, continuing the blanket exemption for the most popular and ubiquitous consumer products today, as well as those to be developed in the future. Yet no cumulative exposure criterion is set for radiating sources for myriad products operating simultaneously. Exemptions are taken one product or service at a time and with this ruling, FCC will continue that policy without setting levels for the sum of effects from different sources and cumulative effects over time, such as DNA damage in the genome that become larger with repeated exposure.

There has been an exponential increase for both low-level RFR fixed transmitters like wifi, and voluntary personal portable/mobile devices. This is in addition to involuntary exposures from accompanying infrastructure like cell towers with multiple providers, antennas mounted on/in existing structures, and DAS systems which bring RFR much closer to the population. There is an increasing new layer of RF with smart grid/metering -- an involuntary direct RF delivery system into homes and businesses. In addition, there has been a large increase in the use of implantable medical devices such as cardiac pacemakers, insulin pumps and deep brain stimulators for Parkinsons Disease, among others, that are susceptible to interference from near-and-far field RFR. And there are increasing uses of implantable RFID devices, too. Both personal environments and large ambient environmental RFR levels have risen dramatically in the last 20 years, and continue to do so.

In the 2010 paper that we published in *Environmental Reviews* [10] -- one of the peer-reviewed publications of Canada's privately owned National Research Council Press -- we included a chart of 59 peer-reviewed studies showing various biological effects at low intensity RFR exposures far below current FCC standards (see Table 3 below). This was the first paper to specifically explore the data on biological effects now common in most urban and suburban settings. All of the works cited apply to what FCC now categorically excludes. Works cited, for instance, would apply to smart grid/metering technology and wifi routers placed on desk tops near a user's head. Such devices therefore cannot be considered benign, despite adherence to FCC guidelines for exemption. In the case of smart meters, RF couples with domestic wiring and travels throughout a building. Because of such coupling with conductive material, no distance from the transmitting source would be effective regulation here**.** And peak exposures during the device's duty cycle, which is the most pertinent exposure parameter, is time-averaged away. This is not protective of public health.

The listed exposure levels at which biological/health effects have been observed are much lower than the FCC's SAR of 4 W/kg, and actually include levels that one would

[10] Levitt, B. B., Lai, H., Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays, Enviro. Rev. 369-395 (2010), doi:10.1139/A 10-018
http://www.nrcresearchpress.com/doi/pdf/10.1139/A10-018

encounter in modern urban/suburban environments today. Furthermore, exposure to smart meter RF, for example, is chronic and unavoidable.

In the very least, FCC should call for a thorough assessment of the smart meter buildout until the emission levels from access points are known, setbacks for access points are recommended from nearby residences/businesses, and a better assessment of cumulative exposures from meters, access points, and wireless components placed on or in appliances themselves -- both singly and in multiples working simultaneously -- can be determined.

We recommend that FCC also advise EPA, FCC, DOE and the legislature that more extensive assessment of smart-grid/metering is needed before this buildout proceeds further. Some of the studies in the chart below are comparable to such exposures.

Table 3. A list of studies reporting biological effects at low intensities of RFR. These papers gave either SAR (W/kg) or power density (μW/cm^2) of exposure.

		SAR (W/kg)	Power density (μW/cm^2)	Effects reported
Belyaev et al. (2005) (in vitro)	915 MHz, GSM 24 & 48 hr	0.037		Genetic changes in human white blood cells
Belyaev et al. (2009) (in vitro)	915 MHz, 1947 MHz GSM, UMTS 24 & 72 hr	0.037		DNA repair mechanism in human white blood cells
Blackman et al. (1980) (in vitro)	50 MHz, AM at 16 Hz	0.0014		Calcium in forebrain of chickens
Boscol et al. (2001) (in vivo) (human whole body)	500 KHz-3 GHz, TV broadcast		0.5	Immunological system in women
Campisi et al. (2010) (in vitro)	900 MHz, CW or 50-Hz AM, 14 days, 5, 10, 20 min per day, CW- no effect		26	DNA damage in human glial cells
Capri et al. (2004) (in vitro)	900 MHz, GSM 1 hr/day, 3 days	0.07		A slight decrease in cell proliferation when human immune cells were stimulated with mitogen and a slight increase in the number of cells with altered distribution of phosphatidylserine across the membrane.
Chiang et al. (1989) (in vivo) (human whole body)	People lived close to AM radio and radar installations for more than one year		10	People lived and worked near AM radio antennae and radar installations showed deficits in psychological and short-term memory tests.
De Pomerai et al. (2003) (in vitro)	1 GHz 24 & 48 hr	0.015		Protein damages
D'Inzeo et al.	10.75 GHz CW	0.008		Operation of acetylcholine-related ion-channels in

(1988) (in vitro)	30-120 sec			cells. These channels play important roles in physiological and behavioral functions.
Dutta et al. (1984) (in vitro)	915 MHz, sinusoidal AM at 16 Hz	0.05		Increase in calcium efflux in brain cancer cells.
Dutta et al. (1989) (in vitro)	147 MHz, sinusoidal AM at 16 Hz 30 min	0.005		Increase in calcium efflux in brain cancer cells.
Fesenko et al. (1999) (in vivo) (mouse- wavelength in mm range)	From 8.15 - 18 GHz 5 hr to 7 days direction of response depended on exposure duration		1	Change in immunological functions.
Forgacs et al. (2006) (in vivo) (mouse whole body)	1800 MHz, GSM-217 Hz pulses, 576 μs pulse width; 2hr/day, 10 days	0.018		Increase in serum testosterone.
Guler et al. (2010) (In vivo) (rabbit whole body)	1800 MHz AM at 217 Hz, 15 min/day, 7 days		52	Oxidative lipid and DNA damages in the brain of pregnant rabbits
Hjollund et al. (1997) (in vivo) (human partial or whole body)	Military radars		10	Sperm counts of Danish military personnel, who operated mobile ground-to-air missile units that use several RFR emitting radar systems, were significantly lower compared to references.
Ivaschuk et al. (1999) (in vitro)	836.55 MHz, TDMA 20 min	0.026		A gene related to cancer.
Jech et al. (2001) (in vivo) (human partial body exposure- not included)	900 MHz, GSM-217 Hz pulses, 577 μs pulse width; 45 min; narcoleptic patients	0.06		Improved cognitive functions.
Kesari and Behari (2009a) (in vivo) (rat whole body)	50 GHz; 2hr/day, 45 days	0.0008		Double strand DNA breaks observed in brain cells
Kesari and Behari (2009b) (in vivo) (rat whole body)	50 GHz; 2hr/day, 45 days	0.0008		Reproductive system of male rats
Kesari et al. (2010) (in vivo) (rat whole body)	2450 MHz, 50-Hz modulation, 2 h/day, 35 days	0.11		DNA double strand breaks in brain cells.
Kwee et al. (2001) (in vitro)	960 MHz, GSM 20 min	0.0021		Increased stress protein in human epithelial amnion cells.
Lebedeva et al. (2000) (in vivo) (human partial body)	902.4 MHz, GSM 20 min		60	Brain wave activation.
Lerchl et al. (2008)	383 MHz (TETRA),	0.08		Metabolic changes.

(in vivo) (hamster whole body)	900 and 1800 MHz (GSM) 24 hr/day, 60 days			
Magras and Xenos (1999) (in vivo) (mouse whole body)	'Antenna park'-TV and FM-radio, Exposure over several generations		0.168	Decrease in reproductive function.
Makova et al. (2005) (in vitro)	915 and 905 MHz, GSM 1 hr	0.037		Chromatin conformation in human white blood cells.
Mann et al. (1998) (in vivo) (human whole body)	900 MHz GSM pulse-modulated at 217 Hz, 577 μs width, 8 hr		20	A transient increase in blood cortisol.
Marinelli et al. (2004) (in vitro)	900 MHz CW 2 - 48 hr	0.0035		Cell's self-defense responses triggered by DNA damage.
Navakatikian and Tomashevskaya (1994) (in vivo) (rat whole body)	2450 MHz CW and 3000 MHz pulse-modulated 2 μs pulses at 400 Hz Single (0.5-12hr) or repeated (15-60 days, 7-12 hr/day) exppsure, CW-no effect	0.0027		Behavioral and endocrine changes, and decreases in blood concentrations of testosterone and insulin.
Nittby et al. (2007) (in vivo) (rat whole body)	900 MHz GSM 2hr/wk, 55wk	0.0006		Reduced memory functions.
Novoselova et al. (1999) (in vivo) (mouse whole body- wavelength in mm range)	From 8.15 -18 GHz, 1 sec sweep time-16 ms reverse, 5 hr		1	Functions of the immune system.
Novoselova et al. (2004) (in vivo) (mouse whole body- wavelength in mm range)	From 8.15 -18 GHz, 1 sec sweep time-16 ms reverse, 1. 5 hr/day, 30 days		1	Decreased tumor growth rate and enhanced survival.
Pavicic et al. (2008) (in vitro)	864 and 935 MHz, CW, 1-3 hrs	0.08		Growth affected in Chinese hamster V79 cells.
Panagopoulos et al. (2010) (in vivo) (fly whole body)	GSM 900 and 1800 6 min/day, 5 days		1 - 10	Reproductive capacity and induced cell death.
Panagopoulos and Margaritis (2010a) (in vivo) (fly whole body)	GSM 900 and 1800 6 min/day, 5 days		10	'Window' effect of GSM radiation on reproductive capacity and cell death.
Panagopoulos and Margaritis (2010b) (in vivo) (fly whole body)	GSM 900 and 1800 1- 21 min/day, 5 days		10	Reproductive capacity of the fly decreased linearly with increased duration of exposure.
Pérez-Castejón et al. (2009) (in vitro)	9.6 GHz , 90% AM, 24 hrs	0.0004		Increased proliferation rate in human astrocytoma cancer cells.

Perssson et al. (1997) (in vivo) (mouse whole body)	915 MHz-CW and pulse-modulated (217-Hz, 0.57 ms; 50-Hz, 6.6 ms) 2-960 min; CW more potent	0.0004		Increase in permeability of the blood-brain barrier.
Phillips et al. (1998) (in vitro)	813.5625 MHz (iDEN); 836.55 MHz (TDMA) 2 hr and 21 hr	0.0024		DNA damage in human leukemia cells.
Polonga-Moraru et al. (2002) (in vitro)	2.45 GHz 1hr		15	Change in membrane of cells in the retina.
Pyrpasopoulou et al. (2004) (in vivo) (rat whole body)	9.4 GHz GSM (50 Hz pulses, 20 μs pulse length) 1-7 days postcoitum	0.0005		Exposure during early gestation affected kidney development.
Roux et al. (2008a) (in vivo) (tomato whole body)	900 MHz		7	Gene expression and energy metabolism.
Roux et al. (2008b) (in vivo) (plant whole body)	900 MHz		7	Energy metabolism.
Salford et al. (2003) (in vivo) (rat whole body)	915 MHz GSM 2 hr	0.02		Nerve cell damage in brain.
Sarimov et al. (2004) (in vitro)	895-915 MHz GSM 30 min	0.0054		Human lymphocyte chromatin affected similar to stress response.
Schwartz et al. (1990) (in vitro)	240 MHz-CW and sinusoidal modulation at 0.5 and 16 Hz, 30 min, effect only observed at 16-Hz modulation	0.00015		Calcium movement in the heart.
Schwarz et al. (2008) (in vitro)	1950 MHz UMTS 24 hr	0.05		Genes in human fibroblasts.
Somosy et al. (1991) (in vitro)	2.45 GHz, CW and 16 Hz square-modulation, modulated field more potent than CW	0.024		Molecular and structural changes in cells of mouse embryos.
Stagg et al. (1997) (in vitro)	836.55 MHz TDMA duty cycle 33% 24 hr	0.0059		Glioma cells showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division.
Stankiewicz et al. (2006) (in vitro)	900 MHz GSM 217 Hz pulses-.577 ms width 15 min	0.024		Immune activities of human white blood cells.
Tattersall et al. (2001) (in vitro)	700 MHz CW, 5-15 min	0.0016		Function of the hippocampus.
Velizarov et al. (1999) (in vitro)	960 MHz GSM 217 Hz square-	0.000021		Decrease in proliferation of human epithelial amnion cells.

	pulse, duty cycle 12% 30 min			
Veyret et al. (1991) (in vivo) (mouse whole body)	9.4 GHz 1 □s pulses at 1000 pps, also with or without sinusoidal AM between 14 and 41 MHz, response only with AM modulation, direction of response depended on AM frequency	0.015		Functions of the immune system.
Vian et al. (2006) (in vivo) plant	900 MHz		7	Stress gene expression.
Wolke et al. (1996) (in vitro)	900, 1300, 1800 MHz, square-wave modulated at 217 Hz; Also 900 MHz with CW, 16 Hz, 50 Hz and 30 KHz modulations	0.001		Calcium concentration in heart muscle cells of guinea pig.
Yurekli et al. (2006) (in vivo) (rat whole body)	945 MHz GSM, 217 Hz pulse-modulation 7 hr/day, 8 days	0.0113		Free radical chemistry.

11. Chronic Exposures, Cumulative Effects, Different Waveforms:

Another important consideration in the setting of RFR exposure guidelines is the effect of **chronic/repeated exposure**. There is not much data on the biological effects of chronic RFR exposure, although some exist. (A list of chronic exposure studies can be found in sections 6 and 9 of http://www.bioinitiative.org/table-of-contents/). There are research data showing that the effects of chronic low level exposures are different than those of acute short-term thermal exposures. A set of similar experiments[11],[12] to those of de Lodge et al[3,4] was carried out in the 1980's to study the effects of repeated RFR exposures. The researchers concluded:

[11] D'Andrea, J.A., DeWitt, J.R., Emmerson, R.Y., Bailey, C., Stensaas, S., and Gandhi, O. P.,Intermittent exposure of rat to 2450-MHz microwaves at 2.5 mW/cm^2: behavioral and physiological effects, Bioelectromagnetics 7:315-328, 1986.

[12] D'Andrea, J.A., DeWitt, J.R., Gandhi, O. P., Stensaas, S., Lords, J.L., and Nielson, H.C.,Behavioral and physiological effects of chronic 2450-MHz microwave irradiation of the rat at 0.5 mW/cm^2, Bioelectromagnetics 7:45-56, 1986.

"…the threshold for behavioral and physiological effects of chronic *(long-term)* RFR exposure in the rat occurs between 0.5 mW/cm^2 **(0.14 W/kg)** and 2.5 mW/cm^2 **(0.7 W/kg)**."

It appears that chronic exposure sensitized the animals to RFR. Therefore, it is insufficient to apply a guideline based on acute exposure (i.e., the data of de Lodge et al.) to a chronic exposure situation such as would be experienced with smart grid/metering technology and most others that are now categorically excluded.

An important question is whether RFR's biological effects are cumulative? There are studies that indicate RFR effects can accumulate with repeated exposures[13]. This is an important consideration in light of so many wireless devices in our midst today. No agency takes chronic exposure or cumulative effects into consideration. Each device or new technology is considered a stand-alone. Therefore, today's true exposures are unknown. This is especially troubling with smart grid/metering's peak exposures during the duty cycle and RFR emissions from 'access points' in the larger grid network. These points have significantly higher duty cycles in order to co-ordinate the signals from thousands of meters.

Another important consideration in the setting of guidelines for RFR exposure is the **waveform characteristics of the field**. There are many reports indicating that the waveform of RFR significantly alters its effectiveness in causing biological effects. Wave characteristics should be factored into the setting of new RFR exposure guidelines, since RFRs in the human environment today are of many different waveforms and characteristics.

And another important consideration is waveforms' specific effects. The following are some examples of reports regarding waveform specificity. (A more extensive list of studies showing waveform-specific biological effects can be found in sections 6 and 9 of http://www.bioinitiative.org/table-of-contents/).

- Campisi et al. (2010) reported increases in free radical activity and DNA fragmentation in brain cells after acute exposure to a 50-Hz amplitude-modulated 900-MHz RFR, whereas a continuous-wave 9000-MHz field produced no effect.
- Franzellitti et al. (2010) showed increased DNA strand breaks in trophoblasts after exposure to a 217-Hz modulated 1.8 GHz-RFR, but a continuous-wave field of the same carrier frequency was without effect.
- Tkalec et al (2013) reported that AM-modulated (1 KHz sinusoidal) 900-MHz RFR is more potent than non-modulated field in causing DNA damage in coelomocytes of exposed earthworms.

[13] Lai, H. Biological effects of radiofrequency radiation from wireless transmission towers. In *"Cell Towers: Wireless Convenience? Or Environmental Hazard?"* Levitt, B.B. (ed.), New Century Publishing, East Canaan, CT, 2001, pp. 65-74, 2001.

- Luukkonen et al. (2009) reported a continuous-wave 872-MHz RFR increased chemically-induced DNA strand breaks and free radicals in human neuroblastoma cells, whereas a GSM-modulated 872-MHz field had no significant effect.
- Zhang et al. (2008) found that gene expression in rat neurons is more sensitive to intermittent than continuous exposure to a 1.8 GHz-RFR.
- López-Martín et al. (2009) found that GSM and unmodulated RFR caused different effects on c-Fos gene expression in the rat brain.
- Croft et al. (2010) reported that 2G, but not 3G, cell phone radiation affected resting EEG.
- Hung et al. (2007) showed that 2, 8, 217 Hz-modulated RFR differentially affected sleep.
- Lopez-Martin et al. (2009) reported that modulated and non-modulated RFR had different effects on gene expression in the brain.
- Nylund et al. (2010) found that different carrier-frequencies (900 MHz verses 1800 MHz) had different effects on protein expression.
- Schmid et al. (2012) concluded that "modulation frequency components (of a RFR) within a physiological range may be sufficient to induce changes in sleep EEG".

Clearly there are more complex factors affecting biological processes with RFR exposures than just SAR and MPE. FCC needs to take waveforms and other transmission factors such as modulation into consideration when setting standards, especially in light of newer systems with far more complicated signaling characteristics.

11. Increasing Ambient Exposures: Humans and Wildlife

Today's wireless applications are raising ambient background levels with no FCC, EPA or other regulatory oversight. New additions to the mix include smart grid/metering creating low-level blanket exposures at ground level, and 3G/4G networks offering endless "apps," TV/music/video downloads, e-books, photos, voice, WiMax Internet connectivity and texting, all via cell phones and tablets. Then there are universal GPS systems close to a user's head (on a close lateral level with the eye) when mounted on a car dashboard. GPS works off of distant satellites and requires stronger signal emission. There is also a host of RF/radar devices built into automobiles today to detect animals on the road or park a vehicle without engaging the driver.

WiMax, already being build out, is ubiquitous wireless internet connectivity intended especially for rural communities that are now low RF areas. WiMax alone will introduce a new blanket of RFR with some systems capable of transmitting in a 12,000 square mile radius with a 62-mile reach from one antenna. The military and Homeland Security has also exponentially increased their use of wireless technology. All of these technologies use extremely complex signals that carry a lot of information. Given the data cited above in Table 3 regarding biological effects at very low intensities, we can no longer afford a presumption of safety with ever-increasing background levels.

RF is a form of energetic air pollution that requires far more regulation by FCC and other agencies, particularly the EPA and the U.S. Fish and Wildlife Service (USFWS). But there is no funding available to study, much less regulate RF at these agencies.

Prior to the telecom buildout in the early 1990's, baseline ambient RFR data was gathered in 1980 by the EPA in the largest multi-region survey ever performed. This data can be used to compare with today's rising exposures, yet no agency has continued to gather information, nor has this early study been updated in the U.S. EPA researchers, Richard Tell and Edwin Mantiply (1980)[14], assessed background levels of broadcast signal field intensity RFR for three years and obtained data at 486 locations distributed throughout 15 large cities. The data collectively represented 14,000 measurements of very high frequency (VHF) and ultra high frequency (UHF) radiation used in TV broadcast in ambient environments and they estimated exposure at 47,000 census districts within the metropolitan boundaries of those cities. At the time, ground-based broadcast signals from TV, AM radio and the then-increasing FM radio transmissions were the only exposures. There were no cellular services and very little satellite transmission at that time.

The study found that 20 percent of the total U.S. population was exposed to time-averaged VHF and UHF broadcast radiation at a median level of 0.0005 microwatts per centimeter squared (μW/cm2). The data suggested that only 1 percent of the population, or about 441,000 people, were potentially exposed to levels greater than 1μW/cm2 – the safety limit recommended by the USSR which was 1000 times more stringent than the U.S. safety guidelines back then. The data seemed reassuring for the general population at that time. Much has changed since then.

One European survey was reported on in Microwave News in 2000.[15] It found that background RFR levels in several cities had increased 10 times over the previous two decades. Changes in U.S. cities were thought to be comparable. In the European report, the primary cause was mobile phone technology. The short piece read:

> **Urban Electrosmog Increasing**
>
> RF/MW radiation levels in urban areas are approximately ten times higher than they were 20 years ago—and most of the increase is due to wireless communications, according to Dr. Yngve Hamnerius of Chalmers University of Technology in Göteborg, Sweden.

[14] Tell, R. A., Mantiply, E. D., Population Exposure to VHF and UHF Broadcast Radiation in the United States, Proceedings of the IEEE, Vol. 68, NO 1, January 1980.

[15] Urban Electrosmog Increasing, Microwave News, Vol. XX No.4, July/august 2000, p. 3. http://microwavenews.com/news/backissues/j-a00issue.pdf

Hamnerius measured radiation levels in the 30 MHz-2 GHz frequency range at 26 sites across Sweden with varying levels of urbanization. In cities, the median power density was 0.05 μW/cm2, with a 61% average contribution from GSM base stations. In rural environments, the radiation levels were about 1,000 times lower with the largest contribution coming from television broadcasters, which account for 48% of the total.

Hamnerius contrasted his results with those of Richard Tell and Edwin Mantiply in the late 1970s, when both were at the U.S. Environmental Protection Agency in Las Vegas. Their survey of 12 large American cities showed that the median exposure of the population was 0.005 W/cm2 (see *Radio Science, 17,* pp.39S-47S, 1982).

The following is a list of RF-levels measured in other countries.

- Amoako et al. (2009)- Ghana- 900-1800 MHz- 0.001 μW/cm^2
- Dode et al. (2011)- Brazil- cell tower- 0.04 - 40.78 μW/cm^2
- Dhami (2011)-India-10 MHz-8 GHz- 1.148 μW/cm^2
- Firlarer et al. (2003)- Turkey- GSM900 MHz - 3 μW/cm^2
- Frei et al. (2009)- Switzerland- 12 different bands from FM (88 MHz- 108 MHz) to W-LAN (2.4-2.5 GHz) - 0.013 μW/cm^2
- Henderson et al. (2006)- Australia- 870-1200 MHz- 0.8 μW/cm^2
- Joseph et al. (2008)- Belgium – FM, GSM900, GSM1800 and UMTS- 0.07 μW/cm^2
- Kim et al. (2010)- Korea- CDMA800 and CDMA1800- 0.6 μW/cm^2
- Thuroczy et al. (2006)- Hungary- 9 bands between 80-2200 MHz- 0.025 μW/cm^2
- Viel et al. (2009) - France- 12 bands: FM to mobile phone- 0.6 μW/cm^2

Although cellular service did not exist when the EPA survey was done, cell service now functions in the UHF bands and higher frequencies. So today's exposures are broadly comparable to background levels noted in that EPA review, which can be used as a baseline. When the U.S. switched to digital TV in 2008, it freed up spectrum "white space" previously used for analog TV transmission. That spectrum space is now allocated for 4G wireless Internet and both the VHF and UHF bands will be used in the upcoming ubiquitous WiMax service in rural areas.

The advent of digital technology, which simulates pulsed waves, significantly changed communications signaling characteristics, allowing for a second universal transmission system to be built on top of the old analog signals. This not only doubled

overall environmental RFR exposures, it introduced a completely new kind. It was the introduction of digital technology that facilitated the reshuffling of various RF bands in the 'limited real estate' of the electromagnetic spectrum. This reshuffling continues at FCC today with new upcoming airwave auctions. There is never enough spectrum to satisfy society's desire to use it. As a consequence, we have now filled in most of the lower nonionizing bands with commercial, private, and military use; split the signals; digitized them; and are now branching into higher frequencies such as infrared to be used in communications.

There is virtually no research to indicate that this is safe for either humans or wildlife but other species are highly sensitive in ways that humans are not. Some infrared frequencies are visible to other species. For instance, birds see the color red in ways that we do not and steady red lights atop towers are attractants at night. Red steady lighted towers are known to kill many more birds that white flashing lights.[16]

Birds' feathers are also known to have piezoelectric properties and are capable of conducting EMF/RF deep within bird body cavities. And birds are known to be sensitive to RFR. [17],[18]

According to Albert M. Manville, II, Ph.D., Senior Wildlife Biologist, Division of Migratory Bird Management at the U.S. Fish and Wildlife Service[19]:

> " The effects of radiation from communication towers on nesting and roosting wild birds are yet unstudied in U.S., although in Europe, Balmori (2005) found strong negative correlations between levels of tower-emitted microwave radiation and bird breeding, nesting, and roosting in the vicinity of electromagnetic fields in Spain. He documented nest and site abandonment, plumage deterioration, locomotion problems, and death in House Sparrows, White Storks, Rock Doves, Magpies, Collared Doves, and other species. While these species had historically been documented to roost and nest in these areas, Balmori (2005) did not observe these symptoms prior to construction of the cellular phone towers. Balmori and Hallberg (2007) and Everaert and Bauwens (2007) found similar strong negative correlations among male House Sparrows. Under laboratory conditions, T. Litovitz (pers. comm.) and De Carlo *et al.* (2002) raised troubling concerns about impacts of low-level, non-thermal radiation from the standard 915 MHz cell phone frequency

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16 Manville, A.M., Anthropogenic-related Bird Mortality Focusing on Steps to Address Human-caused Problems – a White Paper for the Anthropogenic Panel, 5th International Partners in Flight Conference, August 27, 2013, Snowbird, Utah

17 Tanner, J.A. Effect of Microwave Radiation on Birds, *Nature* 210, 636 (07 May 1966);doi:10.1038/210636a0

18 Tanner, J.A., Romero-Sierra, C., Davie, S.J. Non-thermal Effects of Microwave Radiation on Birds, *Nature* 216, 1139 (16 December 1967); doi:10.1038/2161139a0

19 Albert M. Manville, II, Ph.D., Senior Wildlife Biologist, Division of Migratory Bird Management (DMBM), U.S. Fish and Wildlife Service, 4401 N. Fairfax Dr.–MBSP 4107 Arlington, VA 22203; 703/358-1963; albert_manville@fws.gov

> on domestic chicken embryos – with lethal results (Manville 2009). Given the findings of the studies mentioned above, field studies should be conducted in North America to validate potential impacts of communication tower radiation – both direct and indirect – to birds and potentially other animals. However, these have yet to be performed." (See References section for Manville citations.)

Dr. Manville is also on the Radio Frequency Inter-Agency Work Group (RFIAWG) and has worked closely with the FCC on towers and bird-death mitigation.

Birds are not the only species of fauna and flora affected. RFR can induce electric and magnetic fields in living tissue. While a complete literature review is beyond the scope of these comments, a selected sampling of both ELF and RFR exposures noted in wildlife includes:

- Alfonso Balmori[20] found that sparrows and other bird species abandoned areas where RF backgrounds were highest due to the presence of cell phone base stations. Other species affected included bats, invertebrates, insects, domestic animals, trees and bushes.
- Ioannis Magras and Thomas Zenos,[21] found increased rates of infertility and growth abnormalities in test animals at some distance from antenna parks where exposure levels were well below standards. By the fifth generation, test animals were permanently infertile.
- Andrea De Carlo, Nicole White, Fuling Guo, Peter Garret, and Theodore Litovitz[22] found decreases in the production of heat shock proteins in chick embryos. Heat shock proteins help maintain the conformation of cellular proteins during periods of stress. A decrease in their production diminishes cellular protection in a way that could lead to cancer and other diseases.
- Atsuko Kobayashi and Joseph Kirchvink[23] found myriad species contain the magnetic crystal magnetite and rely on it for critical activities in mating, direction-finding, and migratory patterns, among other things. Magnetite couples with external EMF/RF couples a million times more efficiently than any other known biological material**.**

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[20] Balmori, A.M., The Effects of Microwave Radiation on the Wildlife, Preliminary Results, Valloid, Spain, 2003.
[21] Magras, I., Zenos, T., RF Radiation-Induced Changes in the Prenatal Development of Mice, Bioelectromagnetics 18:455-461, 1997).
[22] DeCarlo, A., White, N., Guo, F., Garret,G. Litivitz, T., Chronic Electromagnetic Field Exposure Decreases HSP70 Levels and Lowers Cytoprotection, Journal of Cellular Biochemistry 84:447-454, 2002.
[23] Kobayashi, A., Kirchvink, J.,Magnetoreception and Electromagnetic Field Effects: Sensory Perception of the Geomagnetic Field in Animals and Humans," Electromagnetic Fields, Biological Interactions and Mechanisms, Ed: Martin Blank, Advances in Chemistry Series 250, 1995, p 367-394.

- W. Loscher and G. Kas,[24] found severe behavioral anomalies in dairy cows near TV and RF-transmitting towers. Effects included lower milk production, excitability, birth defects, mastitis and others.
- A. Belyavskaya[25] found that plant roots exposed to extremely low magnetic fields exhibited a strong cytochemical reaction in root cells after exposure.

Other species are affected by increasing ambient backgrounds, perhaps even more so than humans due to their different physiologies. Effects seen in the literature for both *in vitro* and *in vivo* research include habitat loss and abandonment, infertility, adverse reproductive outcomes, cellular stress, and chemical changes, among others. And there are plausible mechanisms for biological action with the presence of magnetite in all species studied. Yet there are no guidelines at any regulatory agency to protect the environment, even though the FCC standards are considered – erroneously in our opinion – to include "environmental" exposures. There are glaring holes in this presumption.

Cellular communication infrastructure, though orders of magnitude lower in power density than broadcast facilities, are vastly more ubiquitous and placed much closer to the human population and wildlife in both urban and rural areas. The increasing advent of technologies like WiMax now affects formerly low RFR environments. Broadband-over-Powerlines will add to the rural exposures. We are doing this with no understanding of the broader consequences.

The rise in ambient RF levels is the single biggest environmental alteration within the last 20 years. Follow-up of the Tell and Mantiply/EPA study and the Hamnerius survey are imperative given today's increasing ambient RF levels.

12: Assessing Outdoor Far-Field Exposures:

Assessing outdoor exposures can be particularly difficult for a variety of factors. One question involves how best to capture field exposure data, e.g. through computer estimates or actual dosimetry measurements? Distance from a generating source has traditionally been used as a surrogate for probable power density but that is imperfect at best, given how RF energy couples with the environment once transmitted. Complicated factors and numerous variables come into play, such as orientation toward the transmitting source, species, size,

[24] Loscher, W., Kas G;, Conspicuous behavioral abnormalities in a dairy cow herd near TV and Radio transmitting antenna, Prakt. Tierarzt [Practical Veterinary Surgeon], 79:5, 437-444, 1998.
[25] Belyavskaya, N.A., Ultrastructure and Calcium Balance in Meristem Cells of Pea Roots Exposed to Extremely Low Magnetic Fields, Elsevier Sciences, Ltd. Pergamon, Adv. Space Res. Vol. 28, No. 4, pp. 645-450, 2001.

physical composition, genetics, presence of metal objects and topography, to name a few.[26] In human populations, the wearing of personal dosimetry devices appears promising for capturing cumulative exposure data.[27] But attaching RF devices to wildlife is ill-advised despite the frequent use of radio collars and RFID chips by biologists to study wildlife. Deadly sarcomas have been observed in tissue around RFID chips imbedded in domestic pets, for instance.[28] While RFID chips are supposed to be passive until called upon to give up information by a device, these sarcomas are an alarm signal that RFID's are: 1) malfunctioning; and 2) the low-level fields caused by the batteries may be affecting tissue. Radio collars attached typically at the head to wildlife transmit constantly and work off of satellites, thus requiring stronger emissions.

One study that indicates the increasing background levels of mobile phone infrastructure was done on humans in 2009 using personal dosimetry devices to examine the total exposure levels of RFR in the Swiss urban population[29]. What they found was startling. Nearly a third of the test subjects' cumulative exposures were from cell tower base stations. Prior to this study, exposure from base stations was thought to be insignificant due to their low-power densities and to affect only those living or working in close proximity to such infrastructure. But this study showed that the general population moves in and out of these particular fields with more regularity than previously thought. That assessment would apply to wildlife, too.

In the study, a sample of 166 volunteers from Basel, Switzerland, agreed to wear personal exposure meters (called exposimeters). Frei et al found that nearly one third of total exposures came from cell phone base stations. Participants carried an exposimeter for 1 week and also completed an activity diary. Results found a mean weekly exposure to all RF and/or EMF sources was 0.013 milliwatts per square centimeter (mW/cm2). Exposure was mainly from mobile phone base stations (32.0%); mobile phone handsets (29.1%); and domestic digital enhanced cordless telecommunications (DECT) phones (22.7%). Mean values were highest in trains (0.116 mW/cm2), airports (0.074 mW/cm2), and tramways or buses (0.036 mW/cm2) and were higher during the daytime (0.016 mW/cm2) than the nighttime (0.008 mW/cm2).

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[26] Levitt, B. B., Lai, H. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays, Enviro. Rev. 369-395 (2010), doi:10.1139/A 10-018 http://www.nrcresearchpress.com/doi/pdf/10.1139/A10-018

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Another surprising finding of this study implied that at the belt, backpack, or in close vicinity to the body in test subjects, the mean base station contribution corresponded to about 7 min of mobile phone use. In other words, ambient exposure from infrastructure was a significant contributor beyond one's personal choice to use individual devices.

RF field strength falls off rapidly with distance from the transmitting source, but predicting actual exposures based on simple distance from antennas using standardized computer formulas is inadequate. Actual exposure metrics can be far more complex in both urban and rural areas, to humans and wildlife alike. Contributing to the complexity is the fact that the narrow vertical spread of the beam creates a low RF field strength at the ground directly below the antenna. As a person or wildlife species moves away or within a particular field, exposures can become complicated, creating peaks and valleys in field strength. Scattering and attenuation alter field strength in relation to building placement, architectural composition, the presence of trees, soil type, and topographical features such as mountains and rock formations.[30] Power density levels can be 1-to-100 times lower inside a building, for instance, depending on construction materials. Exposures can differ greatly depending on numerous factors, such as orientation toward the generating source, as well as the presence of conductive mediums like water, or minerals in soil containing salt, iron and copper. Exposures can be twice as high in upper floors as in lower floors, as found by Anglesio et al.[31] This would apply to birds/bats/bees and other insects receiving higher exposures when flying at a lateral plane with transmitting antennas atop a tower or mounted on other structures.

Although distance from a transmitting source has been shown to be an unreliable determinant for accurate exposure predictions, it is nevertheless useful in general ways. For instance, it has been shown that radiation levels from a tower with 15 non-broadcast radio systems will fall off to natural background levels at approximately 1500 feet, or approximately 500 meters.[32] This would be in general agreement with the lessening of symptoms in human populations living near cell towers at a distance over 1000 ft (300

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meters) found by Santini et al[33], Abdel-Rassoul et al, [34]Hutter etc al ,[35] Navarro et al,[36] and Oberfield et al.[37]

Unfortunately, there is very little far-field distance-to-safety ratios research for wildlife as this has not been studied with that focus in mind. What little EMF/RF field research on wildlife has been conducted, has been focused on behavior, mortality and reproductive outcomes.

13. Conclusion: The following are suggestions to FCC in updating the RFR exposure standards:

- Use both SAR and MPE but not interchangeably.
- Post SAR's on the FCC's website, on products, and at point-of-sale.
- Take waveform specifics and modulation into consideration.
- Increase tower/antenna array monitoring for compliance with FCC standards.
- Institute large setbacks from tower installations, 1500' minimum for cell towers at 150' in height. Lower height DAS systems should be discouraged unless large setbacks from dwellings/business can be attained.
- Tell Congress that the EPA should be refunded for EMF/RF research and standards setting/review; and that USFWS should have research appropriations to specifically study RFR effects on wildlife.
- Decrease MPE's – FCC is supposed to regulate the airwaves and enforce safety. Assisting industry is secondary.
- Reduce categorical exclusions based solely on power density. Ubiquity of exposures, such as from smart grid/metering, also count.
- Set limits for chronic exposures from multiple sources and cumulative effects.
- Make clear that FCC standards as currently written are for human exposures only and do not include wildlife or protect the environment.
- Take a Precautionary Approach
- Institute more field measurement and less computation.

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Appendix A Attached:

Levitt, B.B., Lai, H. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays, Enviro. Rev. 369-395 (2010), doi:10.1139/A 10-018 http://www.nrcresearchpress.com/doi/pdf/10.1139/A10-018

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