An open letter to the US-FCC and US-HHS: How electronically generated coherent EMFs used in wireless communication act via voltage-gated calcium channel activation to produce diverse biological effects.

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Abstract

Michael Faraday & Pierre Guitard showed early in the 19th century, that electric currents produced a coherent electromagnetic field (EMF) in the space around them which produced, in turn, strong electric and magnetic forces. Most natural EMFs are incoherent, being produced by many photons going in different vector directions with different polarities, phases and often frequencies, producing only miniscule forces. The coherent electronically generated are required for all wireless communication because of the essential role of strong electric forces in such communication. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has touted "safety guidelines" which argue that only thermal effects can be produced by EMFs and that their biological effects are determined by their intensities averaged over either 6 minutes or 30 minutes. However, EMF biological effects have been shown to be produced electric forces and magnetic forces acting on a structure called the voltage sensor which controls the voltage gated ion channels with the most important effects produced be the calcium (VGCC) channels where EMF activation acts via elevated intracellular calcium. Blockers of the VGCCs greatly lower diverse EMF effects. The physics and the biology provide multiple findings which falsify ICNIRP and similar "safety guidelines" such that the scientific method requires that they be thrown out.

The Physics of EMFs

It was first shown by Michael Faraday, the great British physicist, in a paper published in 1831, that electric currents induce electromagnetic fields (EMFs) in the space surrounding them (1-3). Chapter 7 in (4) entitled "Electromagnetic Induction" is a detailed discussion of the physics of such induction. Faraday later inferred that such induced EMFs must be coherent because the whole induced field is induced by the same electric current (2) and while he never proved such coherence, he did show that such electronically generated EMFs produced strong electric forces and magnetic forces. In 1836, Faraday constructed and studied what later became known as Faraday cages (5) which protected sensitive electronic devices and later living tissues from effects produced by such strong electric forces. Coherence of such electronically generated EMFs was demonstrated experimentally by the French physicist Pierre Guitard in 1850 (3).

In 1909, the Nobel prize in physics was given to Guglielmo Marconi and the Austrian physicist Karl Ferdinand Braun, working in Heidelburg, for showing that coherent electronically generated EMFs could act via their strong electric forces in wireless telegraphy (6,7). Braun's contribution

was to design the emitting antennae so as to maintain the coherence of the electric field such that maximum electric forces are placed on the receiving antennae (7). Subsequently, all wireless communication has been shown to act similarly via their coherent electronically generated EMFs and their strong electric forces. This includes radio, television, cordless phones, radar, satellite phones, smart meters, Wi-Fi, Bluetooth, etc., etc. Furthermore, EMF reflection off of either smooth or rough surfaces and also EMF refraction, often described as reflection, scattering and diffraction, have each been shown to make wireless communication much more difficult as shown in each of the three most cited wireless communication university textbooks (8-10). Reflection, diffraction and scattering each disrupt the coherence of electronically generated EMFs. The importance of maintaining EMF coherence in wireless communication has been a major focus in the design of emitting antennae used in wireless communication (10-13) as well as in other contexts (14).

Powerline transmission including both high voltage powerlines and dirty electricity (containing higher frequency transients) can also act via their coherent EMFs to produce biological effects via their strong electric and/or magnetic forces.

It should be noted that most natural EMFs are incoherent, being composed of astronomical numbers of individual photons going in different vector directions with different phases and polarities and sometimes with different frequencies. They produce, therefore, only miniscule electric or magnetic forces.

ICNIRP and Other Similar "Safety Guidelines"

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an organization set up in conjunction with the telecommunications industry to suggest safety guidelines to be used to protect us from such non-ionizing radiation including electronically generated radiation used for wireless communication (15-17). The guidelines were originally proposed in 1998 and republished in very similar form in 2002 and 2020. They are all based on all biological effects being thermal effects where the assessments of possible effects were made based on average EMF intensities averaged over either a 6-minute period or a 30-minute period. Average intensities over 6 minutes or 30 minutes may make sense if only thermal effects occur from EMF exposures because heating of tissues can typically occur slowly over time. Similar "safety guidelines" based on intensities averaged over 6 minutes or 30 minutes and only thermal effects occurring have been adopted by the US-FCC and many other national and international regulatory agencies.

I will discuss towards the end of this paper how various physics and biological findings falsify the predictions of the "safety guidelines".

Electronically Generated EMFs Act Via Voltage-Gated Ion Channel (VGIC) Activation and Particularly Via Voltage Gated Calcium Channel (VGCC) Activation: The Voltage Sensor as the Direct Target of Electronically Generated EMFs

My first paper on what I later came to know were coherent, electronically generated EMFs, showed that diverse such EMFs each acted via activation of voltage gated calcium channels (VGCCs) to produce elevated intracellular calcium $[Ca^{2+}]i$ (18). The key findings here are that

effects produced by diverse such EMFs were greatly lowered by using VGCC-specific calcium channel blockers. The EMFs studied included static electric and magnetic fields, extremely low frequency EMFs including 50 or 60 Hz from our electric power wiring, intermediate frequency EMFs, radio/microwave frequency EMFs and nanosecond pulse EMFs. VGCC activation was later shown to include pulse modulated EMFs which are used in all wireless communication except for FM radio or 2G cell phones (19) and also millimeter wave frequency EMFs (20). The VGCC-specific blockers used in these studies included verapamil and the dihydropyridines which each specifically block the L-type channels. The studies also showed a T-type, N-type and P/Q-type blocker could each greatly lower effects when used alone or in conjunction with other blockers (18). Each of those four types of channels are controlled by a structure called the voltage sensor through which changes in electric forces can open the channel. This paper (18) has been cited over 700 times (Google Scholar) and has, therefore, been assessed by the scientific community to be a very well documented well supported paper.

One very important paper that was not cited on (18) because it did not come up in my literature search is the El-Swefy et al study (21) published in 2008. This study showed that 2 h pr day of low intensity mobile phone base station (also known as cell phone tower) radiation produced massive neurodegeneration in rats. In four weeks, 34% of the brain cell were dead (21). Ref (21) also showed that amlodipine, one of the dihydropyridine VGCC calcium channel blockers, greatly lowered both 11 measured effects and also four observed behavioral effects (21,22).

While the calcium channels are responsible for producing most of the biological effects of these electronically generated EMFs other VGICs, each controlled by a similar voltage sensor including the sodium, potassium and chloride channels are also activated by these EMFs (23-25). Another channel, the large calcium-activated potassium (BK) channel is also activated by EMFs (25,26) and has been shown to have a similar voltage sensor (27,28).

Three research groups that each showed that EMFs act activating VGIC channels each proposed that this occurs by putting forces on the charged amino acid side chains of the voltage sensors controlling the VGICs (19,23,24). Each argued that the structure of the voltage sensor makes is especially sensitive to such forces (19,23,24). However, they do not provide proof for that mechanism. It is possible that the EMFs act via depolarization of the plasma membrane and that depolarization acts via the voltage sensor to activate the channels. There are, however studies that do provide such proof. Three studies used patch clamp & voltage clamp methodologies (30) to prove such direct action (31-33). Those studies (31-33) showed that when electronically generated EMFs activated the voltage-gated sodium channels, the voltage-gated potassium channels and the L-type VGCCs via direct activation rather than by plasma membrane depolarization. It may be inferred, therefore, that in these studies such EMFs act directly on the electric charges of the voltage sensor rather than indirectly via depolarization.

However, that is not the whole story. Two biophysical studies (34,35) have each shown that when very short EMF pulses produce supraphysiological voltage gradients across regions of the plasma membrane, they can produce electroporation pores in channels containing a voltage sensor. While these two studied mainly the voltage-gated sodium channels and the VGCC calcium channels, other studies have demonstrated similar responses in other channels containing a voltage sensor. When longer term electric fields alter the plasma membrane

potential in one part of the cell, ions tend to move to produce a more uniform membrane potential around the cell plasma membrane. However, as discussed in the Rems et al (34) paper, very short EMF pulses produce very different membrane potentials across different parts of the cell's plasma membrane because of the time it takes for ions to move around. Short pulses may may then only produce electroporation in a region of the plasma membrane but once electroporation occurs in a cell, it depolarizes the entire plasma membrane leading to activation of many of the VGICs. There are many studies in the EMF-Portal database where short pulses act via electroporation to produce EMF effects; many of these have been published by Dr. AG Pakhomov and his colleagues. I will discuss pulsation again later in this paper.

The central role of the voltage sensor in each of these mechanisms should not be surprising. Catterall et al (36) have shown that the voltage sensor is the main mechanism by which electrical forces produce consequent biochemical and physiological changes in the cells of our bodies.

ICNIRP 2020: Falsifying Evidence

As I think you know, the core of the scientific method is that when we have a scientific theory, and all such theories must make testable predictions and when repeated studies falsify those predictions, the theory must be thrown out. The 2020 ICNIRP "safety guidelines" predict that there are only thermal effects and that those thermal effects or lack thereof can be predicted based on average EMF intensities averaged over a 6 minute period or 30 minute period. Those predictions can, therefore be used to determine whether we have well documented falsifying evidence.

We will discuss here the falsifying evidence from the physics and also from the biology, in some cases in conjunction with the physics.

Michael Faraday in papers published in 1831 to 1836, showed that electric currents produced an electromagnetic field (EMF) in the space around those currents and he proposed that such electromagnetic fields would be coherent and would, therefore produce strong electric forces and magnetic forces. Faraday showed that these electronically generated EMFs did produce strong electric forces and magnetic forces and Pierre Guitard showed in 1850 that these electronically generated EMFs are coherent. These findings, therefore show that these electronically generated EMFs can act via electric forces and/or magnetic forces to produce biological effects consequently falsifying the ICNIRP prediction that there can only be thermal effects.

The physics also showed in the early 20th century that the electronically generated strong electric forces were essential for wireless communication. Therefore, the ICNIRP "safety guidelines" may protect us from incoherent natural EMFs but systematically fail to protect us from electronically generated EMFs including those used for wireless communication. These findings, therefore falsify the use of the ICNIRP "safety guidelines" for all the uses for which they were developed – namely to protect us from human electronically generated EMFs.

In terms of the biology, the most important falsifying findings are where various electronically generated EMF effects are greatly lowered by VGCC-specific calcium channel blockers. Because

calcium channel blocker studies, often look at multiple effects, there are over 100 such findings in publications I have cited. The classical example of that is the El Swefy et al. (21) study where a total of 15 different effects caused by electronically generated EMFs were blocked by amlodipine. Such findings simultaneous falsify any possible thermal mechanism while documenting that each effect is produced via VGCC activation. Consequently, the VGCC calcium blocker studies are more than sufficient on their own to falsify the "safety guidelines" and require, therefore, as a consequence of the core principle of the scientific method, that the "safety guidelines" must be thrown out.

The physics of wireless communication shows that all wireless communication as it is currently done requires that such communication be done by using coherent electronically generated EMFs which produce strong electric and magnetic forces such that those electric forces must be strong enough to carry the information being communicated. Therefore, the physics predicts that such wireless communication EMFs will be especially active in producing VGCC activation because of those strong forces and consequently when the "safety guidelines" falsely claim that only thermal effects can occur, the assessment failure produced by that false claim may be especially egregious with regard to wireless communication EMFs. Consequently, current "safety-guideline" assurances of safety fail most profoundly with regard to those EMFs that are of greatest concern to both portions of the public and the scientific community—those used for wireless communication.

Dr. Igor Belyaev and DNA Resonance Effects

Dr. Igor Belyaev and colleagues have published a series of papers on millimeter wave DNA effects (37,38). What they have found, is that certain very specific EMF frequencies in the millimeter wave frequency range can produce effects on the DNA in the bacterium *Escherichia coli* and that the exact frequencies producing these effects vary with the size of the *E. coli* genomic circular DNA. Such specific frequency responses have been interpreted in terms of resonance with the specific target of those frequencies. Consequently, the inference made by Belyaev et al that the DNA itself is the target is well-supported. Furthermore, because mammalian cells produce similar effects from irradiation with a similar but not identical frequency strongly suggests that DNA is also the EMF target when similar effects are also occurring in mammalian cells. Because the ICNIRP "safety guidelines" assume that all EMF effects are thermal effects rather than effects produced by resonance with a specific cellular target, these findings again falsify the ICNIRP "safety guidelines."

Further Consideration of Certain Sections of (15).

Table 2 in ICNIRP 2020 (15) is identical to a table in ICNIRP 1998 (16) . I don't see substantial changes in the "safety guidelines" over time, although there have been changes in the accompanying rhetoric. Table 2 is entirely based on only thermal effects occurring and on intensities averaged over 6 minute periods. It allows much higher exposures for partial body exposures as compared with whole body exposures. It should be noted that when the effects are produced via effects at the levels of individual cells as is the case with the VGCC activation mechanism, the impacts on individual cells will be the same for whole body and partial body

exposures. Table 2 also allows occupational exposures to be higher as compared with general public exposures.

2 quotes from p. 487 in (15):

1. For the purpose of determining thresholds, evidence of adverse health effects arising from all radiofrequency EMF exposures is considered, including those referred to as 'low-level' and 'non-thermal', and including those where mechanisms have not been elucidated. *Similarly, as there is no evidence that continuous (e.g., sinusoidal) and discontinuous (e.g., pulsed) EMFs result in different biological effects (Kowalczuk et al. 2010; Juutilainen et al. 2011).* (italics added)
2. *However, there is no evidence that the radiofrequency spectral component from an EMF pulse (without the low-frequency component) is sufficient to cause changes in the permeability of cell membranes.* (Italics added)

In order to analyze these two claims, it is necessary to examine the scientific literature on two different types of EMF pulsation, nanosecond EMF pulses and pulse modulation pulses, with the latter being used to carry information in almost all wireless communications, the exceptions being FM radio and 2G cell phones.

Nanosecond pulses are defined as pulses with length between 1 nanosecond and 1 microsecond. These are pure pulses that go from zero to a peak and back to zero within that time range. There is no underlying frequency that is modulated. There are circa 300 studies in the EMF-Portal database, where nanosecond pulses produce biological effects. A substantial number of these studies were reviewed in the Batista Napotnik et al review (39). In several of these studies, it was shown that VGCC-specific calcium channel blockers greatly lowered effects (40-43), showing that as in the case other EMFs, nanosecond pulses act primarily via VGCC activation and consequent increases in $[Ca^{2+}]i$. showing therefore, that nanosecond pulse EMFs act similarly to other electronically generated EMFs. ICNIRP claims in statement 2 above, that you must have low frequency radiation in order to get changes in cell membrane permeability, but if one does a Fourier analysis (a mathematical method calculates intensity values of underlying frequencies for any type of radiation), you will never find any low frequency radiation in a nanosecond pulse – they simply go up and down too rapidly. So here is another situation where the genuine science and in this case mathematics, falsifies ICNIRP's claim that low frequency EMFs are essential for causation of certain biological effects.

There is a second ICNIRP claim which is falsified by the nanosecond pulse studies. ICNIRP claims in their "safety guidelines" that biological activity of EMFs can be predicted by their average intensities averaged over either a six minute or 30-minute period. However, when you take nanosecond pulses that produce biological effects and average them over a six minute period, typically roughly 10^{10} to 10^{12} times longer than the pulse itself, this decreases the average intensity by a factor something like 10^{10} to 10^{12}, ICNIRP "safety guidelines" then predicts there cannot be any effects but as already stated, there are effects produced by most of these nanosecond pulses. So these findings falsify the use of long-term (6 minute) average intensities in the "safety guidelines". I want to state here, that this conclusion is not original with me.

Let's now go over to pulse modulation pulsation. There have been 11 published often highly cited articles which have each reviewed a literature showing that electronically generated pulse modulated EMFs produce in most cases, much higher biological effects than do non-pulsed, also known as continuous wave EMFs of the same or even higher average intensities (19,44-53). Three of those papers were experimental studies that added much more experimental evidence on this and where the title of the article clearly shows its relevance. ICNIRP falsely claims in the first quotation above, that there is no evidence of this. Consequently, here is another highly repeated falsification of an ICNIRP claim and since there are large amounts of contrary evidence, ICNIRP's failure here raises questions about its credibility elsewhere.

I want you to look at the abstract of the Creighton et al (47) paper

Exp Eye Res. 1987 Sep;45(3):357-73. doi: 10.1016/s0014-4835(87)80123-9. **In vitro studies of microwave-induced cataract. II. Comparison of damage observed for continuous wave and pulsed microwaves**

M O Creighton [1], L E Larsen, P J Stewart-DeHaan, J H Jacobi, M Sanwal, J C Baskerville, H E Bassen, D O Brown, J R Trevithick

Abstract

Depth of damage caused by pulsed (PU) and continuous wave (CW) microwaves was estimated by scanning electron microscopy in rat lenses fixed immediately, after irradiation in vitro in circulating thermostatically controlled buffered saline. Pulses of 10 microseconds width and 24 kW peak power were delivered to the lens at different repetition rates in order to permit the same total energy to be delivered during 6, 20 or 60 min of irradiation at specific absorption rate (SAR) values of 0, 5.75, 11.5, 23, 69, 231 and 750 mW g-1; total energy [power (pow) x time] deposited in the lens was 0, 0.23, 0.46, 1.38, 4.6, and 15 W min g-1. Damage (granular degeneration of cells at the lens equator) was measured at the apex of penetration of the degeneration. The depth of degeneration (dep) of Pu or CW was compared either: (1) by a one-way analysis of variance (ANOVA) for the CW data alone and the 11 combinations of (pow x time); or (2) by using two alternative models to fit the data, to permit experimental distinguishment between: (a) reciprocal effects of pow x time; and (b) separate effects. *Using the ANOVA analysis, the Pu mode of irradiation resulted in more damage at the same average power for every combination tested except one (23 mW g-1, 6 min).* Although the separate-effects models explained more of the variation in depth of damage, the reciprocal effects model may provide an adequate fit for practical purposes and has the advantage of greater simplicity. For both models, the pulsed irradiation mode produced 4.7 times the depth of damage caused by CW irradiation. These results are discussed in relation to previous Pu-CW comparisons. It is proposed that this additional damage at the same average power is caused by thermoelastic expansion (TEE).

What you can see here, is that Creighton et al (47), have done 18 different comparisons of effects produced by pulsed EMFs with identical average intensity continuous wave (non-pulsed) EMFs and in 17 of the 18, the pulsed EMFs produced statistically significantly higher effects than did the continuous wave EMFs of the same average intensity. These findings again falsify the

ICNIRP claim that average intensities over a 6 minute period can predict biological effects. Much more importantly, it is incomprehensible that any group of ethical scientists could claim that "*there is no evidence that continuous (e.g., sinusoidal) and discontinuous (e.g., pulsed) EMFs result in different biological effects"* when there are vast numbers of findings, many of them highly cited, that show just the opposite.

Table 9. Electric currents averaged over 6 minutes.

On Table 9 in (15), ICNIRP does for the first time raise the issue of electric fields producing effects. However, it assumes in Table 9, that all electrical effects can be assessed via average field strengths averaged over 6 minutes. That assumption is incorrect, as shown by the nanosecond pulse studies discussed above in this section. It follows that the structure of this proposed "safety guideline" has again been falsified.

In summary, I have not found any substantive part of ICNIRP (15) that is scientifically well supported, although it is possible that I have missed something. Rather, it appears that ICNIRP has apparently systematically avoided examining any findings that falsify its "safety guidelines" and has, therefore, systematically avoided following the scientific method.

Note to the FCC:

There are 9 distinct bodies of falsifying evidence presented here which the scientific method demands that each be taken seriously. Unless each of these can be proven to be false they each falsify important ICNIRP claims. 6 of these may be considered the most important because they falsify essential parts of the "safety guideline". You have threatened to remove submissions for certain reasons but if you remove this one you will be providing a strong argument that you are anti-scientific.

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