Eight Repeatedly Documented Findings Each Show that EMF Safety Guidelines Do Not Predict Biological Effects and Are, Therefore Fraudulent: The Consequences for Both Microwave Frequency Exposures and Also 5G

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Abstract

ICNIRP, US FCC, EU and other EMF safety guidelines are all based on the assumption that average EMF intensities and average SAR can be used to predict biological effects and therefore safety. Eight different types of quantitative or qualitative data are analyzed here to determine whether these safety guidelines predict biological effects. In each case the safety guidelines fail and in most of these, fail massively. Effects occur at approximately 100,000 times below allowable levels and the basic structure of the safety guidelines is shown to be deeply flawed. The safety guidelines ignore demonstrated biological heterogeneity and established biological mechanisms. Even the physics underlying the safety guidelines is shown to be flawed. Pulsed EMFs are in most cases much more biologically active than are non-pulsed EMFs of the same average intensity, but pulsations are ignored in the safety guidelines despite the fact that almost all of our current exposures are highly pulsed. There are exposure windows such that maximum effects are produced in certain intensity windows and also in certain frequency windows but the consequent very complex dose-response curves are ignored by the safety guidelines. Several additional flaws in the safety guidelines are shown through studies of both individual and paired nanosecond pulses. The properties of 5G predict that guidelines will be even more flawed in predicting 5G effects than the already stunning flaws that the safety guidelines have in predicting our other EMF exposures. The consequences of these findings is that "safety guidelines" should always be expressed in quotation marks; they do not predict biological effects and therefore do not predict safety. Because of that we have a multi-trillion dollar set of companies, the telecommunication industry, where all assurances of safety are fraudulent because they are based on these "safety guidelines."

Introduction

The current safety guidelines including the EU safety guideline, the US FCC safety guidelines, the 2013 UK safety guidelines, Canada's safety code 6 and the recent revisions proposed in the 2018 ICNIRP draft, are all very similar to although modified from of the ICNIRP 1998 safety guidelines. The viability of each of these is dependent on the viability of the 1998 ICNIRP safety guidelines [International Commission on non-ionizing radiation protection. 1998 ICNIRP GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC, MAGNETIC AND ELECTROMAGNETIC FIELDS (UP TO 300 GHZ) Health Physics 74 (4):494-522]. There are ongoing processes to make the "safety guidelines" even looser to allow the rollout of 5G and while these are important, they are not considered in this paper.

Table 1: 1998 ICNIRP "Safety Guidelines"

	Frequency range	**Whole-body SAR (averaged over 6 minutes**	**Localized SAR (head & trunk, averaged over 6 minutes**	**Localized SAR (limbs, averaged over 6 minutes**
Occupational exposure	100 KHz-10 GHz	0.4 (W/kg)	10 (W/kg)	20 (W/kg)

General public exposure	100 KHz-10 GHz	0.08 (W/kg)	2 (W/kg)	4 (W/kg)

There are three points that need to be considered:

- Because specific absorption rates (SAR) only predict thermal (heating) effects, there is no reason to assume that these "safety guidelines" predict non-thermal effects.
- There is no reason why effects that occur with very brief exposures should be assumed to be predicted by average exposures over 6 minutes. Some of the more recent guidelines, including the recent ICNIRP draft and the FCC occupational exposure guidelines are averaged over 30 minutes, making this issue of averaging still more problematic.
- When one is concerned about non-thermal responses that are localized, such as local oxidative stress or apoptosis or local DNA effects, there is no reason to use much less stringent guidelines for localized exposures as compared with whole body exposures.

These "safety guidelines" are the basis of the guidelines from the EU, the US FCC, Canada's safety code 6 and others and while there are some minor differences, these ICNIRP levels can be taken as being similar to each of them. Each of these use exposures averaged over 6 minutes or 30 minutes, where allowable levels are based on SAR and, therefore, only protect us from thermal effects. For example, the EU 1999 general public safety guidelines, COUNCIL RECOMMENDATION of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) are identical to those listed by ICNIRP in Table 1 (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31999H0519&from=EN). The Australian (ARPANSA) April, 2002 "safety guidelines" for both general public and occupational exposures are identical to the 1998 ICNIRP guidelines (https://www.arpansa.gov.au/sites/default/files/legacy/pubs/rps/rps3.pdf).

The 1999 FCC "safety guidelines" are listed in Table 2, below and the similarities to and also some differences with the ICNIRP guidelines, shown in Table 1 can be seen.

Table 2: 1999 US FCC occupational and general public limits for both whole body and localized (partial body) exposures

	Frequency range	**Whole body SAR**	**Localized (partial body) SAR**
Occupational exposure	100 KHz – 6 GHz	<0.4 W/kg averaged over 30 minutes	<8 W/kg averaged over 30 minutes
General public exposure	100 KHz – 6 GHZ	<0.08 W/kg averaged over 6 minutes	<1.6 W/kg averaged over 6 minutes

The same three concerns expressed above regarding the ICNIRP guidelines are also concerns with respect to the FCC guidelines. The occupational FCC guidelines are weaker than the 1998 ICNIRP guidelines because it uses 30 minute as opposed to 6 minute averaging. The general public whole body guidelines, possibly the most important, are identical for the two guidelines. The localized (partial body) FCC levels are slightly more stringent than are 1998 ICNIRP levels. There are some differences, but the overall structure of both is very similar, with both based on average intensities or SAR and both, therefore, only possibly predicting thermal effects.

We have, then three points that were raised, above, each of which raise serious questions about the "safety-guidelines." But no information is provided to this point in this paper, as to whether

these guidelines predict biological effects and therefore safety or not. This paper is mainly focused on the following question: How then do the allowable "safety guideline" Exposure levels levels compare with levels found in empirical studies to produce actual effects? Eight distinct types of repeatedly found patterns of evidence are considered here, each of which clearly show that the "safety guidelines" do not predict biological effects.

1. I list here bodies of evidence from published reviews, that clearly show that non-thermal exposures to microwave and other frequency EMF, at levels far below "safety guideline" allowable levels, produce each of 9 different types of important health-related effects. Many of the citations listed here are from my 90 page EMF document but substantial numbers of new findings are listed here, as well.

These effects are as follows:

1) **Lowered fertility, including tissue remodeling changes in the testis, lowered sperm count and lowered motility and other measures of lowered sperm quality, lowered female fertility including ovarian remodeling, oocyte (follicle) loss, lowered estrogen, progesterone and testosterone levels (that is sex hormone levels), increased spontaneous abortion incidence, lowered libido** (25 reviews).

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2) **Neurological/neuropsychiatric effects including sleep disturbance/insomnia; fatigue/tiredness; headache; depression/depressive symptoms; lack of concentration/attention/cognitive dysfunction; dizziness/vertigo; memory changes; restlessness/tension/anxiety/stress/agitation; irritability** (29 reviews).

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3) **Effects on cellular DNA including single strand and double strand breaks in cellular DNA and on oxidized bases in cellular DNA; also evidence for chromosomal mutations produced by double strand DNA breaks. These produce all of the important type of mutations, as described at the DNA level that have roles in cancer causation and in human whole organism mutation** (24 reviews).

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4) **Apoptosis/cell death (an important process in production of neurodegenerative diseases that is also important in producing infertility responses)** (15 reviews).

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5) **Oxidative stress/free radical damage** (important mechanisms involved in almost all chronic diseases; direct cause of cellular DNA damage) (25 reviews).

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There are also 9 additional reviews on cardiac effects. Those cardiac effects, include tachycardia, arrhythmia and bradycardia (with bradycardia typically reported after long times of exposures). Some recent studies have also reported heart palpitations. Arrhythmias, especially when they are associated with either bradycardia or severe tachycardia, are often associated with sudden cardiac death. Sudden cardiac death causes over 5% of the total mortality in technologically advanced countries, so this could be a major source of EMF-caused fatality.

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We have here, a total of 197 bodies of evidence each showing that non-thermal exposures well below ICNIRP, FCC or other "safety guidelines" cause an important health-related effect. These 9 different non-thermal effects are not the only effects apparently being produced. These 197 bodies of evidence *individually* provide strong and in many cases compelling evidence against any claims that can be made on the basis of the ICNIRP, US FCC, EU or other similar "safety guidelines" as do thousands of primary literature citations.

What response do we have from the telecommunications industry or other organizations that have supported the industry positions. The only thing that we have are statements similar to the statement put out by Dr. Jeffrey Shuren, M.D., J.D., Director of the FDA's Center for Devices and Radiological Health on the National Toxicology Program's report on radiofrequency energy exposure as follows: "Based on our ongoing evaluation of this issue, the *totality of the available scientific evidence* (italics added) continues to not support adverse health effects in humans caused by exposures at or under the current radiofrequency energy exposure limits. We believe the existing safety limits for cell phones remain acceptable for protecting the public health." This statement, as were similar statements from other organizations, provided not one iota of evidence in support of the claims. This is obviously unacceptable. What such individuals and organizations need to do when considering the *totality of the evidence* is to consider each of the reviews providing evidence for each of these nine different effects, as well as each of the relevant underlying primary literature citations cited in these reviews. If they wish to rebut these repeated findings, they need to cite each of these reviews, providing an objective description of the relevant evidence described within them and then and only then, provide whatever evidence they may have rebutting the positions taken in these reviews. The complete failure to do this means that the positions taken by Dr. Shuren and similar positions of others on this are fatally flawed. Those flaws go to the heart of the scientific method. Dr. Karl Popper, one of the two most important philosophers of science of the 20th century, has argued compellingly that falsifying information, information that falsifies a theory or hypothesis, is the most important type of information in science. Here we have 197 bodies of evidence that falsify the position of the industry and organizations that historically have supported the industry with no response whatsoever other than a completely undocumented denial.

2. There were also 13 reviews cited in Chapter 1 of my 90 page document and listed immediately below, each of which showed that pulsed EMFs are, in most cases, much more biologically active than are non-pulsed (also known as continuous wave) EMFs of the same average intensity. Because average intensities, averaged over a 6 minute period or even worse a 30 minute period, are the basis of the ICNIRP, US FCC, EU, SCENIHR and Canadian guidelines this is a fatal flaw in the structure of those safety guidelines. Average intensities are ***not*** predictive of biological effects and therefore cannot be used as the basis of any useful regulatory scheme. Pulsation is also of great importance, because all wireless communication devices, communicate at least in part, via pulsation and the smarter they are, the more they pulse. Radar units also expose us to pulsations because of the phased arrays that are involved. Consequently, the role of pulsation is stunningly important with regard to the EMFs we are most exposed to.

13 Reviews Each Showing that Pulsed EMFs Are, in Most Cases Much More Biologically Active than Are Non-Pulsed (Continuous Wave) EMFs of the Same Average Intensity:

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3. The following comes from (Pall ML. 2018 Wi-Fi is an important threat to human health. Environ Res. 2018 Jul;164:405-416; full citations can be obtained from that paper; information inserted into that text is italicized to identify it): How are the non-thermal EMF effects produced? The author found the answer to this question in the already published scientific literature (Pall, 2013). That study showed that in 24 different studies [there are now a total of 26 Pall, (2015b) *and two additional examples were cited in the Wi-Fi paper, for a total of 28*], effects of low-intensity EMFs, including microwave frequency and also extremely low frequency EMFs, static electrical fields and static magnetic fields could be blocked by calcium channel blockers, drugs that are specific for blocking voltage-gated calcium channels (VGCCs). There were 5 different types of calcium channel blockers used in these studies, each thought to be highly specific, each structurally distinct and each binding to a different site on the VGCCs. In papers where multiple effects were studied, all studied effects were blocked or greatly lowered by calcium channel blockers. These studies show that EMFs produce diverse non-thermal effects via VGCC activation Pall 2013; 2014; 2015a & b; 2016a & b) in many human and animal cells. In plant cells, EMFs activate somewhat similar calcium channels and produce somewhat similar effects on oxidative stress, cellular DNA damage and calcium signaling (Pall, 2016a). Furthermore, many different effects shown to be produced in repeated studies by EMF exposures, including the effects discussed above, can be produced by downstream effects of VGCC activation, via increased [Ca2+]i, as discussed in detail below.

Before leaving this issue, it is important to discuss why the VGCCs are so sensitive to activation by these low-intensity EMFs. The VGCCs each have a voltage sensor which is made up of 4 alpha helixes in the plasma membrane, with each such helix having 5 positive charges on it, for a total of 20 positive charges (Pall, 2015b). These voltage sensor helixes are each called S4 helixes because each is the fourth helix in a distinct multi-helix domain. Each of these voltage sensor charges is within the lipid bilayer part of the plasma membrane. The electrical forces on the voltage sensor are very high for three distinct reasons (Pall 2015b; 2015a; 2016a). 1. The 20 charges on the voltage sensor make the forces on voltage sensor 20 times higher than the forces on a single charge. 2. Because these charges are within the lipid bilayer section of the membrane where the dielectric constant is about 1/120th of the dielectric constant of the aqueous parts of the cell, the law of physics called Coulomb's law, predicts that the forces on those charges will be approximately 120 times higher than the forces on charges in the aqueous parts of the cell. 3. Because the plasma membrane has a high electrical resistance whereas the aqueous parts of the cell are highly conductive, the electrical gradient across the plasma membrane is estimated to be concentrated about 3000-fold, as shown by Ohm's law. The combination of these effects means that comparing the forces on the voltage sensor with the forces on singly charged groups in the aqueous parts of the cell, the forces on the voltage sensor are approximately 20 X 120 X 3000 = 7.2 million times higher (Pall, 2015b). The physics predicts, therefore, extraordinarily strong forces activating the VGCCs via the voltage sensor. It follows that the biology tells us that the VGCCs are the main target of the EMFs and the physics tells us why they are the main target. Thus the physics and biology are pointing in the same direction. All of these findings contradict the basic assumptions of the safety guidelines which are based on average exposures averaged over at least 6 minutes and which set allowable levels based on SAR, a measure of tissue heating and therefore are only relevant to thermal effects.

There are also additional findings pointing to the voltage sensor as the direct target of the EMFs. In addition to the VGCCs, there are also voltage-gated sodium, potassium and chloride channels, with each of these having a voltage sensor similar to those found in the VGCCs. Lu et al (2015) reported that voltage gated sodium channels, in addition to the VGCCs were activated by EMFs. Tabor et al (2014) found that Mauthner cells, specialized neurons with special roles in triggering rapid escape mechanisms in fish, were almost instantaneously activated by electrical pulses, which acted via voltage-gated sodium channel activation to subsequently produce large [Ca2+]i increases. Zhang et al (2016) reported that in addition to the VGCCs, potassium and chloride channels were each activated by EMFs, although these other voltage-gated ion channels had relatively modest roles compared with the VGCCs in producing biological effects. Each of these three studies, the Lu et al (2015) study, the Tabor et al (2014) study and the Zhang et al (2016) study used specific blockers for these other voltage-gated ion channels to determine their roles. The Tabor et al (2014) study also used genetic probing to determine the role of the voltage-gated sodium channels. Lu et al (2015) also used whole cell patch clamp measurements to measure the rapid influx of both sodium and calcium into the cell via the voltage-gated channels following EMF exposure. *One important finding that is not in the Wi-Fi paper is that Tekieh et al, in a 2016 paper (Effects of electromagnetic field exposure on conduction and concentration of voltage gated calcium channels: A Brownian dynamics study. Brain Res. 2016 Sep 1;1646:560-569), showed that VGCCs in isolated plasma membranes, were activated by three different frequencies of microwave radiation. That shows that EMF activation of the VGCCs is directly produced by EMF impact on the VGCC protein.* Sodium influx, particularly in electrically active cells, act in the normal physiology to depolarize the plasma membrane, leading to VGCC activation such that the voltage-gated sodium channels may act primarily via indirect activation of the VGCCs. In summary then, we have evidence that in animal including human cells, seven distinct classes of voltage-gated ion channels are each activated by EMF exposures: From the Pall, 2013 review, four classes of voltage-gated ion channels were shown from calcium channel blocker studies, to be activated by EMFs, L-type, T-type, N-type and P/Q –type VGCCs. In this paragraph we have evidence that three other channels are also activated, voltage-gated sodium channels, voltage-gated potassium channels and voltage-gated chloride channels. Furthermore the plant studies strongly suggest that the so called TPC channels, which contain a similar voltage sensor, are activated in plants allowing calcium influx into plants to produce similar EMF-induced responses (Pall 2016a). One can put those observations together with the powerful findings from the physics, that the electrical forces on the voltage-sensor are stunningly strong, something like 7.2 million times stronger than the forces on the singly charged groups in the aqueous phases of the cell. Now you have a stunningly powerful argument that the voltage sensor is the predominant direct target of the EMFs. *Because heating is produced predominantly by the EMF forces on singly electrically charged groups in aqueous solution, the 7.2 million figure suggests that safety guidelines allow us to be exposed to EMFs that are approximately 7.2 million times too high. The failure of the "safety guidelines" to discuss the relevant physics of the voltage sensor means that the physics underlying the "safety guidelines" is deeply flawed.*

There is one additional finding that should be discussed here. In a study published by Pilla (2012), it was found that pulsed EMFs produced an "instantaneous" increase in calcium/calmodulin-dependent nitric oxide synthesis in cells in culture. What Pilla (2012) showed was that following EMF exposure, the cells in culture, must have produced a large increase in [Ca2+]i, this in turn produced a large increase in nitric oxide synthesis, the nitric oxide diffused out of the cells and out of the aqueous medium above the cells into the gas phase, where the nitric oxide was detected by a nitric oxide electrode. This entire sequence occurred in less than 5 seconds. This eliminates almost any conceivable indirect effect, except possibly via plasma membrane depolarization. Therefore that the pulsed EMFs are acting directly on the

voltage sensors of the VGCCs and possibly the voltage-gated sodium channels, to produce the [Ca2+]i increase.

Why is it that the VGCCs, acting via calcium influx, seem to be much more important in producing EMF effects than are the other voltage-gated ion channels? Probably for three reasons: 1. Ca2+ ions under resting conditions in cells have about a 10,000-fold concentration gradient driving them into the cell, and over a million-fold electrochemical gradient also driving them into the cell. Because of this, one can have huge calcium influxes upon channel activation. 2. [Ca2+]i produces many important regulatory effects, such that over activation of those effects can have very large pathophysiological consequences. 3. Sustained elevation of [Ca2+]i produces major cell damage.

This section of the Wi-Fi paper was followed by an additional section showing how VGCC activation acting via elevated [Ca2+]i, can produce each of the non-thermal effects documented above and elsewhere in the scientific literature.

4 & 5. There is a large literature on nanosecond pulses producing biological effects. If you search under nanosecond pulse in the EMF-Portal database, you will find 213 hits where when each of these are examined individually, over 100 are genuine nanosecond pulse studies that produced non-thermal effects. These do produce effects but when they these pulses have their intensities averaged over 6 minutes or 30 minutes, that fall far short of the levels that "safety guidelines" predict are needed to produce effects. This discrepancy with "safety guidelines" was noted in the second earliest nanosecond pulse study listed in the EMF-portal database [Raslear TG, Akyel Y, Bates F, Belt M, Lu ST. 1993. Temporal bisection in rats: the effects of high-peak-power pulsed microwave irradiation. Bioelectromagnetics 14:459-478]. If you take a typical pulse that may last for let say 60 nanoseconds and average it over a 6 minute period (about 6 $X10^9$ times longer), as the FCC, EU and other "safety guidelines" do, the average intensity (and average SAR) is so low that, of course, the safety guidelines predict there cannot be effects. ***But there are repeatedly found effects in nanosecond pulses ranging from 2 ns to 600 ns.*** So here again the "safety guidelines" are not predictive of biological effects. It makes no sense to average intensities over approximately 10^{10} times longer than it takes to produce an effect. The logic here is the same as if the following were to occur: Let's assume that you are concerned about someone shooting you with a high power rifle bullet traveling at about 700 meters per second. The bullet takes about 50 microseconds to tear your body apart. If someone from a regulatory authority tells you that you don't need to worry about that, if you average the force of the rifle bullet over a 21 day period (about 10^{10} times longer than 50 microseconds), the average intensity is so low, you don't need to worry about it. If someone were to tell you that, you would laugh in their face and state that they are either completely incompetent or completely corrupt. That is exactly the correct response in dealing with the EMF safety guidelines of the regulatory authorities. There are several of these nanosecond pulse studies that have shown that VGCC activation has a key role in producing them [Azarov et al, 2019 Excitation of murine cardiac myocytes by nanosecond pulsed electric field. J Cardiovasc Electrophys 30:392-401; Hristov et al, 2018. Expression of voltage-gated calcium channels augments cell susceptibility to membrane disruption by nanosecond pulsed electric fields. Biochim Biophys Acta Biomembr 1860:2175-2183; Vernier PT, Sun Y, Chen MT, et al. 2008 Nanosecond electric pulse-induced calcium entry into chromaffin cells. Bioelectrochemistry 73: 1–4; Craviso GL, Choe S, Chatterjee P, et al. 2010 Nanosecond electric pulses: a novel stimulus for triggering Ca2+ influx into chromaffin cells via voltage-gated Ca2+ channels. Cell Mol Neurobiol 30: 1259–1265]. Two such studies also implicate the voltage-gated sodium channels as having roles. These findings show, therefore, that the direct target of the nanosecond pulses is the voltage sensor of these channels and show therefore, that these are not thermal effects. Consequently, it is not surprising that the "safety guidelines" do not predict

effects produced from nanosecond pulses, because these "safety guidelines" do not predict non-thermal effects.

When I started to research the issue of effects of nanosecond pulses, this area seemed to be straightforward. Nanosecond pulses produced effects, produced at least in part via VGCC activation, effects that were not predicted by the "safety guidelines." However, when one looks at the nanosecond literature, it is clear that other important types of studies clearly document additional findings that also conflict with "safety guideline" predictions. One of these is that two nanosecond pulses of identical polarities can produce supra-additive effects when the two occur within a few microseconds of each other [Semenov et al. 2018 Electropermeabilization of cells by closely spaced paired nanosecond-range pulses. Bioelectrochemistry 121: 135-141]. The second is that when one studies paired nanosecond pulses *of opposite polarities*, the second pulse can greatly depress the effects produced by the first pulse [Pakhomov AG, et al. 2014 Cancellation of cellular responses to nanoelectroporation by reversing the stimulus polarity. Cell Mol Life Sci 71:4431-4441; Gianulis EC, et al. 2015 Electroporation of mammalian cells by nanosecond electric field oscillations and its inhibition by electric field reversal. Sci Rep 2015 Sep 8;5:13818. Doi: 10.1038/srep13818; Sözer EB, Vernier PT. 2019 Modulation of biological responses to 2 ns electrical stimuli by field reversal. Biochim Biophys Acta Biomembr. 2019 Apr 11. pii: S0005-2736(19)30077-X. doi: 10.1016/j.bbamem.2019.03.019]. Here again, the pulses must occur within a few microseconds of each other.

"Safety guidelines" do not allow for either supra-additive or depressive effects of a second pulse and do not take into consideration the polarity of exposures and are, therefore, yet again deeply flawed – they falsely assume that all exposures act additively such that average intensities predict effects. This flaw falsifies another assumption of the safety guidelines. When those guidelines assume that EMFs always act additively, one of the underlying assumptions behind that is that EMFs act as scalar variables. What the polarity effects show, however is that EMFs are vector variables, having direction as well as intensity. The important roles of polarity here, shows the vector nature of EMFs and the importance of that vector nature to these paired nanosecond pulse studies. It was known in the 19th century that EMFs have vector properties, not scalar properties. It can be seen from this, that the "safety guidelines" are inconsistent with the physics, not just the biology. We have then, different types of findings regarding pairs of nanosecond pulses, each of which is completely inconsistent with predictions of "safety guidelines." 5G is designed to be particularly highly pulsed in order to carry extraordinarily high amounts of information, so that 5G will inevitably have trillions of nanosecond pulses. It follows that using "safety guidelines" to predict effects of 5G radiation is even more problematic than using "safety guidelines" to predict effects of other types or radiation.

I do not think it is surprising, that pairs of nanosecond pulses that occur within a few microseconds of each other may produce either supra-additive or depressive effects, depending on the polarity of the second pulse. The primary direct target of these pulses is the voltage sensor of the VGCCs and other voltage-gated ion channels, as discussed above such that the properties of the voltage sensor predict how it may be expected to behave in response to EMF exposures. The voltage-sensor has four alpha helixes, each designated an S4 helix and with each S4 helix having 5 positive charges, with the 4 S4 helixes together making up the voltage sensor. Most of those positive charges are 3 amino acid residues apart from each other, such that the closest charged residues stick out from the helix pretty much on the same side of the helix. Three of those positive charges in each S4 are electrostatically attracted to negative residues on other helixes thought to be in fixed positions. What is thought to happen in activation is that there a ratcheting of the S4 helixes toward the extracellular space, ratcheting such that the negative

charges are now bound to a positive charge 3 residues away from the one that was previously bound. The ratcheting also produces some turning of each S4 helix. This needs to occur several times on each of the four S4 helixes to open the channel and allow calcium ions to flow. This ratcheting may occur in response to nanosecond pulse exposures, but the actual secondary structural changes that occur in the voltage-gated ion channel may take much longer than does the ratcheting process. Consequently, the effects of a second pulse, depending on its relative polarity compared with the first pulse, can interact over time periods shorter than the time required for the secondary structural change required to open of the channel.

It should be noted that studies of pulses in the microsecond or millisecond range have not been shown to produce either the supra-additive effects of pulses of identical polarity or the lowered effects produced by a second pulse of opposite polarity. This may be because the relative timing of the two pulses is too far apart.

6. There is also a large literature on the existence of exposure intensity windows where certain specific ranges of intensity of a particular EMF, ***produce maximum biological effects and where ranges either lower or higher produce much lower effects***. The consequences of these findings is that dose response curves are non-linear and are also non-monotone, that is they do not always increase with increasing exposure nor do they always decrease with decreasing exposure. Therefore, the ICNIRP, US FCC, EU and other similar "safety guidelines" are fatally flawed for still an additional reason. I am listing here a series of studies that have reviewed studies of this type. Some of these are genuine review articles and some are primary literature articles that have reviewed substantial amounts of earlier literature. One of the things that is striking here, is that many of these studies have found exposure windows that occur at levels 3, 4 or 5 or more orders of magnitude below the safety guideline cutoffs. Consequently, one can get not just effects but large effects when an exposure window occurs are levels on the order of 100,000 times below allowable "safety guideline" levels. So again, the safety guidelines give us absolutely no assurance of safety.

a. Pall, M. L. 2015 Scientific evidence contradicts findings and assumptions of Canadian Safety Panel 6: microwaves act through voltage-gated calcium channel activation to induce biological impacts at non-thermal levels, supporting a paradigm shift for microwave/lower frequency electromagnetic field action. Rev. Environ. Health 3, 99-116. doi: 10.1515/reveh-2015-0001.
b. Belyaev, I., 2005. Non-thermal biological effects of microwaves. Microwave Rev. 11, 13-29.
c. Belyaev, I., 2015. Biophysical mechanisms for nonthermal microwave effects. In: Markov M.S. (Ed), Electromagnetic Fields in Biology and Medicine, CRC Press, New York, pp 49-67.
d. Adey WR. 1980 Frequency and power windowing in tissue interactions with weak electromagnetic fields. Proc IEEE 68, 119-125.
e. Blackman CF, Kinney LS, House DE, Joines WT. 1989 Multiple power density windows and their possible origin. Bioelectromagnetics 10:115-128.
f. Panagopoulos DJ, Margaritis LH. 2009 Biological health effects of mobile telephone radiations. Int J Med Biol Front 15:33-76.
g. Persson BRR, Eberhardt J, Malmgren L, Persson MB, Brun A, Salford LG. 2005 Effects of microwaves from GSM mobile phones on blood-brain barrier and neurons in rat brain. PIERS Online 1:638-641.
h. Wei Q, Cao ZJ, Bai XT. 2005 [Effect of 900 MHz electromagnetic fields on the expression of the GABA receptor of cerebral cortex cortical neurons in postnatal rats] Wei Sheng Yan Jiu 34: 546-548.
i. Markov MS. 2004 Myosin light chain modification depending on magnetic fields II. Electromagn Biol Med 23:125-140.

j. Thompson CJ, Yang YS, Anderson V, Wood AW. 2000 A cooperative model for Ca++ efflux windowing from cell membranes exposed to electromagnetic radiation. Bioelectromagnetics 21:455-464.

7. Another important factor in determining EMF responses is the type of cell being studied. The relevant studies documenting the importance of cell type are studies where different cell types were studied by the a specific research group using identical methodologies and where the different cell types repeatedly responded differently to the same EMF exposures. I reviewed several studies where such findings were obtained in my 2013 study where single strand breaks in cellular DNA were being measured (Pall ML 2013 Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. J Cell Mol Med 17:958-965. doi: 10.1111/jcmm.12088). I also reviewed several studies of this type when reviewing various genotoxicity studies in my 2015 study (Pall, M. L. 2015 Scientific evidence contradicts findings and assumptions of Canadian Safety Panel 6: microwaves act through voltage-gated calcium channel activation to induce biological impacts at non-thermal levels, supporting a paradigm shift for microwave/lower frequency electromagnetic field action. Rev. Environ. Health 3, 99-116. doi: 10.1515/reveh-2015- 0001). Belyaev IY (2010 Dependence of non-thermal effects of microwaves on physical and biological parameters. Eur J Oncol Library 5: 187-217) reviewed earlier a number of studies, on pp.202 & 203, showing that non-thermal EMF effects were cell type specific. It has repeatedly been found in such studies that stem cells are unusually sensitive to EMF exposures, producing effects where most other cell types do not. Some of these studies have been reviewed by Dr. Belyaev and his colleagues (Belyaev IY, Markovà E, Hillert L, Malmgren LO, Persson BR. 2009 Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/gamma-H2AX DNA repair foci in human lymphocytes. Bioelectromagnetics 30:129-141. doi: 10.1002/bem.20445; Markovà E, Malmgren LO, Belyaev IY. 2010 Microwaves from Mobile Phones Inhibit 53BP1 Focus Formation in Human Stem Cells More Strongly Than in Differentiated Cells: Possible Mechanistic Link to Cancer Risk. Environ Health Perspect 118:394-399. doi: 10.1289/ehp.0900781). These cell-type specific findings clearly show that that effects are produced via cell type specific biological processes and consequently all claims that are made that one can predict effects just from the physical properties of the EMFs, ***as the EU, FCC, Canadian and other safety guidelines do, are fraudulent***.

8. The last of these are findings have shown that there are *very specific EMF frequencies which produce vastly larger EMF effects than do other slightly different frequencies.* These have been interpreted as being due to resonance interactions, where the specific frequency produces a resonance response in the target involved and therefore produces vastly larger responses. These findings have been reviewed four times, to my knowledge:
a. Belyaev, I., 2005. Non-thermal biological effects of microwaves. Microwave Rev. 11, 13-29.
b. Belyaev IY. 2010 Dependence of non-thermal effects of microwaves on physical and biological parameters. Eur J Oncol Library 5: 187-217.
b. Belyaev, I., 2015. Biophysical mechanisms for nonthermal microwave effects. In: Markov M.S. (Ed), Electromagnetic Fields in Biology and Medicine, CRC Press, New York, pp 49-67.
c. Adey, WR. 1980 Frequency and power windowing in tissue interactions with weak electromagnetic fields. Proc IEEE 68, 119-125.

I would suggest that in animals and plants, the most likely target of such a resonance interaction would be the ion channel voltage sensors. We have no evidence as to whether this is correct or not. Interestingly the only such evidence occurs in the bacterium *Escherichia coli* (reviewed in the second review in the previous paragraph) where the target appears to be the DNA of the cell and where the resonance interaction is influenced by the supercoiling of the DNA.

Summary of these eight distinct types of findings:

To my knowledge, every time that we have repeated quantitative or qualitative studies that can be used to test whether the "safety guidelines" predict biological effects, the "safety guidelines" fail in such predictions and fail massively. Those failures are of almost every conceivable type. We started out with this paper looking at the ICNIRP, FCC and EU "safety guidelines" which are each based on the assumption that one can use average intensities or average SAR, averaged over either 6 minute or 30 minute periods, to predict biological effects. They each use of Specific Absorption Rates (SAR) to set the allowable levels such that allowable levels are based on the assumption that there are only thermal effects, because SAR do not predict any non-thermal effects. These failures of the "safety guidelines" which act, therefore, to falsify the safety guidelines are summarized in Table 3.

These failures, which should be viewed as fatal flaws, can be categorized into five different types, as shown in Table 3, each listed with the number of types of findings documenting each type.
1. The guidelines are fatally flawed because they are based on intensities averaged over 6 minutes or 30 minutes. (documented by 3 different types of findings, see column 3 Table 3)
2. The guidelines are fatally flawed because the allowable exposures are based only on thermal effects. (documented by 6 different types of findings, see column 3 Table 3)
3. The guidelines are fatally flawed because they ignore the underlying biology of non-thermal effects. (documented by 2 different types of findings, see column 3 Table 3)
4. The guidelines are fatally flawed because of errors in the physics. (documented by 2 different types of findings, see column 3 Table 3)
5. The guidelines are fatally flawed because they ignore the actual dose-response curves. (documented by 4 different types of findings, see column 3 Table 3)

Table 3: How 8 Different Types of Repeated Findings Each Falsify EMF "Safety Guidelines"

Finding(s)	**How These Findings Falsify "Safety Guidelines"**	**Types of Fatal Flaws Shown**
9 different effects are shown, each in from 9 to 39 different bodies of evidence, from different published reviews, occur at levels well below those allowed by safety guidelines: 197 bodies of evidence each falsify "safety guidelines"	"Safety guidelines" predict that none of these effects should occur at levels well below "safety guideline" allowable exposure level, but 197 bodies of evidence from published reviews each show that one of them does occur. Consequently, data show that "safety guideline" predictions are massively falsified.	2. The guidelines are fatally flawed because the allowable exposures are based only on thermal effects.
13 reviews each show that pulsed EMFs, are in most cases much more biologically active than of non-pulsed (continuous wave) EMFs of the same average intensity	These findings falsify "safety guideline" assumptions that biological effects can be predicted based on average intensities, averaged of a 6 minute or 30 minute periods. Because wireless communication devices all communicate, at least in part, via pulsations and radar exposures are also pulsed	1. The guidelines are fatally flawed because they are based on intensities averaged over 6 minutes or 30 minutes. 5. The guidelines are fatally flawed because they ignore the actual dose-response curves.

	because of the use of phased arrays, this falsification is highly relevant to most of the common exposures that we have. Because 5G is designed to be extraordinarily highly pulsed, this falsification is predicted to be especially relevant to 5G exposures.	
The primary mechanism of action of EMFs producing non-thermal effects, is the activation of voltage-gated calcium channels (VGCCs) as shown by 28 studies each showing that EMF effects can be blocked or greatly lowered by calcium channel blockers. Several other types of evidence support these findings.	The electrical forces on voltage sensor, controlling the VGCCs and other voltage-gated ion channels that are also activated, are estimated to be 7.2 million times stronger than the forces on singly electrically charged groups in the aqueous phases of our cells and bodies, based on the physics. This suggests that allowable exposure levels in the "safety guidelines" are approximately 7.2 million times too high We have a confluence of the science where both the biology and the physics provide strong evidence for this overall mechanism. This has been influential to much of the scientific community where the first (2013) paper published on this has at this writing, been cited	2. The guidelines are fatally flawed because the allowable exposures are based only on thermal effects. 3. The guidelines are fatally flawed because they ignore the underlying biology of non-thermal effects. 4. The guidelines are fatally flawed because of errors in the physics.
Nanosecond pulses, usually studied with pulses of from 2 to 600 nanoseconds, produce effects in over 100 such studies, but when these are averaged over a 6 minute (or even worse 30 minute) period, the average intensities (or SAR) are so low that the "safety guidelines" predict there cannot be any such effects. Some of these studies have shown that nanosecond pulses produce effects via VGCC activation (see above).	The failure of the predictions of the "safety guidelines" here, provides another falsification of those guidelines. There is no rationale for taking such nanosecond pulse findings and averaging their intensity of 6 minutes which is circa 10^{10} times longer than 50 nanoseconds. But that is exactly what the "safety guidelines" do. These findings clearly show that you cannot take average intensities averaged over 6 minutes (or longer for that matter) to predict biological effects -- these averages have nothing to do with predicting biological effects. The extraordinarily high pulsation rate that 5G will inevitably entail	1. The guidelines are fatally flawed because they are based on intensities averaged over 6 minutes or 30 minutes. 2. The guidelines are fatally flawed because the allowable exposures are based only on thermal effects. 5. The guidelines are fatally flawed because they ignore the actual dose-response curves.

	predicts that this nanosecond pulse failure of the "safety guidelines" will be particularly severe with 5G.	
Studies of pairs of nanosecond pulses produce still additional flaws for the "safety guidelines." When such pairs occur within a few microseconds of each other, pairs of the same polarity produce supra-additive effects. However pairs of opposite polarity produce much lower effects than does the first pulse alone – that is the second pulse of opposite polarity greatly lowers the effects produced by the first pulse. How, then can we make sense of these two findings? They can both be explained by the fact that EMFs are vectors not scalars and therefore second pulses with different polarities relative to the first pulse can produce very different effects. Nanosecond pulses have been shown to produce effects via VGCC activation and I discuss in the text how these findings are consistent with EMF impacts on the voltage sensor.	Both of these pair effects are inconsistent with "safety guidelines" which do not allow second pulses to produce either supra-additive effects or greatly lowered effects. Furthermore because the "safety guidelines" assume you can predict biological effects based on intensities averaged over 6 minutes or 30 minutes, they also assume that averaging (that is calculating an arithmetic mean) is something you can do with EMFs. The problem here is that EMFs are vectors, not scalars, such that one cannot calculate an arithmetic mean as you can do with scalars. It has been known for approximately 200 years that EMFs are vectors so the "safety guidelines" conflict with long established physics. We have, then, three "safety guideline" problems created by these findings. 1. Neither supra-additive nor greatly lowered effects produce by a second pulse occurring within a few microseconds of the first are allowed by the safety guidelines. 2. These opposite effects show that the vector nature of these EMFs can be used to explain the opposite effects produced by the second pulse, depending on its polarity. 3. However that vector nature means that you cannot calculate arithmetic means in the way that the "safety guidelines" do. Consequently, we have a problem here with the "safety guideline" physics, not just with the biology. Please note that the VGCC mechanism discussed above, shows an additional problem with the "safety	1. The guidelines are fatally flawed because they are based on intensities averaged over 6 minutes or 30 minutes. 2. The guidelines are fatally flawed because the allowable exposures are based only on thermal effects. 4. The guidelines are fatally flawed because of errors in the physics.

	guideline" physics.	
There are exposure intensity windows, where a particular type of EMF produced maximum biological effects within a specific exposure intensity window, but both lower and higher intensities produce much lower effects.	Some of these intensity windows have been found at intensities 5 orders of magnitude below allowable exposures, according to the "safety guidelines."	2. The guidelines are fatally flawed because the allowable exposures are based only on thermal effects. 5. The guidelines are fatally flawed because they ignore the actual dose-response curves.
It has been shown that when different cell types are exposed to EMFs using identical methodologies by the same research group, they often respond very differently to those EMFs. These findings clearly show that biological heterogeneity must be a part of any valid safety guidelines.	The current "safety guidelines" do not consider biological heterogeneity, and are based solely on physics (please note, even the physics is deeply flawed as noted above). These biological heterogeneity effects falsify the current "safety guidelines" because they are not considered in those "safety guidelines." Because all non-thermal effects are produced through the impact of EMFs on the cells of our bodies, this demonstrates a universal fatal flaw in those "safety guidelines."	3. The guidelines are fatally flawed because they ignore the underlying biology of non-thermal effects.
Highly specific EMF frequencies produce effects at exposure levels many orders of magnitude lower than do EMFs of nearby frequencies, presumably due to resonance interactions with their target.	"Safety guidelines" assume that nearby frequencies always have identical or nearly identical SAR and therefore, also assume that they will have identical or nearly identical effects. It follows that these assumptions are again falsified.	2. The guidelines are fatally flawed because the allowable exposures are based only on thermal effects. 5. The guidelines are fatally flawed because they ignore the actual dose-response curves.

Column 3 summarizes the fatal flaws in the "safety guidelines" demonstrated by each of the eight types of studies. Those fatal flaws fall into five different categories as follows: 1. The guidelines are fatally flawed because they are based on intensities averaged over 6 minutes or 30 minutes. 2. The guidelines are fatally flawed because the allowable exposures are based only on thermal effects.3. The guidelines are fatally flawed because they ignore the underlying biology of non-thermal effects. 4. The guidelines are fatally flawed because of errors in the physics. 5. The guidelines are fatally flawed because they ignore the actual dose-response curves.

The collective failures of the "safety guidelines" documented here, may well be the most massive failure in the history of science to pay attention to the science. They may well be the most massively consequential such collective failure, because of the vast proliferation of technologies based on these safety guidelines in essentially every country on earth, consequential because of both the human impact and ecological impacts of the EMF effects. Each of these eight distinct types of findings show that the ***safety guidelines are fraudulent because they do not predict biological effects***. While this document is aimed at the 1998 ICNIRP and US FCC safety

guidelines, the similar safety guidelines produced by EU, Canada safety code 6, the 2013 UK guidelines and others are similarly fraudulent for each of those same eight reasons. ***All guarantees of safety given by these organizations or by industry organizations, which are based on these or similar safety guidelines, are similarly fraudulent***. The fraudulence is caused, in part, by the series of false assumption underlying these safety guidelines: Assumptions that average intensities or average SAR can be used to assess safety are false. Assumptions that one can ignore pulsations including very short spikes and nanosecond pulses are false. Assumptions that you one ignore biological heterogeneity and assess effects simply based on physics are false. Assumptions that dose-response curves are linear or at least monotone are false. Assumptions that there are no mechanisms that can explain the existence of non-thermal effects are false. Assumptions that electrical forces produced by low intensity EMFs are too weak to do anything are false. Assumptions that identifying average SARs in a specific study is of special importance in judging the quality or biological relevance of the study are false. The consequences of all this, is that we have a multi-trillion dollar (or multi-trillion euro) set of industries, the telecommunication industries where all assurances of safety are based entirely on massive fraud.

I wish that there were some simple modification of these or other guidelines that could provide more reliable safety guidelines, but no such modification exists. At this point in time, the only way to determine biological safety is to do biological safety testing. And biological safety testing is very challenging because of the important roles of:

1. Complex dose-response curves, with regard to intensities and frequencies. The exposure windows create particular challenges, because of high level effects produced by levels of exposure as much as 5 orders of magnitude below current safety guidelines.
2. Biological heterogeneity is important as shown by different responses of different cell types.
3. The physics is complex both with regard to the vector nature of EMFs and the stunning sensitivity of the main direct target of EMFs, the voltage sensor, to the electrical forces of weak EMFs.
4. The complex roles of pulsation as shown by studies of nanosecond, microsecond and millisecond pulses.

<u>What About 5G?</u>

5G will entail using millimeter wave EMFs with sufficient band width and extraordinary levels of pulsation to wirelessly communicate many orders of magnitude greater amounts of information per unit time than do current wireless communication systems. This is clearly stated in the paper that I think of as a propaganda document which, then, fails to take into account any of the established findings previously discussed in this document (Wu T, Rapaport TS, Collins CM. 2015 Safe for generations to come. IEEE Microw Mag. 2015 March ; 16(2): 65–84.) The extraordinary 5G health problems are created, in part, by the extraordinary pulsation levels. We not only have the 13 reviews each of which show that pulsed EMFs are, in most cases much more biologically active than are non-pulsed EMFs of the same average intensity but we also have the nanosecond pulse studies that are particularly relevant to 5G. The nanosecond pulse studies, described above are particularly relevant to 5G because of the extraordinary pulsation levels of 5G antennae communicating with the "internet of things" will inevitably involve astronomical numbers of nanosecond pulses. The nanosecond pulses are relevant because the individual nanosecond pulses produce effects no predicted by the "safety guidelines." They are also especially relevant because of the supra-additive effects seen when nanosecond pulses of identical

polarity occur within a few microseconds of each other and these supra-additive effects are also not predicted by the "safety guidelines."

Additional 5G health problems are also created in two ways, by the millimeter wave frequencies. The electrical parts of millimeter waves are highly absorbed by materials including the materials in our buildings and the materials in our bodies. Such absorption means that the 5G plans have entailed putting out tens of millions of antennae in close proximity to our homes and other buildings, putting out very high power EMFs, such that the electrical parts can penetrate into our homes and other buildings such that electrical devices can communicate with the 5G antennae. The penetration into buildings will entail use of phase arrays which produce an additional type of pulsation to which we are to be exposed. The high absorption argues that these millimeter waves will be particularly active in activating the VGCCs because the mechanism of such absorption involves interacting with electrically charged groups, including the electrically charged groups of the voltage sensor. That is one very large problem, very high level VGCC activation. The second large problem is the high numbers and high power of the so called small cell antennae which means that it will be essentially impossible to avoid the 5G EMFs, especially when we are outside and have no shielding between our bodies and the antennae. I predict, therefore, that 5G will inevitably create not only human but also ecological disasters of unparalleled proportions. Small mammals and birds and insects will be heavily impacted because of their large surface to volume ratios. The same thing will be true of plants where even large trees have their leaves and reproductive organs highly exposed. One of the consequences that I predict is that we will have huge conflagrations because EMFs make plants vastly more flammable. That may make fires much worse than the recent California fires commonplace. I am, therefore, profoundly concerned about both the human effects and the ecological effects.

One of the claims that the industry makes is that millimeter wave frequencies to be used in most 5G radiation will be absorbed in the outer 1 mm of the body and that therefore, 5G will have no effects in underlying tissues. I showed in Chapter 7 of my 90 page document what the industry claims about penetration of microwave effects were false such that microwaves act at least 40 times more deeply in the body than the industry claims is possible. The way the physics can produce such deeply penetrating effects was also discussed. I predicted therefore that millimeter waves will act deeply as well. Now we have evidence from two CIA translated documents that millimeter waves act at least 20 times more deeply in the body than the industry claims is possible (Zalyobokskaya NP, 1977. Biological effect of millimeter radiowaves. Vrachebnoye Delo 3: 116-119. Declassified and Approved for release 2012/05/10: CIA-RDP88B01125R000300120005-6; Levedeva NN, Reactions of the central nervous system to peripheral effects of low-intensity EHF emissions. Approved for release 2000/08/10: CIA-RDP96-00792R000100070001-9).

The first of these documents shows that internal organs of rodents including heart, kidney, liver spleen and bone marrow can be heavily impacted by low intensity continuous millimeter wave radiation. There are even more severe effects on the skin, as may be expected. These studies show that these millimeter wave EMFs produce effects at least 20 times deeper than the industry claims is possible. The effects seen start out as modest effects that can be reversible with cessation of exposure but become much more severe with increasing times of exposure. The human study (second paper) was an EEG study where electrical activity in the brain was being monitored. Here for the low intensity millimeter continuous wave EMF exposure to have effects, it must penetrate the hair, skin, skull and meninges surrounding the brain. Again, in humans effects are found at least 20 times deeper than the industry claims is possible.

How then are these highly penetrating effects produced? Although the electrical parts of the EMFs may be absorbed readily, the magnetic parts are very highly penetrating. These can then put forces on dissolved ions in the aqueous phases of our cells and tissues, moving them and regenerating the electrical parts of the EMFs, with the same frequency and same pulsations, just with much lower intensity. However with the voltage sensor of the VGCCs so stunningly sensitive to the electrical forces, this can produce effects very deeply within the body.

These deep effects produced by the millimeter wave EMFs in these two CIA documents, no doubt deeply underestimate that genuine 5G radiation will produce, given that 5G produces extraordinarily high level of pulsations. What effects do I predict for genuine 5G? I predict that similar but much more severe effects will be produced by 5G as are produced by microwave frequency EMFs. I also predict because of the roles of aqueous dissolved ions in producing these deep effects, that regions of the body with large such internal "bodies of water" may be expected to produce particularly severe problems. These may include:

a) Various types of birth defects because of the role of the amniotic fluids and the increased extracellular water content in the tissues of the fetus.
b) Massive epidemics of blindness due to the role of the aqueous and vitreous humors of the eye.
c) Massive epidemics of kidney failures due to the water in the kidney.
d) Larger epidemics of life threatening cardiac changes in the electrical control of the heart, because of the large blood fluids in the heart.
e) Large epidemics of circulatory problems, possibly including aortic and other arterial aneurisms.
f) Large epidemics of autoimmune disease, because of the impact of 5G irradiation on signaling in the T-cells in the blood.

The only way to test for these and other health impacts is to do biological testing with genuine 5G radiation with all of the pulsations that will be involved once it is connected to the "internet of things." Those many billions of connections imply astronomical numbers of pulsations including nanosecond pulsations. Biological testing of genuine highly pulsed 5G radiation is exactly what the regulatory agencies and the industry are both avoiding doing.

There is some evidence with regard to d, above, from worrisome cardiac effects produced by non-pulsed millimeter wave frequency radiation on animals. Chernyakov GM, Korochkin VL, Babenko AP, Bigdai EV. 1989 Reactions of biological systems of various complexity to the action of low-level EHF radiation. In Devyakov ND, (ed.) Millimeter Waves in Medicine and Biology. Moscow: Radioelectronica pp. 141-167. (in Russian) found that millimeter waves could produce tachycardia and arrhythmia in the hearts of frogs, even when the hearts were detached from neuronal control. Potekhina IL, Akoyev GN, Yenin LD, Oleyner (1992 Effects of low-intensity electromagnetic radiation in the millimeter range on the cardiovascular system of the white rat. Fiziol Zh 78:35-41 (in Russian)) found that 20 minute exposures to non-thermal non-pulsed millimeter wave EMFs of certain frequencies caused pronounced arrhythmia in the rat. 3 hour exposures caused about 25% of the animals to undergo apparent sudden cardiac death. You will note that earlier in this paper, the possible causation of sudden cardiac death in humans from EMF exposures was discussed. These two studies of millimeter wave cardiac effects also showed, as did other studies discussed above, that the millimeter waves can act vastly more deeply in the body than the industry claims is possible.

These animal studies on non-pulsed millimeter wave effects, discussed in the previous paragraph, make very plausible some animal effects that were reported to occur in The Netherlands during a

recent introduction of 5G (Massive starling death by 5G? #FactCheck. http://wearechange.nl/?p=729). Here starling birds died suddenly over a several day period of possible sudden cardiac death during the approximate time period of 5G introduction. This is still a matter of controversy and I am not making any conclusions here. But what is clear is that the finding that non-pulsed millimeter wave frequency EMF exposures can cause cardiac effects in animals including apparent sudden cardiac death makes it much more plausible that similar observations in birds may have been caused by 5G radiation during 5G testing.

I am simply going to repeat a statement I made earlier. The "safety guidelines" have been known to be bogus for over 40 years, based on findings of non-thermal effects at levels of exposure well below those allowed under our "safety guidelines."