

Dr. Magda Havas' Comments Regarding:

Peer Review of the Draft NTP Technical Reports on Cell Phone Radiofrequency Radiation, March 26-28, 2018

Submitted March 12, 2018 before 0200 hours Eastern Time via email to: [REDACTED]

Below are my comments about the NTP Draft report.

1. First let me introduce myself.

I am an environmental toxicologist and a tenured professor at Trent University, Canada and for the past 20 plus years I have been studying the biological effects of electromagnetic fields and electromagnetic radiation and I have been working with people who have developed electrohypersensitivity (EHS). I have more than 180 publications and have given more than 350 lectures in 30 countries on this topic, including an invited talk to NIEHS on EHS. That talk—*Magda Havas talks at NIEHS May 9, 2016 on Electromog and Electrohypersensitivity*—was video taped and is available at <https://www.youtube.com/watch?v=fqMCjEs9oxE>. I also provide expert testimony in both Canada and the United States on legal cases related to the harmful effects of electromog. Internationally, I am considered as an expert in this area of research and serve as a science advisor to a number of organizations across the globe.

2. No known mechanism linking NIR to cancer.

Scientists have much more confidence in statements related to biological effects once they understand or have a sense of the **mechanisms** involved. We are repeatedly told that there are no known mechanisms explaining cancer for people exposed to non-ionizing radiation (NIR). This statement is incorrect. I will provide one mechanism that is fully described and supported by research in hundreds of peer-reviewed publications and relates to both extremely low frequency electromagnetic fields and radiofrequency/microwave radiation. This is not the only mechanism but is one that is well studied and explains many of the symptoms of RFR exposure including cancer. This mechanism is related to free-radical damage that is known to be involved with ionizing radiation.

Ionizing radiation (IR) has enough energy to break chemical bonds, produce free radicals leading to reactive oxygen species (ROS), which can then cause cancerous growth. So IR increases ROS. Non-ionizing radiation also increases ROS but through a different mechanism. NIR interferes with several repair mechanisms that neutral ROS leading to the same outcome as IR ...

an increase in ROS and the potential for carcinogenic growth. Havas 2016 describes the mechanisms involved and provides references to peer-reviewed research.

Havas, M. 2016. When theory and observation collide: Can non-ionizing radiation cause cancer? *Environmental Pollution* 221:501–505.

<https://www.sciencedirect.com/science/article/pii/S0269749116309526?via%3Dihub>

3. I will limit the rest of my comments to the statements made in the following draft paragraph:

QUOTE: *There is a very limited set of research investigating the general toxicity of cell phone RFR in humans because most of the focus for research has been on the potential for carcinogenic effects. Studies in humans have failed to demonstrate any consistent adverse health effects in cell phone RFR-exposed populations. There are reports of some exposed individuals that complain of acute, subjective effects following exposure to cell phone RFR, including headaches, fatigue, skin itching, and sensations of heat (Frey, 1998; Chia et al., 2000; Hocking and Westerman, 2000; Sandström et al., 2001; Santini et al., 2002a,b). However, these have primarily been reported in people that consider themselves electrosensitive, and not in the general population. It has been suggested that there are likely other causes, not cell phone RFR, for these subjective symptoms (Kwon and Hämäläinen, 2011). In fact, the validity of electrosensitivity as an actual phenomenon has been questioned and debated. Variable results have been observed in the electroencephalogram (EEG) of volunteers exposed to RFR during sleep. Some studies indicate that exposure to cell phone RFR induces changes in sleep latency and sleep EEG (Mann and Röschke, 1996; Wagner et al., 1998, 2000; Borbély et al., 1999; Huber et al., 2000, 2002, 2003; Loughran et al., 2005; Hung et al., 2007; Regel et al., 2007; Lowden et al., 2011). Glucose metabolism in the brain, a marker for brain activity, is increased 34 GSM- and CDMA-Modulated Cell Phone in the region of the brain closest to the antenna (Volkow et al., 2011). While these results demonstrate exposure related effects, the toxicologic significance of these findings is unclear. No effects of cell phone RFR on the neuroendocrine system, auditory and vestibular systems, or consistent effects on cognitive performance have been reported in humans. There is also no clear evidence of effects on heart rate or blood pressure.*

3.1. *There is a very limited set of research investigating the general toxicity of cell phone RFR in humans because most of the focus for research has been on the potential for carcinogenic effects.*

While there is limited research being conducting in North America due to the absence of funding, other countries around the world are filling the gap. A Google-Scholar search using the terms *radio frequency radiation health effects* will yield more than 300,000 references.

There is considerable research on the biological effects of radiofrequency radiation (RFR) and much of it relates to cell phones and cell phone base station. Few would argue that in

considering the biological effects of cell phones we should ignore the effects associated with cell phone base stations as the cell phone cannot operate without a series of base stations.

Furthermore, studies of cell phones/cell phone antennas and Wi-Fi are yielding similar results and both of these exposures involve microwave radiation.

I expect the committee is familiar with the **BioInitiative Reports** (www.bioinitiative.com) that document the scientific studies showing adverse biological effects of RFR at levels well below thermal effects and below the International and U.S. guidelines for these frequencies. Some have classified these reports as “cherry picking” but cherry picking relates to studies that show positive effects related to an agent. These studies are falsifying the claims that RFR is safe by citing studies showing adverse biological effects. Falsification is a basic element of science as first introduced by Carl Popper, one of the pre-eminent science philosophers of our time. Furthermore a number of chapters appear in **Pathophysiology 2009**, volume 16, issues 2–3 and are peer-reviewed.

3.2. Studies in humans have failed to demonstrate any consistent adverse health effects in cell phone RFR-exposed populations.

One series of studies related to RFR exposure from cell phone use and Wi-Fi exposure include effects on reproduction and especially effects on sperm viability, motility, and morphology. According to Friesen 2015, at least twenty (20) studies show abnormalities in sperm (motility, shape, cellular stress), which have clear implications for male infertility and at least five (5) studies show DNA damage, which has implications for passing on genetic abnormalities to offspring which could be multi-generational. Tables 3 and 4 from Friesen 2015 at reproduced below listing the studies and their main findings:

Table 3. Studies with evidence of harm (26) [source: Friesen 2015]

Studies with evidence of harm Male reproductive system: sperm/DNA (Human, animal and cell studies)	Comments
Ahmed (2011). Mobile phone RF-EMW exposure to human spermatozoa: an in vitro study. <i>Pakistan Journal of Zoology</i>	... sperm motility affected
Al-Damegh (2012). Rat testicular impairment induced by electromagnetic radiation from a conventional cellular telephone and the protective effects of the antioxidants vitamins C and E. <i>Clinics (São Paulo, Brazil)</i>	...testicular impairment
Atasoy (2013). Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices. <i>Journal of Pediatric Urology</i>	... deleterious effects on testes
Avendaño (2012). Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. <i>Fertility and Sterility</i>	... decreased sperm motility
Baste (2012). Pregnancy outcomes after paternal radiofrequency field exposure aboard fast patrol boats. <i>Journal of Occupational and Environmental Medicine</i>	... association with perinatal mortality
Dama (2013). Mobile phones affect multiple sperm quality traits: A meta-analysis. <i>F1000Res. F1000Research</i>	... sperm quality affected

Dkhil (2011). Sperm function is affected by the electromagnetic radiation emitted by mobile phone. <i>African Journal of Microbiology Research</i>	... weakened sperm
Falzone (2011). The effect of pulsed 900-MHz GSM mobile phone radiation on the acrosome reaction, head morphometry and zona binding of human spermatozoa. <i>International Journal of Andrology</i>	... sperm shape affected
Ghanbari (2013). The Effects of Cell Phone Waves (900 MHz-GSM Band) on Sperm Parameters and Total Antioxidant Capacity in Rats. <i>International Journal of Fertility & Sterility</i>	... decrease in sperm motility and viability
Gutschi (2011). Impact of cell phone use on men's semen parameters. <i>Andrologia</i>	... pathological shape of spermatozoa
Jurewicz (2013). Lifestyle and semen quality: role of modifiable risk factors. <i>Systems Biology in Reproductive Medicine</i>	> 10 years cell phone use , decreased sperm motility
Kesari (2011). Effects of radiofrequency electromagnetic wave exposure from cellular phones on the reproductive pattern in male Wistar rats. <i>Applied Biochemistry and Biotechnology</i>	... clear indications of infertility patterns
Kesari (2012). Evidence for mobile phone radiation exposure effects on reproductive pattern of male rats: role of ROS. <i>Electromagnetic Biology and Medicine</i>	... reduction in testosterone, distortion of spermatozoa
Kumar (2011). Influence of microwave exposure on fertility of male rats. <i>Fertility and Sterility</i>	... disrupted reproductive pattern
Kumar (2012). Impact of microwave at X-band in the aetiology of male infertility. <i>Electromagnetic Biology and Medicine</i>	... deleterious reproductive factors
Kumar (2013). Influence of electromagnetic fields on reproductive system of male rats. <i>International Journal of Radiation Biology</i>	... DNA strand breakage, shrinkage of testes
Liu, C. (2013). Exposure to 1800 MHz radiofrequency electromagnetic radiation induces oxidative DNA base damage in a mouse spermatocyte-derived cell line. <i>Toxicology Letters</i>	... DNA damage
Liu, C. (2013). Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: A protective role of melatonin. <i>International Journal of Radiation Biology</i>	... DNA damage
Lukac (2011). In vitro effects of radiofrequency electromagnetic waves on bovine spermatozoa motility. <i>Journal of Environmental Science and Health. Part A, Toxic/hazardous Substances & Environmental Engineering</i>	... negative effect on spermatozoa motility
Meo (2011). Hypospermatogenesis and spermatozoa maturation arrest in rats induced by mobile phone radiation. <i>Journal of the College of Physicians and Surgeons--Pakistan: JCPSP</i>	... abnormal spermatozoa
Milan (2011). Effects of Polygonum aviculare herbal extract on sperm parameters after EMF exposure in mouse. <i>Pakistan Journal of Biological Sciences: PJBS</i>	...reduced sperm motility
Mouradi (2012). The use of FDTD in establishing in vitro experimentation conditions representative of lifelike cell phone radiation on the spermatozoa. <i>Health Physics</i>	...cellphone distance from testes
Rago (2013). The semen quality of the mobile phone users. <i>Journal of Endocrinological Investigation</i>	...DNA fragmentation
Sajeda (2011). Effect of mobile phone usage on semen analysis in infertile men. <i>Tikrit J Pharm Sci.</i>	... decrease in sperm quality
Veerachari(2012). Mobile Phone Electromagnetic Waves and Its Effect on Human Ejaculated Semen: An in vitro Study. <i>International Journal of Infertility and Fetal Medicine</i>	... DNA fragmentation ... sperm stress
Wu (2012). Cytokines produced by microwave-radiated Sertoli cells interfere with spermatogenesis in rat testis. <i>Andrologia</i>	... spermatogenesis interference

Table 4. Studies with little or no effects (2) and reviews (4) [source: Friesen 2015]

Studies showing little or no effects and Reviews	Comments
Male reproductive system -sperm/DNA (Human, animal and cell studies)	
Imai (2011). Effects on rat testis of 1.95-GHz W-CDMA for IMT-2000 cellular phones. <i>Systems Biology in Reproductive Medicine</i> , 57(4), 204–209.	... no weight change, no evident testicular toxicity
Trošić (2013). Histological and cytological examination of rat reproductive tissue after short-time intermittent radiofrequency exposure. <i>Arhiv Za Higijenu Rada I Toksikologiju</i> no effect on testicular function
Agarwal (2011). Cell phones and male infertility: a review of recent innovations in technology and consequences. <i>International Braz J Urol: Official Journal of the Brazilian Society of Urology</i>	Review
Gye (2012). Effect of electromagnetic field exposure on the reproductive system. <i>Clinical and Experimental Reproductive Medicine</i>	Review
La Vignera (2012). Effects of the Exposure to Mobile Phones on Male Reproduction: A Review of the Literature. <i>Journal of Andrology</i>	Review
Merhi (2012). Challenging cell phone impact on reproduction: A Review. <i>Journal of Assisted Reproduction and Genetics</i>	Review

3.3 QUOTE: *There are reports of some exposed individuals that complain of acute, subjective effects following exposure to cell phone RFR, including headaches, fatigue, skin itching, and sensations of heat (Frey, 1998; Chia et al., 2000; Hocking and Westerman, 2000; Sandström et al., 2001; Santini et al., 2002a,b). However, these have primarily been reported in people that consider themselves electrosensitive, and not in the general population. It has been suggested that there are likely other causes, not cell phone RFR, for these subjective symptoms (Kwon and Hämmäläinen, 2011). In fact, the validity of electrosensitivity as an actual phenomenon has been questioned and debated.*

3.3.1 First of all, some of the studies related to EHS are objective. I notice that neither the study by Rea et al. 1991 nor the study by Havas et al. 2010 are mentioned above as these use objective markers for EHS rather than a subjective assessment and both studies are blinded to minimize the placebo effect. The Havas et al. study shows various reactions to radiation generated by a cordless phone at 2.4 GHz and at a maximum intensity of 0.3% of the U.S. guideline for this frequency. Those reactions include arrhythmia, tachycardia, increase in sympathetic tone and a decrease in parasympathetic tone (typical stress response) during microwave exposure. Those who reacted were classified as having EHS. So, once again this can be used as one test for assessing EHS.

Rea, W.J., Pan, Y., Fenyves, E.J., Sunisawa, I., Suyama, H., Samadi, N., and Ross, G.H. 1991. Electromagnetic field sensitivity. *J. Bioelectr.* **10**: 241–256. See also <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4818065/>

Havas, M, J. Marrongelle, B. Pollner, E. Kelley, C. Rees, and L. Tully. 2010. Provocation study using heart rate variability shows microwave radiation from 2.4 GHz cordless phone affects autonomic nervous system. *European Journal of Oncology*, Vol. 2:273-300.

3.3.2 Second, the concept of EHS has been around for decades, although it was known by different labels such as neurasthenia, microwave sickness, radiowave illness, electrical sensitivity, electrohypersensitivity, and now idiopathic environmental intolerance by the WHO. Whatever it is called, the symptoms overlap.

Dr. Zoy Glaser, was the microwave expert for the U.S. Naval Medical Research Institute and in 1972 he published a bibliography of more than 2000 studies on microwave bioeffects. This document is available at: <http://www.magdahavas.com/pick-of-the-week-1-more-than-2000-documents-prior-to-1972-on-bioeffects-of-radio-frequency-radiation/>

The specific biological and health effects, provided in Glaser 1972, are listed below:

A. Heating of Organs* (Applications: Diathermy, Electrosurgery, Electrocoagulation, Electrodesiccation, Electrotomy)

This includes heating of the whole body or part of the body like the skin, bone and bone marrow, lens of the eye with cataracts and damage to the cornea; genitalia causing tubular degeneration of testicles; brains and sinuses; metal implants causing burns near hip pins etc. These effects are reversible except for damage to the eye.

B. Changes in Physiologic Function

This includes contraction of striated muscles; altered diameter of blood vessels (increased vascular elasticity), dilation; changes in oxidative processes in tissues and organs; liver enlargement; altered sensitivity to drugs; decreased spermatogenesis leading to decreased fertility and to sterility; altered sex ratio of births in favor of girls; altered menstrual activity; altered fetal development; decreased lactation in nursing mothers; reduction in diuresis resulting in sodium excretion via urine output; altered renal function; changes in conditioned reflexes; decreased electrical resistance of skin; changes in the structure of skin receptors; altered rate of blood flow; altered biocurrents in cerebral cortex in animals; changes in the rate of clearance of tagged ions from tissues; reversible structural changes in the cerebral cortex and diencephalon; changes in electrocardiographs; altered sensitivity to light, sound, and olfactory stimuli; functional and pathological changes in the eyes; myocardial necrosis; hemorrhage in lungs, liver, gut and brain and generalized degeneration of body tissue at fatal levels of radiation; loss of anatomical parts; death; dehydration; altered rate of tissue calcification.

C. Central Nervous System Effects

This includes headaches; insomnia; restlessness (daytime and during sleep); changes in brain wave activity (EEG); cranial nerve disorders; pyramidal tract lesions; disorders of conditioned reflexes; vagomimetic and sympathomimetic action of the heart; seizure and convulsions.

D. Autonomic Nervous System Effects

Altered heart rhythm; fatigue, structural alterations in synapses of the vagus nerve; stimulation of the parasympathetic nervous system leading to Bradycardia and inhibition of the sympathetic nervous system.

E. Peripheral Nervous System Effects

Effects on locomotor nerves.

F. Psychological Disorders

Symptoms include neurasthenia (general bad feeling); depression; impotence; anxiety; lack of concentration; hypochondria; dizziness; hallucinations; sleepiness or insomnia; irritability; decreased appetite; loss of memory; scalp sensations; fatigue; chest pain, tremors.

G. Behavioral Changes in Animals Studies

Effects include changes in reflexive, operant, avoidance and discrimination behaviors.

H. Blood Disorders

Effects include changes in blood and bone marrow; increased phagocytic and bactericidal functions; increased rate of hemolysis (shorter lifespan of cells); increased blood sedimentation rate; decreased erythrocytes; increased blood glucose concentrations; altered blood histamine content; changes in lipids and cholesterol; changes in Gamma Globulin and total protein concentration; changes in number of eosinophils; decrease in albumin/globulin ratio; altered hemopoiesis (rate of blood corpuscles formation); leukopenia (increased number of white blood cells and leukocytosis; reticulocytosis (increase in immature red blood cells).

I. Vascular Disorders

This includes thrombosis and hypertension.

J. Enzyme and Other Biochemical Changes (in vitro)

Changes in the activity of cholinesterase (also in vivo); phosphatase; transaminase; amylase, carboxydismutase; denaturation of proteins; inactivation of fungi, viruses, and bacteria; killed tissue cultures; altered rate of cell division; increased concentration of RNA in lymphocytes and decreased concentration of RNA in brain, liver and spleen; changes in pyruvic acid, lactic acid and creatinine excretions; changes in concentration of glycogen in liver (hyperglycemia); altered concentrations of 17-ketosteroids in urine.

K. Metabolic Disorders

Effects include glycosuria (sugar in urine); increase in urinary phenols; altered processing of metabolic enzymes; altered carbohydrate metabolism.

L. Gastro-Intestinal Disorders

Effects include anorexia; epigastric pain; constipation; altered secretion of stomach digestive juices.

M. Endocrine Gland Changes

Effects include altered functioning of pituitary gland, thyroid gland (hyper-thyroidism and enlarged thyroid, increased uptake of radioactive iodine), and adrenal cortex; decreased corticosteroids in blood; decreased glucocorticoidal activity; hypogonadism (with decreased production of testosterone).

N. Histological Changes

Changes in tubular epithelium of testicles and gross changes.

O. Genetic and Chromosomal Changes

Effects include chromosomal aberrations (shortening, pseudochiasm, diploid structures, amitotic divisions, bridging, "stickiness"; irregularities in chromosomal envelope); mutations; mongolism; somatic alterations (not involving nucleus or chromosomes); neoplastic diseases (tumors).

P. Pearl Chain Effect

This refers to intracellular orientation of subcellular particles and orientation of cellular and other (non-biologic particles, i.e. mini magnetics) affecting orientation of animals, birds, and fish in electromagnetic fields.

Q. Miscellaneous Effects

These include sparking between dental fillings; metallic taste in mouth; changes in optical activity of colloidal solutions; treatment for syphilis, poliomyelitis, skin diseases; loss and brittleness of hair; sensations of buzzing, vibrations, pulsations, and tickling about head and ears; copious perspiration, salivation, and protrusion of tongue; changes in the operation of implanted cardiac pacemakers; changes in circadian rhythms.

3.4 QUOTE: *There is also no clear evidence of effects on heart rate or blood pressure.*

This statement is incorrect. There is considerable evidence that RFR affects the cardiovascular and the autonomic nervous system. See Havas, M. 2013. Radiation from wireless technology affects the blood, the heart, and the autonomic nervous system, Rev Environ Health 28(2-3): 75–84. <https://www.ncbi.nlm.nih.gov/pubmed/24192494>

Below is one image from the above-mentioned publication showing that exposure to a cordless phone and a wired computer causes rouleau formation of the blood. Consequently rouleau formation can be used as one diagnostic to identify those people who have EHS. See video: <https://www.youtube.com/watch?v=0KGD4dDILkg>. When blood cells stick together they are unable to deliver sufficient oxygen to cells and are unable to remove waste products that can build up and cause a variety of symptoms. In severe cases they can lead to stroke and heart failure if the blood blocks blood vessels that carry oxygen to the brain and heart.

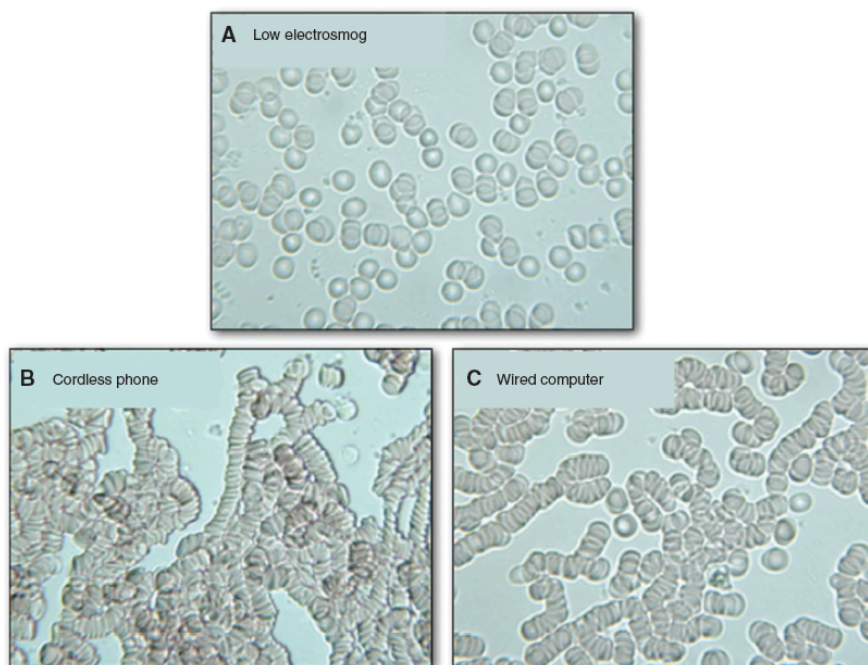


Figure 4 Live blood cells in a low-electrosmog environment (A), after using a cordless phone for 10 min (B), and after using a wired computer for 70 min (C).

Once again, this information about radiofrequency radiation affecting the heart has been available since at least the mid 1960s. See also **Cleary 1969** *Biological Effects and Health Implications of Microwave Radiation*. Available at this link: <http://www.magdahavas.com/pick-of-the-week-22-a-very-important-symposium/>

Here is a direct quote from this symposium (page 94):

In the interest of occupational hygiene, many ... investigators ... have recommended that cardiovascular abnormalities be used as screening criteria to exclude people from occupations involving radio-frequency exposures.

A growing number of students are complaining of headaches, heart palpitations, dizziness, nausea, difficulty concentrating as more schools replace wired Internet connections with Wi-Fi routers. Perhaps students and their teachers who are complaining of heart palpitation should be screened for cardiovascular abnormalities at the beginning of the school year to determine if they can tolerate the microwave radiation generated by Wi-Fi routers and nearly cell phone base stations. Certain cardiovascular abnormalities that often go undetected include Wolff–Parkinson–White syndrome, supraventricular tachycardia (SVT) and long QT syndrome, which can be fatal.

3.5 Final thoughts ...

I trust that the information I provided in this report will have some bearing on the discussion related to the NTP Report.

Our exposure to microwave radiation cannot continue to escalate; yet this is exactly where we are heading with 5G and the IoT. People are becoming ill with symptoms of EHS, are having difficulty reproducing and are dying of cancer. Students in schools with Wi-Fi are going home with headaches and experiencing heart palpations. Schools are installing defibrillators

We cannot continue to ignore this trend. Scientists doing research in this area have presented a number of appeals and resolutions to have guidelines changed to make them more protective. As of 2000 have been more than 20 such appeals/resolutions See:

<http://www.magdahavas.com/international-experts-perspective-on-the-health-effects-of-electromagnetic-fields-emf-and-electromagnetic-radiation-emr/>


One such group is the International EMF Scientists (emfscientist.org) who submitted an appeal to the WHO and the UN in 2015. I reproduce that appeal below. It has been signed by 236 EMF scientists from 41 countries.

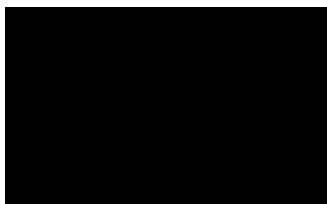
Collectively we also request that:

1. children and pregnant women be protected;
2. guidelines and regulatory standards be strengthened;
3. manufacturers be encouraged to develop safer technology;

4. utilities responsible for the generation, transmission, distribution, and monitoring of electricity maintain adequate power quality and ensure proper electrical wiring to minimize harmful ground current;
5. the public be fully informed about the potential health risks from electromagnetic energy and taught harm reduction strategies;
6. medical professionals be educated about the biological effects of electromagnetic energy and be provided training on treatment of patients with electromagnetic sensitivity;
7. governments fund training and research on electromagnetic fields and health that is independent of industry and mandate industry cooperation with researchers;
8. media disclose experts' financial relationships with industry when citing their opinions regarding health and safety aspects of EMF-emitting technologies; and
9. white-zones (radiation-free areas) be established.

Please do not allow politics and greed to get in the way of science and policy. We need standards that are truly protecting health of people and the health of the environment. We cannot continue to allow children to be exposed to this radiation in their home, in schools, and on city streets. The technology can be made much safer than it is at present with fibre optics and wired connections and that includes “smart meters” and “smart appliances.” We need to educate pregnant women and men wanting to have families on how to minimize their exposure to RFR. We cannot continue like we did with asbestos and tobacco and ignore the scientific evidence for decades. Anyone who is intimately familiar with the research cannot honestly make the statement that this radiation is safe at current levels. With 5G, those levels are going to increase. It is the responsibility of those men and women in the NTP and at NIEHS to speak out and to make their voices heard. We owe that to ourselves and to future generations.

Respectfully submitted,
March 12, 2018, before 0200, eastern time, via email to: 



Magda Havas, BSc, PhD