

1 December 2016

Ms Deborah Schulte, M.P.
Chair, Standing Committee on Environment and Sustainable Development
House of Commons
Ottawa, ON K1A 0A6
By Email: ENVI@parl.gc.ca

Re: Canadian Environmental Protection Act (CEPA) Review

Dear Ms Schulte,

On behalf of Canadians for Safe Technology (C4ST), I am submitting our brief in response to the Standing Committee on Environment and Sustainable Development seeking input from stakeholders for its review of the Canadian Environmental Protection Act, 1999 (CEPA).

We recommend that the committee:

- 1) establish a new category for anthropogenic electromagnetic non-ionizing radiation (NIR) as an agent that can have toxic effects on human health and the environment OR expand its definition of "substance" to include electromagnetic fields (EMFs) in the non-ionizing electromagnetic radiation range. This will help to address the major gap of the absence of protection of non-human organisms and inadequate protection of humans to NIR exposures. Currently Health Canada's Safety Code 6 (Health Canada, 2015) is the only guideline for human protection from unsafe radiofrequency/microwave exposures; the only established effect recognized at frequencies used for telecommunications is thermal (heating) effects. As outlined in our brief, NIR can act as an agent causing adverse effects on animate organisms at ambient levels in non-thermal ways;
- 2) include provisions to include assessments of NIR as an agent that can have synergistic effects on substances.

Our submission outlines some of the science supporting the points stated above and includes a link to a 2014 letter from a director in the US Department of the Interior to another US department detailing some of our same concerns about wildlife and exposure to NIR.

Thank you for your consideration of this important issue. I would be pleased to respond to any questions.

Sincerely,



Frank Clegg

C4ST is a national, not-for-profit, volunteer-based coalition of citizens, including parents and experts. Our mission is to educate and inform Canadians and policy makers about the dangers of exposure to unsafe levels of radiation from technology; and to work with all levels of government to create healthier communities, particularly for children and families.

Canadians for Safe Technology (C4ST) brief to the Standing Committee on Environment and Sustainable Development regarding input from stakeholders for its review of the Canadian Environmental Protection Act, 1999 (CEPA)

- 1 December 2016-

Living organisms are electrochemical beings. Communications between living cells consist of electrical and chemical signals. There is increasing evidence that anthropogenic electromagnetic fields (EMFs), in the frequencies found at levels occurring in some everyday living situations, are interfering with these electrochemical communications vital to good health.

There are two ranges in the non-ionizing radiation (NIR) category in the electromagnetic spectrum generally recognized as being of concern as they are rapidly increasing with modern technologies. Both extremely low frequencies (ELF - background to 3 kHz) and radiofrequency/microwave radiation (RF/MW - 3 kHz to 300 GHz) have been shown to affect living organisms at very low levels of exposure to NIR.

Health Canada's Safety Code 6 guidelines, which set safety limits in the radiofrequency/microwave range, apply only to humans. It is the position of C4ST that these guidelines do not adequately protect human health. One of the major flaws of Safety Code 6 is that Health Canada recognizes only thermal (heating) effects to be harmful and dismisses the enormous body of literature (some cited below) demonstrating non-thermal effects at below Safety Code 6 (2015) limits e.g. oxidative stress and DNA damage. We are not aware of any Canadian guidelines or standards for non-human life forms.

Below we outline only some of the reasons, with supporting evidence, why NIR should be included in the revised CEP Act - either in an expanded definition of "substance" or in a separate category.

C4ST recommendation:

1) establish a new category for electromagnetic non-ionizing radiation (NIR) as an agent that can have toxic effects on human health and the environment OR expand its definition of "substance" to include electromagnetic fields (EMFs) in the non-ionizing electromagnetic radiation range.

To provide substantiation for inclusion of non-ionizing radiation in the Act, we have responded to three definitions:

- [1] air pollution (Section 3),
- [2] substances (Section 3) and
- [3] toxic substances (Section 64).

Canadian Environmental Protection Act, 1999

The preamble to the CEP Act states it is "***An Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development.***"

Interpretation

Section 3. Definitions

[1] ***air pollution means a condition of the air, arising wholly or partly from the presence in the air of any substance, that directly or indirectly***

C4ST: Electromagnetic fields (EMFs) are pervasive in our air. Sources of EMFs in our air space include both extremely low frequencies (ELF) and radiofrequency/microwave (RF/MW) radiation. ELF includes emissions from high power lines and household electricity. RF/MW radiation includes higher frequencies commonly used for wireless communications e.g. cell tower antennae, broadcast towers for radio signals, satellite communications transmissions, radar, smart meters, cell phones, Wi-Fi routers, etc. Although present for many decades, the sources of NIR emissions are increasing immensely. Dr. Olle Johansson of the Karolinska Institute in Sweden estimates levels are now millions of times above historical background levels.

(a) endangers the health, safety or welfare of humans;

C4ST: Applies to electromagnetic fields:

Adverse health effects have been documented extensively in the peer-reviewed scientific literature - at population, individual, cell and molecular levels.

For example:

- The World Health Organization, International Agency for Research on Cancer classified wireless radiofrequency/microwave radiation as a class 2B carcinogen in 2011 (Baan et al., 2011).

- The same classification was given to magnetic fields in 2001/2002 (recently reaffirmed)(WHO/IARC, 2001). There has been a consistent statistically significant association between high power tension lines and childhood leukemia (Ahlbom et al., 2001).

- The Academy of Environmental Medicine, in a position statement, outlines many of the documented health effects on humans from non-thermal RF/MW radiation.

"Genotoxic effects from RF exposure, including studies of non-thermal levels of exposure, consistently and specifically show chromosomal instability, altered gene expression, gene mutations, DNA fragmentation and DNA structural breaks.⁴⁻¹¹ A statistically significant dose response effect was demonstrated by Maschevich et al. , who reported a linear increase in aneuploidy as a function of the Specific Absorption Rate(SAR) of RF exposure.¹¹ Genotoxic effects are documented to occur in neurons, blood lymphocytes, sperm, red blood cells, epithelial cells, hematopoietic tissue, lung cells and bone marrow. Adverse developmental effects due to non-thermal RF exposure have been shown with decreased litter size in mice from RF exposure well below safety standards.¹² The World Health Organization has classified RF emissions as a group 2 B carcinogen.¹³ Cellular telephone use in rural areas was also shown to be associated with an increased risk for malignant brain tumors.¹⁴

The fact that RF exposure causes neurological damage has been documented repeatedly. Increased blood-brain barrier permeability and oxidative damage, which are associated with brain cancer and neurodegenerative diseases, have been found.^{4,7,15-17} Nittby et al. demonstrated a statistically significant dose-response effect between non-thermal RF exposure and occurrence of albumin leak across the blood-

brain barrier.¹⁵ Changes associated with degenerative neurological diseases such as Alzheimer's, Parkinson's and Amyotrophic Lateral Sclerosis (ALS) have been reported.^{4,10} Other neurological and cognitive disorders such as headaches, dizziness, tremors, decreased memory and attention, autonomic nervous system dysfunction, decreased reaction times, sleep disturbances and visual disruption have been reported to be statistically significant in multiple epidemiological studies with RF exposure occurring non-locally.¹⁸⁻²¹

Nephrotoxic effects from RF exposure also have been reported. A dose response effect was observed by Ingle and Ghosh in which RF exposure resulted in mild to extensive degenerative changes in chick embryo kidneys based on duration of RF exposure.²⁴ RF emissions have also been shown to cause isomeric changes in amino acids that can result in nephrotoxicity as well as hepatotoxicity".²⁵

The complete paper and the numbered citations can be found at:

https://www.aeonline.org/emf_rf_position.php

Of importance to note is that Health Canada's Safety Code 6, which sets limits for safe human exposure, recognizes only thermal (heating) as an "established" adverse effect of telecommunications frequencies. Although Health Canada says it considers all of the effects, a full rationale has not been provided on how it dismisses extensive evidence of non-thermal effects at below Safety Code 6 limits.

(b) interferes with the normal enjoyment of life or property;

C4ST: Applies to electromagnetic fields. C4ST is contacted frequently by individuals who are adversely affected by electromagnetic fields in their regular living environment.

-In addition to the information above, Dr. Riina Bray, Dr. Magda Havas and Mr. Frank Clegg in their testimony to the Standing Committee on Health in 2015 describe the situation where many Canadians have had their lives disrupted by exposure to EMFs at everyday levels.

<http://www.parl.gc.ca/Committees/en/HESA/StudyActivity?studyActivityId=8597445>

- Some Canadians gave testimonials of severe adverse effects to wireless radiation that affected their everyday quality of life:

1. Royal Society of Canada public consultation October 28th, 2013 and
- 2 Health Canada, July 9th, 2014, (contact Frank Clegg for details).

- Canadian Human Rights Commission has a policy established in 2007 on accommodation of environmental sensitivities, including symptoms related to low levels of electromagnetic radiation related to technologies.

http://www.chrc-ccdp.gc.ca/sites/default/files/policy_sensitivity_0.pdf

http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf

-Sweden recognizes electrosensitivity as a functional impairment (Johansson, 2015).

- Spain has legally recognized electrosensitivity

<https://beingelectrosensitive.blogspot.ca/2016/08/spain-ehs-legally-recognised.html>

- Dr. Gro Harlem Brundtland former Prime Minister of Norway, former director of the World Health Organization and lead author of the Brundtland Report, *Our Common Future*, which spearheaded the sustainable development movement, is among those who report symptoms e.g. headaches, from cell phone use.

<http://www.magdahavas.com/gro-harlem-brundtland-talks-at-the-university-of-waterloo/>

Dr. Dominique Belpomme of France is one of several medical professionals who have documented biomarkers in humans for electrosensitivity.

Belpomme, D., et al. (2015). Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder. *Reviews on Environmental Health*, 30(4), 251–271

EXTRACT: "Much of the controversy over the causes of electro-hypersensitivity (EHS) ... lies in the absence of both recognized clinical criteria and objective biomarkers for widely accepted diagnosis... Our data strongly suggest that EHS ... can be objectively characterized and routinely diagnosed by commercially available simple tests... involve inflammation-related hyper-histaminemia, oxidative stress, autoimmune response, capsulothalamic hypoperfusion and BBB [blood-brain-barrier] opening, and a deficit in melatonin metabolic availability; suggesting a risk of chronic neurodegenerative disease..."

(c) endangers the health of animal life;

C4ST: The adverse effects on animal life by electromagnetic fields are well documented in the published scientific peer-reviewed literature.

A particularly rigorous, well designed study by Dr. Engels' team in Germany, demonstrated that the orientation of the European robin was disrupted by ambient AM radiofrequency signals at non-thermal conditions.

Engels, S., Schneider, N.-L., Lefeldt, N., Hein, C. M., Zapka, M., Michalik, A., ... Mouritsen, H.. (2014). Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird. *Nature*, 509(7500), 353–356.

Extract: "...we show that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise... These fully double-blinded tests document a reproducible effect of anthropogenic electromagnetic noise on the behaviour of an intact vertebrate."

Concerns, particularly with regard to migratory birds, are outlined by Mr. Willie Taylor, Director, Office of Environmental Policy and Compliance, United States Department of Interior to Mr. Eli Veenendaal of the US Department of Commerce.

https://www.ntia.doc.gov/files/ntia/us_doi_comments.pdf

https://doi_dev.opengov.ibmcloud.com/oepc/director-office/taylor

Biological effects for ELF - EMFs has been well documented in domestic animals. For example, cows can have severe adverse reactions when grounding of electrical current is done incorrectly (Hillman et al., 2013).

(d) causes damage to plant life or to property; or

C4ST: Damage to plant life by electromagnetic fields is well documented in the published scientific peer-reviewed literature.

For example:

- **Waldmann-Selsam, C., Balmori-de la Puente, A., Breunig, H., & Balmori, A. (2016). Radiofrequency radiation injures trees around mobile phone base stations. *The Science of the Total Environment*, 572, 554–569**

Extract: "The measurements of all trees revealed significant differences between the damaged side facing

a phone mast and the opposite side, as well as differences between the exposed side of damaged trees and all other groups of trees in both sides... These results are consistent with the fact that damage afflicted on trees by mobile phone towers usually start on one side, extending to the whole tree over time."

Also see the review by Halgamuge, 2016.

(e) degrades or alters, or forms part of a process of degradation or alteration of, an ecosystem to an extent that is detrimental to its use by humans, animals or plants.

C4ST: Damage to humans, animals and plants by electromagnetic fields is well documented in the published scientific peer-reviewed literature. One of many examples is that of bees. Declining numbers of pollinators alone are having large impacts on some ecosystems. Effects on some pollinators, supported by similar findings in other insects, indicate that EMFs may be a contributing factor in the decline in abundance.

1. Favre, D.. (2011). Mobile phone-induced honeybee worker piping. *Apidologie*, 42(3), 270–279.

Extract: "The audiograms and spectrograms revealed that active mobile phone handsets have a dramatic impact on the behavior of the bees, namely by inducing the worker piping signal."

2. Harst, W., Kuhn, J., & Stever, H.. (2006). Can electromagnetic exposure cause a change in behaviour? Studying possible non-thermal influences on honeybees. An approach within the framework of educational informatics.. *ACTA SYSTEMATICA - International Journal*, vi(1), 1–6.

Extract: "... honey bees are suitable biomarkers to serve as a model of a living being to study learning processes in this aspect [non-thermal high-frequency electromagnetic fields] ... "

3. Kimmel, S., Kuhn, J., Harst, W., & Stever, H.. (2007a). Electromagnetic radiation: influences on honeybees (*Apis mellifera*). In *Preprint (IIAS-InterSymp Conference, Baden-Baden 2007)* http://agbi.uni-landau.de/material_download/preprint_IAAS_2007.pdf. Retrieved from http://www.hese-project.org/hese-uk/en/papers/kimmel_iaas_2007.pdf

Extract: "The presented data set of [partially significant results] is based on earlier studies in 2005, which showed significant differences in returning, 39.7% of the non-irradiated bees came back compared to 7.3% of the irradiated ones. Standard commercial DECT phones were used as exposition source."

4. Kumar, N. R., Sangwan, S., & Badotra, P.. (2011). Exposure to cell phone radiations produces biochemical changes in worker honey bees. *Toxicology International*, 18(1), 70–72.

Extract: "There was reduced motor activity of the worker bees on the comb initially, followed by en masse migration and movement toward 'talk mode' cell phone. The initial quiet period was characterized by rise in concentration of biomolecules including proteins, carbohydrates and lipids..."

5. Sharma, V. P., & Kumar, N. R.. (2010). Changes in honeybee behaviour and biology under the influence of cellphone radiations. *Current Science(Bangalore)*, 98(10), 1376–1378.

Extract: "A significant ($p < 0.05$) decline in colony strength and in the egg laying rate of the queen was observed. The behaviour of exposed foragers was negatively influenced by the exposure, there was neither honey nor pollen in the colony at the end of the experiment."

Some examples of studies in other insect species that support the findings of adverse biological effects reported in bees:

1. Atli, E., & Unlü, H.. (2006). The effects of microwave frequency electromagnetic fields on the development of *Drosophila melanogaster*. *International Journal of Radiation Biology*, 82(6), 435–441.

Extract: "...10 GHz EMF can cause developmental delay and decrease the number of offspring in *D. melanogaster*. "

2. Cammaerts, M.-C., De Doncker, P., Patris, X., Bellens, F., Rachidi, Z., & Cammaerts, D. (2012). GSM 900 MHz radiation inhibits ants' association between food sites and encountered cues. *Electromagnetic Biology and Medicine*, 31(2), 151–165.

Extract: "...They kept no visual memory at all (instead of keeping 10% of it as they normally do). The impact of GSM 900 MHz radiation was greater on the visual memory than on the olfactory one. These communication waves may have such a disastrous impact on a wide range of insects using olfactory and/or visual memory, i.e., on bees."

3. Cammaerts, M.-C., & Johansson, O.. (2013). Ants can be used as bio-indicators to reveal biological effects of electromagnetic waves from some wireless apparatus. *Electromagnetic Biology and Medicine*, 1–7.

Extract: "...we designed and validated a fast and easy test on ants – these insects being used as a biological model – for revealing the effect of wireless equipments like mobile phones, smartphones, digital enhanced cordless telephone (DECT) phones, WiFi routers and so on. This test includes quantification of ants' locomotion under natural conditions, then in the vicinity of such wireless equipments. Observations, numerical results and statistical results allow detecting any effect of a radiating source on these living organisms."

4. Cammaerts, M.-C., Rachidi, Z., Bellens, F., & De Doncker, P.. (2013). Food collection and response to pheromones in an ant species exposed to electromagnetic radiation. *Electromagnetic Biology and Medicine*, 32(3), 315–332.

Extract: "...[Exposed] ants followed trails for only short distances, no longer arrived at marked areas and no longer orientated themselves to a source of alarm pheromone. Also when exposed to electromagnetic waves, ants became unable to return to their nest and recruit congeners; therefore, the number of ants collecting food increases only slightly and slowly. After 180 h of exposure, their colonies deteriorated. Electromagnetic radiation obviously affects social insects' behavior and physiology."

5. Margaritis, L. H., Manta, A. K., Kokkaliaris, K. D., Kokkaliaris, C. D., Schiza, D., Alimisis, K., ... Ziomas, K.. (2013). *Drosophila* oogenesis as a bio-marker responding to EMF sources. *Electromagnetic Biology and Medicine*.

Extract: "A total of 280 different experiments were performed... All EMF sources used created statistically significant effects regarding fecundity and cell death-apoptosis induction, even at very low intensity levels (0.3 V/m blue tooth radiation), well below ICNIRP's guidelines, suggesting that *Drosophila* oogenesis system is suitable to be used as a biomarker for exploring potential EMF bioactivity."

6. Panagopoulos, D. J.. (2012). Effect of microwave exposure on the ovarian development of *Drosophila melanogaster*. *Cell Biochemistry and Biophysics*, 63(2), 121–132.

Extract: "The study showed that the ovarian size of the exposed insects is significantly smaller than that of the corresponding sham-exposed insects, due to destruction of egg chambers by the GSM radiation, after DNA damage and consequent cell death induction in the egg chamber cells of the virgin females as shown in previous experiments on inseminated females."

[2] substance means any distinguishable kind of organic or inorganic matter, whether animate or inanimate, and includes
(a) any matter that is capable of being dispersed in the environment or of being transformed in the environment into matter that is capable of being so dispersed or that is capable of causing such transformations in the environment,

C4ST: Electromagnetic fields (EMFs) are a form of energy that can adversely affect matter. Some of the issues are covered in Havas (2016). The influence of EMFs on chemical reactions is well documented in the long-time journal, *Microwave Chemistry*. This journal, well known to chemical engineers, documents the application of low level, non-thermal levels of microwave radiation to accelerate chemical reactions on a commercial scale.

(b) any element or free radical,

C4ST: Formation of free radicals is well documented for RF/MW radiation at below standards. See review by (Yakymenko et al., 2016)

(c) any combination of elements of a particular molecular identity that occurs in nature or as a result of a chemical reaction, and

C4ST: DNA damage, likely due to oxidative stress and the production of free radicals, has been documented in over 70 studies (see review by (Yakymenko et al., 2016)). Also see (Belpomme et al., 2007).

Also: **Blank, M., & Goodman, R. (2009). Electromagnetic fields stress living cells. *Pathophysiology: The Official Journal of the International Society for Pathophysiology / ISP*, 16(2–3), 71–78.**

Extract: "Electromagnetic fields (EMF), in both ELF (extremely low frequency) and radio frequency (RF) ranges, activate the cellular stress response, a protective mechanism that induces the expression of stress response genes, e.g., HSP70, and increased levels of stress proteins, e.g., hsp70...While low energy EMF interacts with DNA to induce the stress response, increasing EMF energy in the RF range can lead to breaks in DNA strands. It is clear that in order to protect living cells, EMF safety limits must be changed from the current thermal standard, based on energy, to one based on biological responses that occur long before the threshold for thermal changes."

DNA breakage in brain cells under non-thermal conditions, and below Safety Code 6 limits, has also been reported in the \$25 million dollar rat/cell phone radiation study conducted by the National Toxicology Program, National Institute of Environmental Sciences (Wyde, 2016).

(d) complex combinations of different molecules that originate in nature or are the result of chemical reactions but that could not practicably be formed by simply combining individual constituents,

C4ST: Synergistic effects of electromagnetic fields (EMFs) and substances is covered under C4ST recommendation 2) below.

PART 5. Controlling Toxic Substances.

[3] Toxic Substances

64 For the purposes of this Part or Part 6, except where the expression "inherently toxic" appears, a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that

(a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity

C4ST: One example: impact on migratory birds which could have their orienting abilities impaired by emissions from telecommunications antennas/towers. See [1]c) above.

(b) constitute or may constitute a danger to the environment on which life depends

C4ST: DNA damage could have multi-generation effects. See review by (Adams, et al 2014).

(c) constitute or may constitute a danger in Canada to human life or health

C4ST: Taking all of the factors described above into consideration - demonstrated effects on humans, domestic animals, wildlife and vegetation - NIR may have far reaching implications for human life and health.

C4ST recommendation:

2) include in the revision of the CEP Act provisions to include assessments of NIR as an agent that can have synergistic effects on substances.

The following studies with short extracts from the abstracts provide evidence that effects of substances can be altered by exposures to EMFs.

- 1. Anghileri, L., Mayayo, E., & Domingo, J. (2006). Iron-Radiofrequency Synergism in Lymphomagenesis. *Immunopharmacology and Immunotoxicology*, 28(1), 175–183.**
Extract: "...The current results (mortality, clinical and histopathological examinations) demonstrated a synergism between radiofrequency and ferric gluconate..."
- 2. Anghileri, L., Mayayo, E., & Domingo, J. (2009). Aluminum, calcium ion and radiofrequency synergism in acceleration of lymphomagenesis. *Immunopharmacology and Immunotoxicology*, 31(3), 358–362**
Extract: "This study that was done on lymphomagenic-bearing mice indicates a synergism aluminum-radiofrequency which induces an early increase in mortality that is in concomitance with lymphoid elements proliferation and infiltration of spleen and liver..."
- 3. Boderá, P., Stankiewicz, W., Antkowiak, B., Paluch, M., Kieliszek, J., Sobiech, J., ... Skopińska-Rózewska, E. (2012). Suppressive effect of electromagnetic field on analgesic activity of tramadol in rats. *Polish Journal of Veterinary Sciences*, 15(1), 95–100**
Extract: "The electromagnetic fields (EMFs) have been shown to alter animal and human behavior, such as directional orientation, learning, pain perception (nociception or analgesia) and anxiety-related behaviors..EMF exposure of both frequencies transiently suppressed analgesic effect of tramadol, significantly reducing paw withdrawal latency in animals treated with this drug ..."
- 4. Byun, Y.-H., Ha, M., Kwon, H.-J., Hong, Y.-C., Leem, J.-H., Sakong, J., ... Kim, N. (2013). Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: a longitudinal study. *PLoS One*, 8(3), e59742**
Extract: "...The results suggest that simultaneous exposure to lead and RF [radio frequency] from mobile phone use was associated with increased ADHD [Attention Deficit Hyperactivity Disorder] symptom risk..."
- 5. Cervellati, F., Valacchi, G., Lunghi, L., Fabbri, E., Valbonesi, P., Marci, R., ... Vesce, F. (2013). 17- β -estradiol counteracts the effects of high frequency electromagnetic fields on trophoblastic connexins and integrins. *Oxidative Medicine and Cellular Longevity*, 2013, 280850 doi:10.1155/2013/280850**
Extract: "... We demonstrate that 17- β -estradiol modulates Cxs [connexins] and Ints [integrins] as well as ER [estrogen receptor] - β expression induced by HF-EMF [high-frequency electromagnetic fields], suggesting an influence of both stimuli on trophoblast differentiation and migration..."
- 6. Céspedes, O., Inomoto, O., Kai, S., Nibu, Y., Yamaguchi, T., Sakamoto, N., ... Ueno, S. (2010). Radio frequency magnetic field effects on molecular dynamics and iron uptake in cage proteins. *Bioelectromagnetics*, 31(4), 311–317 doi:10.1002/bem.20564**
Extract: "Superparamagnetic nanoparticles increase their internal energy when exposed to radio frequency magnetic fields due to the lag between magnetization and applied field ... the proteins have a reduced iron intake rate of about 20%. Our results open a new path for the study of non-thermal bioeffects of radio frequency magnetic fields at the molecular scale."
- 7. Kostoff, R. N., & Lau, C. G. Y. (2013). Combined biological and health effects of electromagnetic fields and other agents in the published literature. *Technological Forecasting & Social Change*, 80(7), 1331–1349**
Extract: "Electromagnetic field (EMF) radiation exerts both stand-alone and combined effects on biological systems. The present study examines the scope of the combined effects; i.e., identify effects on biological systems from combined exposure to electromagnetic fields/radiation and at least one other agent... The number of potential environmental agent combinations is large, and each combination could

potentially have beneficial or adverse effects; much work remains to be done before definitive statements about EMF safety can be made.”

8. López-Martín, E., Relova-Quintero, J. L., Gallego-Gómez, R., Peleteiro-Fernández, M., Jorge-Barreiro, F. J., & Ares-Pena, F. J. (2006). GSM radiation triggers seizures and increases cerebral c-Fos positivity in rats pretreated with subconvulsive doses of picrotoxin. *Neuroscience Letters*, 398(1–2), 139–144.

Extract: "... We conclude that GSM-type radiation can induce seizures in rats following their facilitation by subconvulsive doses of picrotoxin, and that research should be pursued into the possibility that this kind of radiation may similarly affect brain function in human subjects with epileptic disorders.”

9. Maaroufi, K., Save, E., Poucet, B., Sakly, M., Abdelmelek, H., & Had-Aissouni, L. (2011). Oxidative stress and prevention of the adaptive response to chronic iron overload in the brain of young adult rats exposed to a 150 kilohertz electromagnetic field. *Neuroscience*, 186, 39–47

Extract: "... When EMF was coapplied with IO [iron overload], lipid peroxidation was further increased as compared to EMF alone while the increase in antioxidant defenses triggered by the sole IO was abolished. These data suggest that EMF exposure may be harmful in young adults by impairing the antioxidant defenses directed at preventing iron-induced oxidative stress.”

References other than those listed in the text (above):

1. Adams, J. A., Galloway, T. S., Mondal, D., Esteves, S. C., & Mathews, F. (2014). Effect of mobile telephones on sperm quality: a systematic review and meta-analysis. *Environment International*, 70, 106–112. doi:10.1016/j.envint.2014.04.015
2. Ahlbom, I. C., Cardis, E., Green, A., Linet, M., Savitz, D., Swerdlow, A., & ICNIRP (International Commission for Non-Ionizing Radiation Protection) Standing Committee on Epidemiology. (2001). Review of the epidemiologic literature on EMF and Health. *Environmental Health Perspectives*, 109 Suppl 6, 911–933.
3. Baan, R., Grosse, Y., Lauby-Secretan, B., El Ghissassi, F., Bouvard, V., Benbrahim-Tallaa, L., ... WHO International Agency for Research on Cancer Monograph Working Group. (2011). Carcinogenicity of radiofrequency electromagnetic fields. *Lancet Oncology*, 12(7), 624–626. doi:10.1016/S1470-2045(11)70147-4
4. Belpomme, D., Irigaray, P., Hardell, L., Clapp, R., Montagnier, L., Epstein, S., & Sasco, A. J. (2007). The multitude and diversity of environmental carcinogens. *Environmental Research*, 105(3), 414–429. doi:10.1016/j.envres.2007.07.002
5. Halgamuge, M. N. (2016). Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants. *ResearchGate*, 1–23. doi:10.1080/15368378.2016.1220389
6. Havas, M. (2016). When theory and observation collide: Can non-ionizing radiation cause cancer? *Environmental Pollution (Barking, Essex: 1987)*. doi:10.1016/j.envpol.2016.10.018
7. Health Canada, H. C. (2015). Limits of human exposure to radiofrequency electromagnetic energy in the frequency range from 3 KHz to 300 GHz. Safety Code 6 (2015), 24. Retrieved from http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/consult/_2014/safety_code_6-code_securite_6/final-finale-eng.pdf
8. Hillman, D., Stetzer, D., Graham, M., Goeke, C. L., Mathson, K. E., Vanhorn, H. H., & Wilcox, C. J. (2013). Relationship of electric power quality to milk production of dairy herds - field study with literature review. *The Science of the Total Environment*, 447, 500–514. doi:10.1016/j.scitotenv.2012.12.089
9. Johansson, O. (2015). Electrohypersensitivity: a functional impairment due to an inaccessible environment. *Reviews on Environmental Health*, 30(4), 311–321. doi:10.1515/reveh-2015-0018
10. WHO/IARC. (2001). Classification of extremely low frequency (ELF) as class 2B (possible carcinogen). *WHO Website*.
11. Wyde, M. (2016). NTP (National Toxicology Program) toxicology and carcinogenicity studies of cell phone radiofrequency radiation. *Presentation, Bioelectromagnetics Society (BioEM) Meeting, Ghent, Belgium*, 32. Retrieved from http://ntp.niehs.nih.gov/ntp/research/areas/cellphone/slides_bioem_wyde.pdf
12. Yakymenko, I., Tsybulin, O., Sidorik, E., Henshel, D., Kyrylenko, O., & Kyrylenko, S. (2016). Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagnetic Biology and Medicine*, 35(2), 186–202.